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2,920,023

ELECTROLYTIC CLEANING OF METAL AND COMPOSITION THEREFOR

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No Drawing. Application April 4, 1955
Serial No. 499,232

23 Claims. (Cl. 204-145)

This invention relates to a process for removing sand, dirt, and scale from metal surfaces and to a novel composition for this purpose. It is particularly concerned with the electrolytic cleaning or descaling of ferrous metal pieces in a molten bath of alkali and salt, the composition of which will assure a clean and bright surface for the ferrous pieces.

Electrolytic cleaning of ferrous metal is generally known and has been carried out employing various molten alkali and/or salt baths. Typical of these baths are those which consist of one or more of sodium or potassium hydroxide, sodium chloride, and sodium fluoride. A difficulty encountered with baths of this type is that they require substantially high temperatures of about 950° F. for their operation, and more particularly that they leave a scum upon the ferrous treated pieces which must thereafter be removed by brushing or other treatment. Moreover, such treatment oftentimes permits the ferrous pieces to have their surfaces discolored.

An object of this invention is to provide an alkali salt composition and a process of using the same which inhibits discoloration and scum formation, which is operable at considerably lower temperatures and which is less costly than known compositions not possessing these advantages.

Other objects of our invention will appear from the following description.

We have discovered that ferrous metal pieces or articles, for example transmission housings or casings may be expeditiously and thoroughly cleaned of sand, dirt and scale by electrolytic treatment in a molten salt bath in which the essential active ingredients are a caustic alkali, preferably sodium hydroxide (NaOH) and/or potassium hydroxide (KOH) and an alkali fluoborate salt preferably sodium fluoborate (NaBF₄) and/or potassium fluoborate (KBF₄). A composition containing these two principal ingredients not only effectively cleans the surface of the ferrous metal, but also make it bright and inhibits its discoloration. It also makes possible an operation in which the bath temperature is substantially lower than those heretofore employed, even as low as 750° and which requires a minimum of power in its functioning. Moreover, it permits the ingredients to be employed in proportions adapted to effect a low cost operation and makes possible the use of low cost equipment providing for a one-way current circuit.

The caustic alkali and the aforesaid alkali fluoborate salts may be used in any combination provided that at least one of each be employed. The caustic alkali operates in its customary capacity of a cleaner. The alkali fluoborate salt also serves as a cleaner to remove undesired dirt, scale and sand and, in addition, produces an effect in the process which at the present time is not fully understood, but which is believed to be that of a catalyst or agent that inhibits the formation of scum on the surface of the ferrous pieces, prevents discoloration thereof, and effects brightening of the same.

Of the aforesaid principal ingredients, we preferably

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use a mixture of sodium hydroxide and potassium fluoborate. The sodium hydroxide is less costly than potassium hydroxide, and the potassium fluoborate is more stable at the temperatures at which processing is carried out and particularly at relatively high temperatures. In this connection, sodium fluoborate has some tendency to slowly decompose at high temperatures.

The caustic alkali and fluoborate salts may be used in a wide range of proportions. The presence of very small amounts of the alkali fluoborate salt, for instance, even as little as one-half of one percent by weight of the composition will in many cases be sufficient to provide a satisfactory working composition. On the other hand, the presence of too much alkali fluoborate salt will produce a condition where this salt does not distribute uniformly in the batch but tends to flocculate. It is preferred that the upper limits of the alkali fluoborate salt be such amount as will be soluble in the molten caustic alkali or salts employed in the composition. Experimentally, we have determined that the alkali fluoborate salt may be used in an amount up to about 25% by weight of the caustic alkali, or stated otherwise, up to about one part by weight of the alkali fluoborate salt to four parts by weight of the caustic alkali.

By reason of cost, we prefer to use a composition in which the caustic alkali comprises the major portion of the principal ingredients of the composition, and in this connection have found that a good proportion for most purposes is about 97% by weight of caustic alkali and about 3% by weight of the alkali fluoborate.

Although not essential to the practice of the present invention, it will be understood that other salts may be added to the principal ingredients of the composition of our invention where desired for specific purposes or solely as extenders. For example, sodium fluoride may be added up to about 20% by weight of the composition as an auxiliary constituent for removing sand inclusions from the metal surface. Sodium borate or potassium borate may be added up to about 10% by weight of the composition as an additional cleaner and to supplement effective brightening of the metal surfaces, and sodium chloride may be added up to about 25% by weight of the composition as a diluent or inert filler to reduce cost. When these additive or extending materials are employed, they will in each case preferably replace equal parts by weight of the caustic alkali except in those instances where the alkali fluoborate salt is used in, at or near its maximum amount in which case a proportional part of the additive material in the ratio of the alkali fluoborate salt to the caustic alkali will replace a part of the alkali fluoborate salt. Moreover, when such additive materials are used in the composition of this invention, it is preferred that the combined weight of the caustic alkali and alkali fluoborate salts aforesaid employed in the composition should be at least 45% by weight of the composition.

In operation of our invention, a molten bath is prepared of the aforesaid principal alkali and salt ingredients, and any additive or extending salts, and heated to a temperature providing a fluent mixture in which all of the salts are completely dissolved. By reason of the nature of our composition, it has been found that a temperature of about 750° to 850° generally between 750° and 800° F. will be found to be sufficiently high to effect this result and that by maintaining the bath temperature within these ranges, good results will be obtained in the operation of our process. Sodium chloride, when used, tends to increase the temperature of the bath necessary for proper operation and is a reason for preferably limiting the amount thereof to not more than 25% by weight of the composition.

After preparation of the molten salt bath, the ferrous work pieces may be immersed therein either by means

of a perforated metal basket or some other conventional handling medium. An electric current is then applied to the work pieces or to the basket of such a nature that the work piece or the basket forms a cathode, with the bath receptacle or any other element positioned therein being made the anode. The amount of current that may be used may vary considerably. Such may be between 1 to 100 amperes per square foot depending upon the character of the ferrous work piece being treated and the rate of cleaning desired. By preference we have found that the current should be maintained for a time up to about twenty minutes, as required, to effect a complete removal of dirt, sand, and scale and leave a clean untarnished bright surface. It will be understood that where desired, suitable known equipment may be provided for effecting reversing of the current through the work piece at alternate intervals, but by reason of cost a unidirectional current is preferred.

As an example of a satisfactory operation for cleaning castings of gray iron we have found it possible to operate with a molten bath composed of a mixture of 97% by weight sodium hydroxide, commercial grade, and 3% by weight of potassium fluoborate, technical grade, at a temperature of 800° F. with a source of D.C. power capable of imparting 20 amperes per square foot of surface area to the castings being treated.

From the foregoing description of our invention, it will be apparent that we have provided a new and novel composition and process for cleaning and descaling ferrous articles. It will be understood that our invention is applicable to all ferrous and ferrous alloy containing structures and may also be possible of use for cleaning other metal work pieces although it is primarily intended for use in connection with ferrous metals. It will be apparent to those skilled in the art that various changes in the composition and specific steps of processing may be made without, however, departing from the spirit or intent of our invention, and hence all changes and modifications and equivalent compositions and process as may come within the purview of the appended claims are contemplated.

We claim:

1. A composition for a molten electrolytic ferrous metal cleaning bath comprising caustic alkali selected from the group consisting of sodium hydroxide and potassium hydroxide and mixtures thereof and alkali fluoborate salt selected from the group consisting of sodium fluoborate and potassium fluoborate and mixtures thereof, said alkali fluoborate salt being present in the proportion of about three parts by weight thereof to about 97 parts by weight of the caustic alkali.

2. A composition for a molten electrolytic metal cleaning bath comprising caustic alkali and alkali fluoborate salt, the combined weight of which is at least 45% of the total weight of the composition and of which said alkali fluoborate salt is between about ½ of 1% by weight of the composition and 25% by weight of the caustic alkali.

3. A composition for a molten salt bath for cleaning of metal by electrolysis therein comprising caustic alkali, sodium chloride in amount up to 25% by weight of the composition, and alkali fluoborate salt in amount between about ½ of 1% by weight of the composition and 25% by weight of the caustic alkali, said caustic alkali and alkali fluoborate salt combined being at least 45% by weight of the composition.

4. A process of cleaning metal comprising fusing a mixture comprising caustic alkali and alkali fluoborate salt to form a molten salt bath, immersing the metal to be cleaned in said molten bath, and directing electric current between said metal and said bath, said caustic alkali and alkali fluoborate salt combined being at least 45% by weight of said mixture and said alkali fluoborate salt being between about ½ of 1% by weight of said mixture and 25% by weight of the caustic alkali.

5. A process of cleaning ferrous metal work pieces comprising fusing a mixture comprising caustic alkali selected from the group consisting of sodium hydroxide and potassium hydroxide and mixtures thereof, and alkali fluoborate salt selected from the group of salts consisting of sodium fluoborate and potassium fluoborate and mixtures thereof to form a molten salt bath, immersing the ferrous metal to be cleaned in said molten bath as an electrode and passing an electric current therethrough, said caustic alkali and alkali fluoborate salt combined being at least 45% by weight of said mixture and said alkali fluoborate salt being between about ½ of 1% by weight of said mixture and 25% by weight of the caustic alkali.

6. A process of cleaning metal comprising fusing a mixture comprising caustic alkali in major amount by weight of the mixture and a minor amount up to about 3% by weight of the mixture effective to substantially inhibit scum and discoloration during cleaning of alkali fluoborate salt selected from the group of salts consisting of sodium fluoborate and potassium fluoborate and mixtures thereof, to form a molten salt bath, immersing the metal to be cleaned in said molten bath as an electrode, and passing an electric current therethrough.

7. An electrolytic process for removing dirt, sand, and scale from the surface of a ferrous metal work piece comprising fusing a mixture comprising caustic alkali and alkali fluoborate salt to form a molten salt bath, placing a ferrous work piece in said molten bath as an electrode while maintaining said bath at a temperature between about 750° F. and 850° F. and passing an electric current therethrough, said caustic alkali and alkali fluoborate salt combined being at least 45% by weight of said mixture and said alkali fluoborate salt being between about ½ of 1% by weight of said mixture and 25% by weight of the caustic alkali.

8. A composition for a molten electrolytic metal cleaning bath comprising caustic alkali, sodium fluoride salt in amount up to 20% by weight of the composition and alkali fluoborate salt in amount between about ½ of 1% by weight of the composition and 25% by weight of the caustic alkali, said caustic alkali and alkali fluoborate salt combined being at least 45% by weight of the composition.

9. A composition for a molten electrolytic metal cleaning bath comprising caustic alkali, alkali metal borate salt in amount up to 10% by weight of the composition, and alkali fluoborate salt in amount between about ½ of 1% by weight of the composition and 25% by weight of the caustic alkali, said caustic alkali and alkali fluoborate salt combined being at least 45% by weight of the composition.

10. A composition for a molten electrolytic metal cleaning bath comprising caustic alkali, sodium chloride salt in amount up to 25% by weight of the composition, sodium fluoride salt in amount up to 20% by weight of the composition, alkali metal borate salt in amount up to 10% by weight of the composition, and alkali fluoborate salt in amount between about ½ of 1% by weight of the composition and 25% by weight of the caustic alkali, said caustic alkali and alkali fluoborate salt combined being at least 45% by weight of the composition.

11. An anhydrous molten electrolytic bath for cleaning ferrous metals consisting essentially of an alkali metal hydroxide and at least 0.5% by weight of an alkali metal fluoborate salt.

12. A composition for a molten electrolytic metal cleaning bath for removing dirt, sand and scale from ferrous metals consisting essentially of alkali fluoborate salt and caustic alkali, said alkali fluoborate being in amount up to 25% by weight of the caustic alkali and sufficient to substantially inhibit discoloration of the ferrous metal and the formation of scum thereon by action of the bath.

13. A composition as claimed in claim 12 further in-

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cluding at least one member of the group consisting of sodium fluoride, sodium borate, potassium borate and sodium chloride, and wherein the combined weight of caustic alkali and alkali fluoborate is at least 45% of the total weight of the composition and the alkali fluoborate is sufficient in amount to substantially inhibit discoloration of the ferrous metal and the formation of scum thereon by action of the bath.

14. A composition for a molten electrolytic metal cleaning bath consisting essentially of caustic alkali selected from the group consisting of sodium hydroxide and potassium hydroxide and mixtures thereof and alkali fluoborate salt selected from the group consisting of sodium fluoborate and potassium fluoborate and mixtures thereof, said alkali fluoborate salt being in amounts up to 25% by weight of the caustic alkali and sufficient to substantially inhibit discoloration of the metal and the formation of scum thereon by action of the bath.

15. A composition for a molten electrolytic metal cleaning bath consisting essentially of sodium hydroxide and potassium fluoborate, said potassium fluoborate being in amount up to 25% by weight of the sodium hydroxide.

16. A composition for a molten electrolytic metal cleaning bath consisting essentially of caustic alkali and sodium fluoborate salt, said fluoborate salt being in amount up to 25% by weight of the caustic alkali.

17. A molten salt bath composition for cleaning ferrous metal by electrolysis therein consisting essentially of caustic alkali and additive salt selected from the group consisting of sodium fluoborate, potassium fluoborate, sodium fluoride, sodium borate, potassium borate and sodium chloride and mixtures thereof, said additive salt providing alkali fluoborate salt in amount sufficient to substantially inhibit discoloration of the ferrous metal and the formation of scum thereon by action of the bath and up to 25% by weight of the caustic alkali.

18. In a process for cleaning ferrous metal in a molten salt bath consisting essentially of caustic alkali by electrolysis therein, the improvement which consists in adding to the bath alkali metal boron and fluorine composition providing alkali fluoborate in amount up to 25% by weight of the caustic alkali and sufficient to substantially inhibit discoloration of the ferrous metal and the formation of scum thereon by action of the bath.

19. A molten salt bath composition for cleaning of metal by electrolysis therein consisting essentially of the

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molten product of heating to fusion caustic alkali and alkali fluoborate salt in amount between about $\frac{1}{2}$ of 1% by weight of the composition and an amount soluble in said molten caustic alkali.

20. A molten salt bath composition for cleaning of metal by electrolysis therein consisting essentially of caustic alkali and alkali boron and fluorine composition providing alkali fluoborate in amount sufficient to substantially inhibit discoloration of the metal and the formation of scum thereon by action of the bath and up to 25% by weight of the caustic alkali.

21. A composition for a molten salt bath for cleaning of metal by electrolysis therein consisting essentially of caustic alkali in amount between about 36 to 99 $\frac{1}{2}$ % by weight of the composition and alkali metal boron and fluorine composition between about $\frac{1}{2}$ % to 44% by weight of the composition and providing alkali fluoborate in amount sufficient to substantially inhibit discoloration of the metal and the formation of scum thereon by action of the bath.

22. A process of cleaning metal comprising fusing a salt mixture consisting essentially of caustic alkali in amount between 36 to 99 $\frac{1}{2}$ % by weight of the mixture and alkali boron and fluorine composition in amount between about $\frac{1}{2}$ % to 44% by weight of the mixture to form a molten bath providing alkali fluoborate, immersing the metal to be cleaned in said molten bath as an electrode and passing an electric current therethrough.

23. A composition for a molten electrolytic metal cleaning bath consisting essentially of caustic alkali, alkali metal borate in amount up to about 10% by weight of the composition, sodium fluoride in amount up to about 20% by weight of the composition and alkali fluoborate salt in amount up to about 25% by weight of the caustic alkali and sufficient to substantially inhibit discoloration of the metal and the formation of scum thereon by action of the bath.

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