

UNITED STATES PATENT OFFICE

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COLORING STAINLESS STEEL

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My invention relates to stainless steel and more especially to coloring the same.

Among the objects of my invention is the production in a simple, economical and thoroughly practical manner of color-coated stainless steel products which in addition to being tough, durable and corrosion-resistant are ornamental, decorative and pleasing to the eye; and which in a variety of adaptations, including trim and hardware for buildings, counters, cabinets, conveyances, and the like, as well as articles of apparel such as slide fasteners, buttons, buckles and clasps, culinary ware, and also objects of art such as bowls, urns and vases, retain their initial beauty in actual practical use for a prolonged period of time.

Other objects in part will be obvious and in part will be pointed out hereinafter.

The invention accordingly consists in the composition of ingredients and mixture of materials, and in the several steps and the relation of each of the same to one or more of the others, and in the articles, products and manufactures resulting therefrom, as described herein, the scope of the useful application of which is indicated in the following claims.

As conducive to a clearer understanding of certain features of my invention, it may be noted at this point that stainless steel is defined as a low-carbon steel comprising 10% to 35% chromium, with or without nickel, and with or without supplemental additions of manganese, silicon, cobalt, copper, molybdenum, tungsten, vanadium, columbium, titanium, and the like, for special purposes, and the balance substantially all iron.

It may be noted further that certain heretofore known processes of producing stainless steel products of pleasing, ornamental, or decorative finish are instrumental in achieving products which are characterized by a natural stainless steel finish, either of dull or satin-like appearance, or, in polished condition, of mirror-like brilliance. The prior art further provides a number of processes which enable the production of color-coated ornamental stainless steel products. The coated products contribute in obtaining new decorative color combinations, color blendings, or contrasts, which are not achievable through the often somewhat monotonous use of naturally finished stainless steel products.

Despite the recognized utility of coated stainless steel products there are certain outstanding features tending to limit their wide acceptance. As pointed out more particularly in Patent

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1,977,270 to Alexander L. Feild, issued October 16, 1934, entitled "Ornamental rustless iron product and art of making the same," heretofore known and/or used processes of color-coating stainless steel with cement, paint and other coating compounds give coatings which aside from being initially expensive, are of necessity impermanent and require constant attention and repair at considerable inconvenience and expense. The coatings achieved often fail to adhere to the underlying metal, and crack, chip or scale-off when the metal is stressed as by bending. In other instances, the coatings or films obtained are porous, lack smoothness, toughness, or uniformity either with respect to thickness or appearance, have little corrosion-resistive value, or are unsuitable from an ornamental or decorative point of view because of poor color quality, insufficient depth of color, or instability of color. Other known coatings, including the conventional hydroxide stainless steel coatings, are characterized by softness or chalkiness and rub-off or wearaway in a very short time, in addition to their being affected by moisture.

One of the outstanding objects of my invention is the provision in a simple, effective, economical and thoroughly reliable manner of stainless steel articles, products or manufactures having an oxide coating of unusual color-depth and beauty, which coating is stable, durable and corrosion-resistant, as well as adherent even where the underlying metal is bent, which coating is smooth, hard and tough without being porous, and which does not rub off readily or wear away during extended use.

Referring now more particularly to the practice of my invention, stainless steel articles or products are provided with coatings of exceptional endurance and of assorted ornamental and decorative colors, by immersion in a strongly oxidizing bath of molten sodium nitrate and/or potassium nitrate, the color achieved on any particular piece of work being controlled primarily by the time of immersion and temperature of the immersion bath.

As illustrative of the practice of my invention, stainless steel sheet, strip or plate, or bars, rods, wire or tubes are formed by cutting, stamping, bending or otherwise shaping to desired pattern or design. The stock conveniently is formed in cold condition, but it will be understood that hot-forming operations may be employed where desired.

The formed article or product is then cleansed

or pickled so as to remove oxide scale, dirt, grease, and the like resulting from the shaping and forming operations. The pickling bath comprises, for example, an aqueous solution of 20% nitric acid and 1% hydrofluoric acid. A quick dip in this bath ordinarily is sufficient. After the stainless steel article or product is substantially clean, it is withdrawn from the pickling bath, is rinsed, and then preferably is subjected to an electrolytic polishing treatment.

Electrolytic polishing is achieved, for example, in accordance with the process disclosed in the copending application Ser. No. 254,888 of James N. Ostrofsky, entitled "Polishing stainless iron and steel," now U. S. Patent 2,335,354, wherein the stainless steel article or product is made the anode in an aqueous electrolyte comprising an aliphatic carboxylic acid such as citric acid and a soluble compound having a sulphate radical such as sulfuric acid; or by anodic treatment in an aqueous solution comprising 60 per cent or more of sulfuric acid as described and claimed in my copending application Ser. No. 378,576, entitled "Polishing stainless iron and steel," now U. S. Patent 2,379,066; or by anodic treatment in an aqueous solution of concentrated perchloric acid as covered in my copending application Ser. No. 319,057, entitled "Electrolytic polishing of stainless iron and steel." After the stainless steel article or product is polished electrolytically, traces of the electrolyte employed are removed as by washing the product in running water. Conveniently, the product is dried in any suitable manner before undertaking the coating step.

In providing an oxide film or coating on stainless steel products in accordance with my invention, I prepare in a melting vat or the like, equipped with a suitable heating unit, a molten salt bath consisting of, or comprising, substantial amounts of, fused sodium nitrate and/or potassium nitrate. Preferably, I employ a salt mixture consisting of approximately 60 parts potassium nitrate and 40 parts sodium nitrate. This mixture has a low melting point and good fusibility, and gives a coating of exceptionally good color quality.

In accordance with my invention, I heat the prepared salt bath to a temperature within the approximate range of 650° F. to 950° F., and then immerse the electrolytically polished stainless article or product in the bath for a period ranging from about 5 to 40 minutes. Temperature of the bath preferably is maintained substantially constant throughout the immersion period. Conveniently, the stainless steel product is left immersed in the bath for the desired time of treatment or is immersed periodically by dipping. In any event, a strong oxidizing action is set up and a coating or film, rich in oxides of iron and chromium accordingly forms on the stainless steel.

The salt bath temperature, I find, determines in large measure the color of oxide coating achieved on the stainless steel product. By using a bath temperature of about 730° F. a coating of straw color is obtained on the metal product. On the other hand, an old gold finish is achieved by maintaining the bath temperature at or around 770° F., a reddish-purple finish is had at approximately 800° F., and blue-black at about 840° F.

Aside from the controlling effect of bath temperature on the color of coating achieved, time of immersion of the stainless steel product in the

bath is another factor which affects the coating, particularly its depth of color, its physical thickness and its adherence to the underlying metal. Thus in coating most stainless steel articles and products, I find that the immersion period of about 5 to 40 minutes employed gives an oxide film of preferred 20 to 50 microns in thickness. A coating thus formed on the underlying metal has excellent depth of color. Moreover, it is dense and adherent.

After a coating of desired color and thickness is formed on the stainless steel product or article, I withdraw the same from the salt bath. It then is washed free of salt to room temperature.

A product or article having the many beneficial characteristics of stainless steel, such as its corrosion-resistance, hardness and strength, and having a durable and beautiful color finish is thus produced without in any way affecting the rustless or corrosion-resistant properties of the metal.

The oxide color film or coating provided is dense, hard, tough, and corrosion-resistant and thus does not wear away readily or wipe off, and moreover, is highly adherent and flexible and does not crack, chip or spall-off even upon being subjected to flexing or bending stresses. The coating has excellent depth of color particularly where the underlying stainless steel has been electrolytically polished, and the color achieved is both uniform in appearance and of stable quality. My coating neither changes color nor fades in atmospheres of varying humidity or as a result of rubbing, and maintains its initial beauty for a prolonged period of time even when exposed to the outdoor elements.

While, as more particularly described above, I prefer to electrolytically polish the stainless steel products and articles prior to coating the same, it will be understood that the electrolytic polishing step may be omitted, either with or without the substitution of another form of cleaning or polishing operation. I find, however, that the coatings obtained on my stainless steel products are more excellent in quality, particularly with respect to depth of color and uniformity of appearance where the electrolytic polishing step is included as a final processing step before coating.

Thus it will be seen that there has been provided in this invention an art in which the various objects, hereinbefore noted, together with many highly practical advantages are successfully achieved. It will be seen that the product is strong, durable and corrosion-resistant, and that it is given a permanent and attractive oxide finish of any one of several pleasing colors in a direct and thoroughly reliable manner without in any way affecting the rustless or corrosion-resistant characteristics of the metal. Moreover, it will be seen that in the practice of my process, I employ materials and equipment which are readily available and which are handled with considerable ease.

As many possible embodiments may be made of my invention and as many changes or alterations may be made in the embodiment hereinbefore set forth, it is to be understood that all matter described herein is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In coloring stainless steel including about 10% to 35% chromium, the art of producing a colorful coating thereon ranging from straw to

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blue-black, which includes immersing the stainless steel for a period of about 5 minutes to about 40 minutes in a molten salt bath essentially consisting of one or more of sodium nitrate and potassium nitrate maintained at a temperature in the range of about 730° F. to about 840° F. depending upon the color desired.

2. In coloring stainless steel, containing about 10% to 35% chromium the art of producing a uniform straw color thereon which includes immersing the stainless steel for a period of about 5 minutes to about 40 minutes in a molten salt bath consisting of one or more of sodium nitrate and potassium nitrate maintained at a temperature of about 730° F.

3. In coloring stainless steel, containing about 10% to 35% chromium the art of producing a uniform old gold finish thereon which includes immersing the stainless steel for a period of about 5 minutes to about 40 minutes in a molten salt bath consisting of one or more of sodium nitrate and potassium nitrate maintained at a temperature of about 770° F.

4. In coloring stainless steel, containing about 10% to 35% chromium the art of producing a uniform reddish-purple finish thereon which includes immersing the stainless steel for a period of about 5 minutes to about 40 minutes in a molten salt bath consisting of one or more of sodium nitrate and potassium nitrate maintained at a temperature of approximately 800° F.

5. In coloring stainless steel, containing about 10% to 35% chromium the art of producing a uniform blue-black finish thereon which includes

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immersing the stainless steel for a period of about 5 minutes to about 40 minutes in a molten salt bath consisting of one or more of sodium nitrate and potassium nitrate maintained at a temperature of approximately 840° F.

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