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POLISHING STAINLESS IRON AND STEEL

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The present invention relates generally to the art of manufacturing stainless iron and steel, and more particularly to the finishing of stainless iron and steel products such as wire, rods, plates, sheets, strip, rounds, bars and the like and the articles fabricated therefrom.

In the manufacture of stainless iron and steel products the surface is of such character that the material has a characteristic grayish appearance. Even where cold rolling or drawing to size is effected without either intermediate or final annealing a satisfactory polish is not obtained. Furthermore, where articles are fabricated from such products by further rolling, drawing or forging they still possess this grayish appearance which in some cases is not objectionable but in others is quite objectionable. This is particularly true where it has been necessary to remove the oxide scale formed during annealing operations.

The common method of removing the fire scale is to subject the material to pickling in a suitable bath. In most cases a rather rough surface results from the pickling of the material but in some cases where electrolytic pickling has been used somewhat lustrous surfaces have been obtained. However, so far as I am aware none of the known commercial pickling processes will give the material a high, mirror-like finish. In order to obtain a material or article having a polished or lustrous finish it has been necessary to resort to mechanical finishing such as grinding or buffing. Furthermore, in the fabrication of articles from such products, if any welding of parts is necessary an oxide scale will form adjacent the weld and it has been necessary heretofore to remove it by similar grinding or buffing operations. As is well-known in this art, all of such grinding and buffing operations are difficult and extremely costly, adding materially to the cost of the finished articles. Frequently in grinding or buffing articles the material is ruined due to lack of sufficient care in the carrying out of these operations and the article or material has to be scrapped.

By the present invention I overcome the objections set forth above and provide a method whereby stainless iron and steel (i. e., iron and steel having a high chromium content) may be given a high, mirror-like finish. In accordance with the present invention this can be accomplished without resort to any of the mechanical methods discussed above and at greatly reduced costs.

Pursuant to the present invention I obtain a high polish by subjecting the material to electrochemical treatment. The material is used as the anode in the treatment. The cathode may be in the form of one or more lead sheets of any suitable configuration. The electrolyte is a solution of an organic acid the stainless salts of which will permit ready flow of corrosion products away from the anode during the treatment and a soluble compound having a sulphate radical, such for example as sulphuric acid or sulphate salts.

I preferably employ a solution comprising citric acid, sulphuric acid and water. I have found that a very high polish can be obtained where the proportions of the materials in the bath are approximately 55% citric acid, 15% sulphuric acid, and 30% water, by weight. These proportions, however, may be varied within relatively wide limits, depending upon the current density employed, the temperature at which the treatment is carried out, and the time of the treatment. Other factors also influence the operating conditions and the proportioning of the ingredients of the bath such as the nature of the material being treated and the character of the original surface thereof. I have also found that the character of the heat treatment, the grain size, and the amount of cold work done on the material has some effect upon the proportioning of the ingredients and the operating conditions to be employed. In the treatment of material of the character in question, the citric acid content of the bath can be varied from approximately 10% to 90% by weight; the sulphuric acid content can be varied from approximately ¼% to 70% by weight; and, the water can be varied from approximately 5% to 50% by weight. Little or no water is necessary if the treatment is carried out at an appropriate temperature to maintain the ingredients of the bath in a fused condition but I have found that it is better to use at least a small amount of water due to the fact that appreciably lower operating temperatures can be utilized.

The current density employed can be varied over a relatively wide range. I have found that current densities of approximately ½ ampere per square inch of material being treated will give entirely satisfactory results, and that current densities as high as 40 amperes per square inch will likewise give entirely satisfactory results. The current density to be utilized in any given case will be regulated according to the desired time of treatment, the character of the bath, the temperatures employed and the nature of the material. The controlling factor with regard to the current density is that it should be sufficient to overcome the gray etching action of the electrolyte. In general, the more aqueous the solution is the higher will be the current density required for polishing. If the current density is not sufficient, regardless of the time of the treatment the desired polishing effect cannot be obtained.

The temperature employed likewise may be varied throughout a substantial range. I preferably maintain the bath at a temperature between approximately 50° C. and 125° C. The temperature should be sufficiently high to maintain the organic acid in solution. The highest temperature which may be employed will vary according to practical limitations arising out of the nature of the electrolyte used.

The time of treatment likewise may be varied over a relatively wide range. In general the time of treatment will vary according to the nature of the solution, the nature of the material, and the current density employed. For any given bath and material the time required to effect the desired polishing will vary according to the current density. When the various factors are properly correlated I have found that extremely high polishes can be obtained in a relatively short period of time varying from ½ minute to 3 minutes.

While I have stated above that I preferably employ a solution of citric acid, sulphuric acid and water as the electrolyte, I have found that any of the organic acids the stainless salts of which will permit ready flow of corrosion products away from the anode during the treatment will give satisfactory results in the bath. I have found that acetic acid, tartaric acid, formic acid, lactic acid, maleic acid, malic acid, succinic acid and glyceric acid will give good results.

While I have stated above that I prefer to use sulphuric acid in the bath, I have found that satisfactory results can be obtained where any soluble compounds containing a sulphate radical is employed.

It will be understood by those skilled in the art that the organic acid may be obtained and embodied in the bath by the addition to the bath of materials which will react under anodic oxidation to form the organic acid or a mixture of organic acids.

By way of example and not by way of limitation I shall set forth herein examples of several treatments which I have found to give excellent results:

Example 1

In treating 18-and-8 stainless steel wire for a period of one minute using a current density of 2½ amperes per square inch and a bath temperature of 100° C. good results were obtained using 2% to 60% sulphuric acid, 10% to 80% citric acid and 20% to 40% water. The citric acid used was U. S. P. powder containing 4½% water.

Example 2

Good results were obtained in the treatment of 18-and-8 stainless steel for a period of three minutes in a bath at 100° C. with a current density of 2½ amperes per square inch, the bath containing from 2% to 50% sulphuric acid, 20% to 80% citric acid, and 20% to 40% water.

Example 3

Good results were obtained by treating 18-and-8 stainless steel wire for a period of one minute in a bath at 100° C. using a current density of 10 amperes per square inch, the bath containing from 2% to 50% sulphuric acid, 20% to 70% citric acid and 30% to 40% water.

Example 4

Using the same material as in Example 3 the same range of bath ingredients, the same current density and the same temperature, good results were obtained by treating the material for a period of three minutes. However, with the sulphuric acid content between 20% and 50%, and the citric acid between 20% and 40% substantial metal losses occurred.

Example 5

Good results were obtained in the treating of 18-and-8 stainless steel wire for a period of one minute in a bath at 100° C. employing a current density of 20 amperes per square inch. The sulphuric acid content of the bath varied between 5% and 40%, the citric acid content between 20% and 60%, and the water content between 30% and 40%.

Example 6

Good results were obtained according to Example 5 where the time of treatment was increased to approximately three minutes. However, where the sulphuric acid content was more than 30% substantial metal losses occurred.

Example 7

Good results were obtained in treating 18-and 8 stainless steel wire for a period of one minute in a bath at 120° C. where the current density was ½ ampere per square inch. The bath in this instance contained from 2% to 40% sulphuric acid, 50% to 90% citric acid, and 10% to 30% water.

Example 8

By increasing the time of treatment from one minute, as set forth in Example 7, to three minutes good results were obtained.

Example 9

Good results were obtained by treating 18-and-8 stainless steel for a period of one minute in a bath at approximately 120° C. employing a current density of 2½ amperes per square inch, the bath containing from 2% to 40% sulphuric acid, 50% to 80% citric acid, and 10% to 30% water.

Example 10

Good results were also obtained where the time of treatment specified in Example 9 was increased to three minutes.

Example 11

In the treatment of 18-and-8 stainless steel for a period of one minute in a bath at from 100 to 125° C. using a current density of 10 amperes per square inch good results were obtained where the bath contained 2% to 40% sulphuric acid, 50% to 80% citric acid, and 10% to 30% water.

Example 12

Good results were obtained with conditions as set forth in Example 11 where the material was treated for a period of three minutes.

Example 13

Where acetic acid was used in the bath in place of citric acid, and where the proportions were 55% acetic acid, 15% sulphuric acid, and 30% water, good results were obtained using a current density of 10 amperes per square inch for a period of one minute, the temperature of the bath being 60° C.

Example 14

Where the bath was composed of 60% tartaric acid, 8% sulphuric acid and 32% water, good results were obtained by using a current density of 10 amperes per square inch for a period of thirty seconds, the bath temperature being 100° C.

Example 15

Where the bath was composed of 55% maleic acid, 15% sulphuric acid and 30% water, good results were obtained using a current density of from 2½ to 10 amperes per square inch for a period of two minutes, the temperature of the bath being 100° C.

Example 16

Good results were obtained by using malic acid in place of the maleic acid of the previous example, the other operating conditions being the same.

Example 17

Where the bath was composed of 46% succinic acid, 12% sulphuric acid and 42% water, good results were obtained with a current density of 10 to 20 amperes per square inch for a period of one-half to two minutes.

Good results were obtained in the treatment of 17% and 12% chrome steels using various current densities, treating periods, and electrolytes. In general, satisfactory results were not obtainable where the acid content of the bath was less than 50% by weight.

In the carrying out of the invention the tank and cathodes will be selected to suit the particular requirements. The tank must be made of a material which will resist the combined action of the acids. A lead lined tank may be utilized as it will satisfactorily resist acids. Appropriate heating means in the form of steam coils or electric heating units may be positioned in the bath to heat the electrolyte to the desired temperature.

The cathode area does not appear to be critical but in order to obtain most satisfactory results it is desirable to have the cathode or cathodes of a size commensurate with the size of the anodes so as to obtain uniform polishing action thereon. Preferably a plurality of cathodes are used so that the anodes with the material being treated thereon can be positioned therebetween. The cathodes may be formed of thick lead sheets. Where articles of irregular shape are being polished it is desirable to have the cathodes conform to the general configuration of the articles in order to obtain uniform polishing without undue loss of metal. In some cases it has been found desirable to place the cathode above the anode in order to prevent the liberated gases from shielding a portion of the anode and thereby cutting down the effective current density.

For the polishing of small articles the anode bars may extend downwardly into the bath between the cathodes and carry thereon metal pins which are not subject to excessive attack by the bath. The articles to be polished may be suspended from these pins. A plurality of articles may be suspended in the bath from a single anode bar.

It will be understood that the process which I provide is not limited to the polishing of articles while stationary in the bath. It may be applied to a continuous process for the treatment of strip, wire or fabricated articles. In a continuous process the contact for supplying the current to the material may be effected by means of rolls or any other suitable devices.

In the above description I have used the expression "stainless salts." By this I mean any of the metallic salts such as chrome, nickel or iron salts which may be formed on solution or dissolution of the alloy.

While I have set forth herein the preferred electrolytes and the preferred operating conditions, it will be understood that my invention is not limited thereto but may be otherwise practiced within the scope of the appended claims.

I claim:

1. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be treated in an aqueous bath consisting principally of an aliphatic carboxylic acid, the stainless salts of which will permit ready flow of corrosion products away from the anode during the treatment, a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath, and passing direct current through the bath of sufficient density to offset the gray etching action of the bath and to polish the metal, the metal being used as the anode.

2. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of an aliphatic carboxylic acid, the stainless salts of which will permit ready flow of corrosion products away from the anode during the treatment, sulphuric acid, and water in an amount less than approximately 50% by weight of the bath, and passing direct current through the bath of sufficient density to offset the gray etching action of the bath and to polish the metal, the metal being used as the anode.

3. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of citric acid, a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath, and passing direct current through the bath of sufficient density to offset the gray etching action of the bath on the metal and to polish the metal, the metal being used as the anode.

4. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of acetic acid, a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath, and passing direct current through the bath of sufficient density to offset the gray etching action of the bath on the metal and to polish the metal, the metal being used as the anode.

5. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of tartaric acid, a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by

weight of the bath, and passing direct current through the bath of sufficient density to offset the gray etching action of the bath on the metal and to polish the metal, the metal being used as the anode.

6. The method of polishing stainless iron and stainless steel by anodic treatment comprising using the metal to be polished as anode and subjecting it to electrolytic action in an aqueous bath consisting principally of an aliphatic carboxylic acid, a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath by passing direct current through the bath, the aliphatic carboxylic acid comprising 10% to 90% of the bath by weight and the current density being sufficient to offset the gray etching action of the bath and to impart a polish to the metal.

7. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of 10% to 90% of an aliphatic carboxylic acid, the stainless salts of which will permit ready flow of corrosion products away from the anode during the treatment, ¼% to 70% sulphuric acid, and water in an amount less than approximately 50% by weight, and passing direct current through the bath while using the metal as the anode, the bath consisting principally of the aliphatic carboxylic acid and sulphuric acid and the current density being sufficient to offset the gray etching action of the bath and to impart a polish to the metal.

8. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of 10% to 90% of an aliphatic carboxylic acid, ¼% to 70% of a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath, and passing direct current having a density of ½ to 40 amperes per square inch through the bath while using the metal as the anode.

9. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of 10% to 90% of an aliphatic carboxylic acid, ¼% to 70% of a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath, and passing direct current having a density of ½ to 40 amperes per square inch of anode surface through the bath while maintaining the bath at an elevated temperature, the metal being used as the anode.

10. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of an aliphatic carboxylic acid, the stainless salts of which will permit ready flow of corrosion products away from the anode during the treatment, sulphuric acid, and water, the sulphuric acid content of the bath being below 70% and the water content of the bath being less than approximately 50% by weight, and passing direct current through the bath of a density sufficient to overcome the gray etching action of the bath and to polish the metal, the metal being used as the anode.

11. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of an aliphatic carboxylic acid, a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath, and passing direct current through the bath of sufficient density and for a sufficient period of time to overcome the gray etching action of the bath on the metal and to impart a polish to the metal while maintaining the bath at an elevated temperature.

12. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of a water soluble aliphatic-carboxylic acid, sulphuric acid, and water in an amount less than approximately 50% by weight of the bath, and passing direct current through the bath of sufficient density to overcome the gray etching action of the bath and to polish the metal while using the metal to be treated as the anode.

13. The method of polishing stainless iron and stainless steel by anodic treatment comprising immersing the metal to be polished in an aqueous bath consisting principally of an aliphatic-carboxylic acid, a soluble compound having a sulphate radical yielding a sulphate ion in the bath, and water in an amount less than approximately 50% by weight of the bath, and passing direct current through the bath using the metal as the anode, the current being of sufficient density to offset the gray etching action of the bath on the metal and to impart a polish thereto.

14. The method of anodically polishing nickel chromium stainless steel, which comprises making said steel the anode in an electrolyte consisting initially of tartaric acid, sulfuric acid, and water, the total water content being about 32% by weight, and passing through said electrolyte an electric current of sufficient density and for a sufficient time to produce the polish.

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