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TREATMENT OF IRON AND STEEL

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This invention relates to improvements in the treatment of iron and steel, and particularly the pickling and subsequent treatment of iron and steel, to prevent or reduce rusting thereof. It also includes improvements in the enameling of iron and steel, and particularly improvements in the preparation of iron and steel articles for the enameling process.

In preparing iron and steel for enameling, and for certain other purposes, it is customary to pickle the metal in an acid bath, usually either hydrochloric or sulphuric acid, remove most of the acid by washing in water, neutralize by dipping in a dilute alkaline bath and then dry. Drying, both of the bare metal and later drying of the metal which has been dipped in a ground coat, is usually accomplished by passing the articles through heated chambers. Some plants, however, are not equipped with adequate drying equipment, and even those which have such driers sometimes find it necessary to resort to slow drying in the open air. Even when the pickled and neutralized metal is passed through a drier some rust tends to form, giving the metal a yellowish-brown color. If the drying is incomplete, or if the factory atmosphere is damp, fairly heavy rust spots will sometimes form on the metal before it is dipped in the ground coat of the enameling process. Even if the metal is in good condition at the time it is dipped in the ground coat, rusting may occur before the ground coat has completely dried.

Although a small amount of rust, iron oxide, may be absored by the ground coat during burning and may have little effect beyond the formation of a dark depression in the ground enamel, the effect is deleterious and begins to cause series difficulty if the amount of rust present is greater than can be absorbed readily and completely in the enamel layer. In its usual form rust appears in scattered and uneven spots, which are the cause of defects in the enamel after burning.

It has previously been recognized that rusting of the metal during drying and before dipping can be reduced to some extent by using in the neutralizing bath a concentration of sodium carbonate somewhat higher than is necessary for more neutralization of the acid, or even better by using a solution of borax for neutralization; but due in part to the fact that these soluble salts are largely removed from the surface of the metal during application of the wet enamel ground coat they may not remain in sufficient amount and may have little effect in preventing rusting during drying of this coat. There is a further objection, that the relatively high concentration of sodium carbonate sometimes used for partial rust protection leaves on the dried metal an appreciable deposit which partly dissolves in the enamel slip during dipping and progressively changes the consistency and working properties of the slip.

I have discovered that chromates can be used in the preparation of iron and steel for enameling and for other purposes, to effect a semi-permanent rust proofing of the iron and steel, reducing or eliminating rusting during handling for some little time after the preparatory treatment. In carrying out my invention, I find it advantageous to add sodium or potassium chromate or bichromate, for example, to the neutralizing bath in which the metal is treated subsequent to pickling in preparation for the enameling or other process. When bichromate is added to an alkaline solution it combines with the alkali to form chromate. In an alkaline solution therefore the result when a bichromate is added is the same as that when a chromate is added except that the alkalinity of the solution is slightly reduced.

Following such preparatory treatment in which the metal is subjected to treatment with a solution containing a chromate, the metal may be air dried or passed through a drier with elimination or substantial reduction in rusting, and usually has a much brighter appearance than is the case where chromates have not been used in the preparatory treatment, and rusting is not only eliminated or reduced during first drying of the metal but the effect continues even after the metal has been dipped in the enamel ground coat, eliminating or greatly reducing rusting during

drying of the ground coat. In some cases the separate drying operation may not be necessary and may be omitted.

Soluble chromates can be used with advantage in accordance with my invention in conjunction with the neutralizing baths ordinarily employed. When used in conjunction with a soda ash neutralizing bath for example, the tendency toward rusting is greatly reduced and the concentration of the soda ash neutralizing bath may be held low enough so that little of the salt is carried over into the enamel slip in which the metal is subsequently dipped. In conjunction with the chromate a concentration under one percent of soda ash may be satisfactorily used under favorable conditions.

Under favorable conditions rusting may be greatly reduced by using chromates with a soda ash neutralizing bath but cannot always be completely eliminated. I have discovered, however, that by using chromates in conjunction with a dilute borax neutralizing bath it is possible to completely prevent rusting both during drying of the bare metal and drying of the enamel ground coat, even though the concentrations of chromate and borax are held quite low and are not sufficient to carry over into the enamel bath in quantities sufficient to appreciably change its characteristics. That is, by adding chromates to a borax neutralizing bath the rust preventing effect persists not only during first drying of the metal but also during drying of the ground coat enamel and up to the time that the ware is fired.

In carrying out my invention, I have, for example, added about one to two tenths of one percent of sodium bichromate to a borax neutralizing bath (containing approximately one percent of borax) in which the metal was to be dipped for a period approximating five minutes. The neutralizing solution may be used either hot or cold, but there is added advantge in using a hot solution. This time and concentration can be varied within quite wide limits. Shorter immersion in a stronger bath gives an effect similar to that of longer immersion in a weaker bath. However, ordinary shop practice limits the time usually available and I have found it advantageous to avoid concentration such that an unnecessarily large amount of chromate is left on the metal during and after drying, particularly if the metal is subjected to a high temperature drying operation. Under normal conditions, the use of the chromate concentration for the time I have indicated by way of example is adequate substantially to prevent rusting during initial drying and any serious rusting during drying of the ground coat.

Under some circumstances, it may be useful to employ a separate chromate-containing bath, containing chromate or bichromate, in the preparation of iron and steel articles for enameling in accordance with my invention; and under certain conditions it may also be desirable to add the chromium compound to the pickling bath. The procedure which will ordinarily be employed will be to pickle the metal in acid, rinse off the acid and neutralize in a bath in which the chromate is added. In some plants it may be more advantageous to pickle, rinse and then neutralize most of the acid in a plain alkali bath before giving the articles the final alkaline chromate treatment. As a measure of economy and efficiency it may sometimes be desirable to use two neutralizing baths and dip the ware first in the bath which is most nearly exhausted and later dip it in the strong bath. Spraying of chromate solution on to the ware can also at times be employed.

While I do not wish to limit myself by any theoretical explanation, yet I believe that the effect of the chromate treatment is to cause the formation of a very thin protective oxide film on the surface of the metal during drying, this thin film serving to prevent further oxidation in the form of rust while at the same time not being thick enough or of a nature to appreciably affect the adhesion of the enamel to the metal during and after burning. There are some authorities who claim that a uniform surface oxidation of the metal is even desirable. Small effects of this kind are difficult to measure with accuracy but I have found that the metal treated in accordance with my invention may be readily enameled and shows none of the difficulties which usually accompany the presence of rust.

Under favorable conditions in ordinary enamel shop practice, rusting may be confined largely to thin edges of the metal, but at best there is nearly always some rusting and this rusting at times, at least, is serious in extent and causes considerable damage. My invention provides a simple and economical method by which trouble due to rusting in the enameling process may be greatly reduced or eliminated.

While I have described the invention in detail in connection with the enameling of iron and steel, for which it is particularly advantageous, certain features of the invention are of more general application to the treatment of iron and steel for other purposes and where prevention or reduction of rusting is desirable. When sheet iron and steel is to be stored for a period before use for any purpose in which a clean rust-free metal is desired, for example, it may be advantageously treated with an alkaline chromate bath, preferably a borax and chromate bath, whether or not such treatment is preceded by an acid pickling treatment. Although this chromate bath may not in all

cases completely prevent rusting, it provides an economical means by which rusting and pitting of the metal may be retarded over appreciable periods of time. This reduction in rusting is highly desirable, even though pickling for complete removal of rust and scale may later be necessary immediately preceding use, since the difficulty of pickling is reduced and a smoother metal is obtained than would be the case with iron and steel which had been stored under ordinary conditions without such rust retarding treatment.

As an example of the further application of the invention, where it is not to be employed in combination with subsequent enameling, may be mentioned the treatment of sheet iron or steel at the rolling mills where it is produced. In cases where pickling is not necessary, the sheets may be subjected to the action of the solution containing chromate to impart to it improved rust resisting properties. In some cases the solution of alkali chromates may not contain additional alkali; but it is more advantageous in many cases to employ a solution containing both alkali chromate and additional alkali, such as sodium carbonate, and particularly alkaline solutions containing both borax and alkali chromate. Where the sheets at the rolling mill are first subjected to pickling with acid, the resulting sheets can then be subjected to the action of the bath containing alkali chromate. The treatment with the alkali chromate therefore, may be supplemental to a pickling treatment, or it may be employed without any preliminary pickling treatment, and the chromate bath may or may not contain additional alkali compounds, in addition to the alkali chromate, although it advantageously contains such alkali compounds, particularly borax. The amounts of borax and chromate can be varied, but solutions can advantageously be employed which contain less than 2% of borax and less than 0.2% of chromate salt.

I claim:—

1. The method of treating iron and steel articles which comprises subjecting the same to an alkaline bath containing borax and a small amount of a soluble chromate and drying the resulting articles.

2. The method of treating iron and steel articles which comprises subjecting the same to the action of an acid pickling bath, subsequently subjecting the same to an alkaline neutralizing bath containing borax and a small amount of a soluble chromate, and drying the resulting neutralized articles.

3. In the enameling of iron and steel articles, the improvement which comprises preparing the articles for enameling by pickling in an acid pickling bath and subjecting the articles to treatment with an alkaline neutralizing bath containing borax and a soluble chromate following pickling and before drying, and subjecting the thus treated articles to an enameling operation.

In testimony whereof I affix my signature.

CLARK M. DENNIS.