UNITED STATES PATENT OFFICE.

CHARLES W. DANFORTH AND NOBLE JONES, OF SHARON, PENNSYLVANIA.

PROCESS FOR ELECTROLYTICALLY REMOVING IRON-OXID SCALE.

939,223. Specification of Letters Patent. Patented Nov. 9, 1909.

No Drawing. Application filed June 25, 1909. Serial No. 504,379.

To all whom it may concern:

Be it known that we, CHARLES W. DANFORTH and NOBLE JONES, citizens of the United States, residing at Sharon, in the county of Mercer and State of Pennsylvania, have invented certain new and useful Improvements in Processes for Electrolytically Removing Iron-Oxid Scale, of which the following is a specification.

Many processes have been proposed for removing iron-oxid scale from the surface of iron and steel. Some by merely dipping the iron or steel in the ordinary "pickle-bath" which latter consists of acids, more or less concentrated. These, if the bath be concentrated so as to work rapidly, are prone to damage the iron or steel, while, if the bath is not so strong as to injure the material dipped, are exceedingly slow and tedious of operation. Scale may also be removed from iron and steel by means of the electric current, in acid, neutral and alkaline solutions, the action being somewhat similar, (though much more rapid and thorough) to the common method of pickling by immersion in acid solution. Direct or alternating current may be used, and alternating current appears to hasten the action of pickling over the ordinary method of dipping. Using a direct current and making the article to be cleansed the anode in an acid electrolyte, the material suffers loss along with the scale but the time required for complete "pickling" is much shortened. By using a dilute acid electrolyte and making the article to be cleansed the cathode, the mill-scale is reduced, and by a proper regulation of current, no steel proper is dissolved. This process, however, is not rapid enough for commercial purposes. When a strong solution of acid is used as the electrolyte, a strong current is necessary to protect the article from "burning", which makes this process too expensive.

Various solutions have been suggested so that the steel would be protected from the action of a strong acid bath without the use of the electric current and without increasing the length of time of immersion. Of the many proposed, the most notable have been stannous chlorid, bisulfate salts and a mixture of acid and hydrocarbon oil. Stannous chlorid is too expensive for practical use. The other two are efficient but reduce the speed of the operation.

The object of our invention is to overcome all these disadvantages and thus produce a flexible, rapid and economical method of removing iron-oxid scale.

By making use of a combination of the electric current in combination with a solution in water of a bisulfate of an alkaline metal, such as sodium or potassium, the process is made rapid and adaptable to all classes of work and produces a better surface on iron and steel for subsequent operations, such as galvanizing, tinning, electroplating, lacquering, enameling, japanning, etc., and this by a much more economical process as a much weaker electric current is required. This protection of the iron or steel by using a solution of a bisulfate salt as an electrolyte is due to the formation, for an instant, of a film of caustic alkali on the surface of the article to be cleansed by the decomposition of the alkaline bisulfate by the action of the electric current, which caustic alkali and free acid radical recombine to form the salt when removed from the sphere of immediate contact with the iron or steel electrode. In the electrolytic method using only acid, the hydrogen evolved is the only protection to the iron or steel from the corrosive action of the strong acid. This necessitates the generation of much more hydrogen than is necessary for the reduction of the oxids in order that the steel be not attacked by the acid.

In our process, both hydrogen and caustic alkali are formed on the steel cathode and since caustic alkali is not gaseous, it has a greater protective effect than gaseous hydrogen because it is not removed so rapidly. Hence very much less caustic alkali will be more effective than the enormous amounts of hydrogen gas generated by the heavy current in the simple electrolytic method. With ten per cent. solution of a bisulfate salt, the strength of the electric current need be but from 7 to 10 amperes to generate sufficient hydrogen to reduce the mill-scale and enough caustic alkali to protect the steel from burning and will remove common mill-scale in less than four minutes. The use of a stronger solution of bisulfate increases the rapidity of the process, with a corresponding increase of the electric current. The proportions to be used and the strength of the electric current depending on speed required. The temperature has a great influence on the speed of the process, but except in special cases it would not be economical to heat above 60° C.

The preferred method of procedure con-

sists of subjecting the iron or steel article to be cleansed as the cathode, in an electrolyte consisting of a solution of a bisulfate of an alkaline metal, to the action of an electric current of such a strength adjusted to the degree of concentration of the bisulfate as to produce the required speed of cleansing, using suitable anodes which will be unaffected by the combined action of the electric current and electrolyte. By way of example, in a case where it is desired to effect the cleaning of the iron or steel article rapidly, the following method is the proper procedure. Make a 50% solution by weight of a bisulfate of an alkaline metal in water at 20° C. Adjust the electric current at 50 amperes per sq. ft., and the temperature of the solution to between 40° and 60° C. As the operation proceeds and the free sulfuric acid is consumed, add oil of vitriol so that the free acid will not fall below 18%. When the solution becomes nearly saturated with iron sulfate, allow the temperature to rise to 75° C., and before deposition of salts begins, draw off the solution and allow to cool. Copperas (iron sulfate) will separate out but none of the alkaline metal salt will crystallize. The only loss of alkaline metal salt will be that adhering to the copperas crystals as "mother-liquor". Remove the crystals from the solution, and raise same to original acidity, and proceed as before.

Where a speed of about four minutes' immersion of the article is sufficient, a 10% solution of the bisulfate of an alkaline metal in water is efficient, using a current of from 7 to 10 amperes per sq. ft.

We are aware of the fact that bisulfate of soda has been used as a "pickling bath" and that a patent therefor was granted to A. K. Eaton of Brooklyn, N. Y., June 10th, 1902, No. 702,050, and also that sulfuric acid in an electrolytic process has been used for removing scale and that patents therefor were granted to Charles J. Reed of Philadelphia, Pa., July 31st, 1906, No. 827,179 and No. 827,180 and June 4th, 1907, No. 855,667, but we are not aware of any process wherein bisulfate of soda is used as an electrolyte for electrolytically removing iron-oxid scale. The Eaton patent shows the use of bisulfate of soda as a pickling agent for iron and steel, but is not an electrolytic process. The Reed patents are for electrolytic processes but do not make use of bisulfate of soda for protection of the steel.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. The process of electrolytically removing iron-oxid scale from the surface of iron and steel, which consists in subjecting same as cathode to the action of an electric current, while submerged in a solution containing bisulfate of an alkaline metal in water.

2. The process of electrolytically removing iron-oxid scale from the surface of iron and steel, which consists in subjecting same as cathode, to the action of an electric current, while submerged in a solution containing an acid sulfate.

3. The method of removing iron-oxid scale from the surface of iron or steel, which consists of passing an electric current of the proper density to same as cathode from an electrolyte containing a solution of a bisulfate of an alkaline metal at a temperature of not less than 40° C.

4. The process of removing iron-oxid scale electrolytically from the surface of iron and steel, which consists in placing same in a solution containing a bisulfate of an alkaline metal in water, and of passing to the metal as cathode an electric current of not less than 7 amperes per square foot.

Witness our hands this 22nd day of June, 1909.

CHARLES W. DANFORTH.
NOBLE JONES.

In presence of—
ROY NEVILLE,
ANNA THOMAS.