

UNITED STATES PATENT OFFICE.

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

PROCESS OF ELECTROLYTICALLY REMOVING IRON-OXID SCALE.

939,224.

Specification of Letters Patent.

Patented Nov. 9, 1909.

No Drawing.

Application filed August 28, 1909. Serial No. 515,120.

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 thorough and rapid) 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 the 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 necessary 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, 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 connection with a solution containing a bisulfate of an alkali metal, such as sodium or potassium, dissolved in diluted sulfuric acid, 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 containing a bisulfate salt dissolved in dilute sulfuric acid 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 from the decomposition of the alkali metal 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 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 a ten per cent. solution of a bisulfate salt in diluted sulfuric acid, 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 in electric current. The addition of strong sulfuric acid to the solution of bisulfate increases the rapidity of the process. The

proportions to be used and the strength of the electric current depending on the 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 consists of subjecting the iron or steel article to be cleansed as the cathode, in an electrolyte containing a solution of a bisulfate of an alkali metal in diluted sulfuric acid, to the action of an electric current of such a strength, adjusted to the degree of concentration of the bisulfate and acid, as to produce the required speed of cleansing, using suitable anodes which will not be effected 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 in less than one and one-half minutes, the following method is the proper procedure. To a 1.15 sp. gr. solution of sulfuric acid at 20° C. add 13% by weight of bisulfate of an alkali metal. The resultant solution will then have a specific gravity of 1.22. 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 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 alkali metal salt will crystallize. The only loss of alkali 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 5% to 10% solution of the bisulfate of an alkali metal in sulfuric acid of 1.06 sp. gr. is efficient, using a current of from 7 to 10 amperes per square foot.

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, 1907, No. 827,179 and No. 827,180, and June 4th, 1907, No. 855,667, but we are not aware of any process wherein both bisulfate of soda and sulfuric acid are used together 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 alkali metal dissolved in diluted sulfuric acid.

2. The process of removing electrolytically 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 mineral acid and acid sulfate.

3. The electrolytic method of removing iron-oxid scale from the surface of iron and steel, which consists in passing an electric current of the proper density to same as cathode from an electrolyte containing bisulfate of an alkali metal dissolved in diluted sulfuric acid, 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 bisulfate of an alkali metal dissolved in diluted sulfuric acid, and of passing to same as cathode an electric current of not less than 7 amperes per square foot.

Witness our hands this 23rd day of August, 1909.

CHARLES W. DANFORTH.
NOBLE JONES.

In presence of—

ANNA THOMAS,
ROY NEVILLE.