POLISHING STAINLESS STEEL

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This invention relates to stainless steel and more especially to a method for brightening the surface of the steel.

An object of our invention is the provision of a simple, practical and reliable method for polishing stainless steel and producing polished articles and products of the steel, wherein the work is effectively and satisfactorily polished with a minimum of equipment and with simple control over operating conditions. Referring now more particularly to the practice of our invention, we subject stainless steel to the action of an aqueous solution containing nitric acid, hydrochloric acid, hydrofluoric acid, and one or more aromatic or aliphatic organic compounds having high molecular weight soluble therein. This solution brightens the steel. Among the aromatic character of which we often employ are the quinoline, anthraquinone, caffeine, cresol, cresoles, phenol, nitrophenol, naphthaline, pyridine, and sulphuric compounds of any of the same. And, we prefer to employ in our brightening solutions, those of the alkaloid class, illustratively vegetable alkaloids such as quinidine, choline, and nicotine, or the animal alkaloids that by the distillation of animal matter such as hair, hides, hoofs and the like. Commercially, quinoline has proved to be most practical in our solutions from the viewpoints of expense, life and general efficiency, and aromatic aliphatic compound most preferred. Good results also are had with the aromatic compound sulfured quinidine and with the aliphatic compound hydroxyethyl thiazolizine sulfide.

The various solutions which we provide exert a pickling action on the stainless steel and also a brightening effect.

In the solutions identified herein, the various acids preferably are concentrated to at least about the extent indicated as follows:

Hydrochloric acid—Specific gravity 1.18 minimum at 60° F.
Hydrofluoric acid—Specific gravity 1.15 minimum at 68° F.
Nitric acid—Specific gravity 1.42 minimum at 60° F.
Sulphuric acid—Specific gravity 1.84 minimum at 60° F.

The exact function of quinoline or of other organic compound of high molecular weight in giving the brightening effect is not entirely clear to us. It is, further, not known to what extent these materials alter in the presence of the acids. There is a possibility that the alkaloid or other organic compound in the particular acid environment create a difference in electrical potential between high and low spots on the stainless steel with eventual leveling of the metal surface to produce the luster. Again, it is possible that the organic material acts as a wetting agent thus facilitating acid reaction on the high spots as compared with low spots on the steel. While the end results of the brightening treatment are quite satisfactory, we do not wish to be bound by any explanation here to the intricacies of the brightening action.

In the practice of our invention, we find that quite satisfactory results are had, to the extent of pickling and polishing, through the use of a solution containing by volume, approximately 2% to 8% nitric acid, 3% to 30% hydrochloric acid, 2% to 32% hydrofluoric acid, 2% to 18% sulfuric acid, and the remainder substantially all water, together with one or more organic compounds of high molecular weight in total amount of about .5% to 6% by weight of bath. Preferably, however, the bath contains approximately 3% to 5% nitric acid, 3% to 6% hydrochloric acid, 2% to 12% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially all water, the percentage figures being by volume, together with aromatic organic compounds, as of the alkaloid class, amounting to about 0.05% to 6% by weight of the bath. Upon subjecting the steel to this solution under proper conditions a polish is readily obtainable. In design to low from high to high depending upon the specific amounts of the solution constituents present.

A specific polishing solution which we prepare and use for achieving high polish in the practice of our invention, contains approximately 3% to 5% nitric acid, 3% to 6% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 5% sulphuric acid, and remainder substantially all water, the percentage figures being by vol-
high molecular weight material, and with aromatic compounds of high acid-resistant lining or surface. At ranges just noted throughout immersion.

2,694,001 patent, together with aromatic organic compounds having total amount ranging from about 2% to 4% by weight of bath.

We usually heat our brightening solutions to temperatures within the range of about 160°F to 185°F, or more, the heating for example being with the solution contained in a vat, tank, or the like having a suitable acid-resistant lining or surface. Brightening is advantageously had by immersing the steel in the heated solution with solution temperature maintained within the range just noted throughout immersion. The products illustratively are immersed as a batch in the brightening solution or, for example, are continuously fed through the solution while supported on a moving rack. Sometimes the products are in the form of stainless steel wire sheet, strip, or the like, which for example is continuously pulled from a coil or roll through the heated solution and is brightened in the heated condition on a suitable reel as after rinsing in clean water.

The time required for brightening stainless steel in the present invention is generally about three minutes to twenty-five minutes, considering the initial condition of the steel and that the activity of the bath increases with the temperature. About a fifteen minute period of immersion is the optimum time of treatment. In our baths, which are satisfactory for brightening to the extent of polishing, a polish usually is obtained on steel with sodium range of time as indicated, where the bath temperature is approximately 160°F to 185°F.

In treating cold-drawn stainless steel products, we often use solutions toward the lower end of the temperature range of 160°F to 185°F, and for hot-worked products, we usually employ the higher temperatures of the approximate range.

The process is useful for brightening stainless steels whether the steels be of straight-chromium grade or of chromium-nickel grade. The chromium-nickel steels are particularly responsive to treatment in our brightening and polishing solutions, though the straight-chromium steels also readily respond to treatment in accordance with our invention. Upon immersing stainless steel of general grade in our brightening solution, a pickling action occurs which is effective for removing such surface defects from the steel as slivers, indented scale, pits, lines, and the like, as may be caused by forming difficulties. Such defects are readily removed by our brightening and polishing solutions. Brightening and polishing solutions also effect the removal of scale, pits, and other processing. Along with the pickling action, brightness is achieved. Our invention, accordingly, is useful for such purposes as finishing stainless steel in that it supplies in a unique operation a means for disposing of blemishes and imperfections and, at the same time, produces a bright surface. The process is useful in such instances as where the stainless steel immersed for treatment has previously been cast, hot-worked or cold-drawn, shaved, ground or machined; wherever brightness is desired or where surface imperfections are to be removed.

Sometimes before subjecting the stainless steel to the action of the brightening bath in accordance with our invention, we immerse the steel in an ordinary pickling solution such as containing suitable amounts of nitric acid, hydrofluoric acid and the remainder substantially all water to remove surface defects. In this manner, for example, a lower grade or more generally bright steel could be brightened in a relatively short time.

We subsequently immerse the steel in any of our brightening solutions containing the aromatic compound or compounds for the brightening our solutions are quite effective for exerting a pickling action on the steel, the preliminary cleaning treatment in a relatively cheap pickling solution or the like is sometimes to the interest of a preliminary cleaning and polishing procedure.

We often use our brightening solutions in any of a variety of conventional pickling tanks, such as made of wood, carbon brick or with non-acidic acid-resisting linings. The solutions readily operate at temperatures which promote brightness without rapid deterioration or loss of the chemicals present. Our solutions are not as potent in concentration as to be objectionably dangerous. In time, of course, the brightening bath suffers a chemical breakdown and loss of efficiency. We are, however, capable of enduring prolonged use, and by way of example some 20,000 pounds of 18-8 stainless steel wire have been polished in 600 gallons of one of our brightening solutions before deterioration of the latter. We often temporarily replenish the bath with any one or all of the acids normally in solution. When the amounts of iron yielded to the bath reaches too great a quantity however (about 5.5% to 7.5%) the acids usually decompose and the bath is best fully replaced.

In certain instances, we introduce thio-cyanate or other suitable anti-freeze material or materials to our solutions, thus to make the latter more satisfactory for shipment or to prevent freezing where cold in the brightening tank.

As illustrative of the practice of our invention several specific examples of our polishing solutions and uses of the same are noted below.

**Example I**

A number of coils of 17% chromium-7% nickel stainless steel wire in the hot rolled, annealed and pickled condition, mean ranges for diameter of 76.5 inch and 76.8 inch in diameter and weighing in total 5966 pounds were treated in a 600-gallon bath containing:

- 5% concentrated sulphuric acid by volume.
- 5% concentrated hydrochloric acid by volume.
- 4% concentrated nitric acid by volume.
- 4% concentrated hydrofluoric acid by volume.
- Balance water, together with quinoidine in the amount of 2% by weight of bath.

In this instance, the bath temperature employed was about 170°F and the time of immersion 15 minutes. Before treatment in the pickling solution, the several coils were dull gray in appearance and exhibited numerous pits and seams caused by hot rolling. When removed from the polishing solution, the coils were smooth and possessed a bright luster. Approximately 0.002 inch of metal was removed from the diameter; seams and pits were eliminated or so minimized as to be unimportant. These polished coils were rinsed in cold water to remove the polishing solution, and thereafter were cold drawn and shipped for fabrication to a customer plant. We find the life of this bath to be particularly good.

**Example II**

In the same bath as in Example I, 3280 pounds of hot rolled, annealed and pickled 17% chromium-7% nickel stainless steel wire, measuring 0.330 inch in diameter, were treated by immersion with prevailing temperature of about 170°F with favorable results. The immersion time in this instance was shortened to 12 minutes.

**Example III**

A bath containing the following ingredients was prepared in a suitable pickling tank for immersion treatment of a 5850 pound lot of cold-drawn and annealed 18-8 chromium-nickel stainless steel wire:

- 5% concentrated sulphuric acid by volume.
- 5% concentrated hydrochloric acid by volume.
- 4% concentrated nitric acid by volume.
- 4% concentrated hydrofluoric acid by volume.
- Balance water, 1 to contain 0.15% of soluble distillate of animal protein in the amount of 0.15% by weight of bath.

The immersion treatment lasted for 12 minutes at about 170°F and this was sufficient to impart a thoroughly satisfactory polish.

**Example IV**

Straight-chromium and chromium-nickel stainless steel products, respectively of 17% chromium and 18-8 chromium-nickel variety were successfully polished in the hot rolled, annealed and pickled condition by immersion in
5 the following polishing solution for about a 15 minute period of treatment.
5% concentrated sulphuric acid by volume.
5% concentrated hydrochloric acid by volume.
4% concentrated nitric acid by volume.
4% concentrated hydrofluoric acid by volume.
Balanced to total 100% with croosote in the amount of
5% by volume of bath.

Thus, it will be seen that in this invention there are
provided a process and treating solution for improving
the surface condition of stainless steel, in which the various objects noted herein together with many thor-
oughly practical advantages are successfully achieved.
It will be seen that the process is simple to practice and
that the treating solutions which we provide lend ease and effectiveness in brightening the steel.

As many possible embodiments may be made of our
invention and as many possible changes may be made in the embodiments hereinbefore set forth, it will be
understood that all matter described herein is to be inter-
preted as illustrative and not as a limitation.

We claim:
1. A polishing solution for stainless steel product comprising
chromium, nickel, and carbon wherein the chromium
content amounts to about 10% to 35% and remainder
substantially iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with at least one organic compound of the alkaloid class amounting to about 0.05% to 6% by weight of bath for sufficient time and at such temperature as to achieve a polishing of the product.

2. A polishing solution for stainless steel product comprising
chromium, nickel, and carbon wherein the chromium
content amounts to about 10% to 35% and remainder
substantially iron, the art which comprises, immersing
the product in a bath essentially consisting of by volume about 3% to 5% nitric acid, 3% to 6% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.5% to 6% by weight of bath, for such time and at such temperature as to achieve a mirror-like finish.

3. A polishing solution for stainless steel product comprising
chromium, nickel, and carbon wherein the chromium
content amounts to about 10% to 35% and remainder
substantially iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.5% to 6% by weight of bath, for such time and at such temperature as to achieve a mirror-like finish.

4. A polishing solution for stainless steel product comprising
chromium, nickel, and carbon wherein the chromium
content amounts to about 10% to 35% and remainder
substantially iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.5% to 6% by weight of bath, for such time and at such temperature as to achieve a mirror-like finish.

5. A polishing solution for stainless steel product comprising
chromium, nickel, and carbon wherein the chromium
content amounts to about 10% to 35% and remainder
substantially iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.5% to 6% by weight of bath, for such time and at such temperature as to achieve a mirror-like finish.

6. A polishing solution for stainless steel product comprising
chromium, nickel, and carbon wherein the chromium
content amounts to about 10% to 35% and remainder
substantially iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.5% to 6% by weight of bath, for such time and at such temperature as to achieve a mirror-like finish.

7. A polishing solution for stainless steel containing
chromium, nickel, and carbon wherein the chromium
content is about 10% to 35% and remainder substantially
iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.05% to 6% by weight of bath.

8. A polishing solution for stainless steel containing
chromium, nickel, and carbon wherein the chromium
content is about 10% to 35% and remainder substantially
iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.05% to 6% by weight of bath.

9. A polishing solution for stainless steel containing
chromium, nickel, and carbon wherein the chromium
content is about 10% to 35% and remainder substantially
iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.05% to 6% by weight of bath.

10. A polishing solution for stainless steel containing
chromium, nickel, and carbon wherein the chromium
content is about 10% to 35% and remainder substantially
iron, said solution essentially consisting of by volume about 2% to 6% nitric acid, 4% to 15% hydrochloric acid, 2% to 6% hydrofluoric acid, 3% to 8% sulphuric acid, and the remainder substantially water, together with organic compound of the alkaloid class amounting to about 0.05% to 6% by weight of bath.

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