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SEPARATING MEDIUM OR REFRACTORY PAINT FOR STEEL SHEETS

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The present invention relates to an improved separating medium to be applied to steel sheets to prevent the sheets from sticking or becoming welded together when subjected to high annealing temperatures.

An object of this invention relates to applying a smooth adhering film to the individual sheets so that the sheets may be handled without danger of the adhering film rubbing off and exposing bare spots which would result in sticking or welding of the stacked sheets when subjected to high annealing temperatures.

Other objects and advantages will become more apparent as the description proceeds.

In the process of manufacture of high quality electrical sheets, it is not only necessary to anneal the sheets at a high temperature, but at times it is also desirable to process them to a smooth bright finish before annealing. When such practice is followed, serious difficulties are frequently encountered in that the sheets become welded together when annealed at high temperatures.

In an attempt to overcome this difficulty, separating media have been used, such as lime, magnesia, alumina, silica, clay, etc. Most of these are applied in suspended form, the vehicle for suspension being generally water and the application made by means of rolls, sprays or dipping. The difficulties encountered with these separating media are that upon drying they are easily rubbed off, leaving bare spots where welding with an adjacent sheet may readily occur during the annealing operation. Another unfavorable feature to the use of these substances is that they form metallic hydroxides which release their water of hydration only at fairly high temperatures. This action produces a very detrimental effect on the magnetic and mechanical properties of silicon-iron sheets. Still another objection to the foregoing separating media is that at high temperature annealing, hard compounds are formed which adhere tightly to the surface of the sheet, thereby introducing punching difficulties generally resulting in low die life.

In order to overcome the foregoing difficulties, I have developed an inexpensive coating medium or paint which can be applied with an ordinary rubber roll coating machine and dried, leaving a smooth adherent film that will not rub off during handling prior to annealing, and is of great value in the processing of high quality electrical sheets.

The following is an example of the materials and manner of preparing the coating medium of the present invention.

Water and talc, which is a natural magnesium silicate, are ground in a ball mill to a paint-like consistency. The formula usually given for natural talc is $H_2Mg_3Si_4O_{12}$ (sometimes written as $H_2O \cdot 3MgO \cdot 4SiO_2$). The temperature of decomposition of the talc is below 850° C. The grinding is continued until the particles are reduced to a very fine size and are readily held in suspension.

To five parts, by volume of this talc-water suspension, I add one volume of a saturated solution of an organic salt of magnesium such, for example, as magnesium acetate, $Mg(C_2H_3O_2)_2$, and stir until thoroughly mixed. A solution including 600 grams of magnesium acetate per liter of water has been found satisfactory. Unsaturated solutions may be employed, but the avoidance of an excess of solvent is preferred by using the saturated solution.

The foregoing proportions may be varied depending upon the consistency and adhesive properties desired for the separating medium. The separating medium may be considered a coating or paint as the talc functions as a pigment, the magnesium acetate as the binder and the water as the vehicle.

A separating medium or paint of the foregoing proportions when applied to a sheet surface and dried at atmospheric temperatures or preferably by heating to a temperature not exceeding 200° C. (412° F.), the decomposition temperature of the magnesium acetate, produces upon the surface of said sheet a smooth, slippery feeling, adhering film. Sheets which have been so treated may be handled without danger of the material rubbing off by handling prior to stacking and exposing bare spots which would result in sticking or welding together of the sheets during the annealing operation.

When the coated sheets are subjected to the annealing treatment which may be carried out at temperatures reaching 1200° C. (2192° F.), the magnesium acetate and the natural talc have decomposed leaving magnesium oxide and finely divided carbon, while water and carbon dioxide are evolved. The latter are drawn from the furnace at low temperatures where their effect on the steel is negligible. A certain amount of silicon dioxide is always present on the surface of electrical, silicon-iron sheets. This silicon dioxide and the magnesium oxide interact and form a synthetic magnesium silicate, which presents a satin-like vitreous or glassy appearance and which crystallographically resembles the mineral enstatite ($MgSiO_3$—a silicic anhydrate of the meta-silicic acid H_2SiO_3), and is of rhombic form, as distinguished from the

natural talc-like magnesium silicate (a silicic anhydrate of the ortho-silicic acid H_4SiO_4 or $2H_2O \cdot SiO_2$), which is crystallographically of monoclinic form. A characteristic property of this coating is to raise the surface resistivity of the sheet. The finely divided carbon prevents oxidation of the sheet should any oxidizing gases or compounds be present. When annealing high silicon-iron sheets, oxidation at high temperatures is always possible, and although it is generally known that carbon may have deleterious effects by carburization, the carbon in the present case is distributed throughout the film of refractory talc and magnesia so that very little comes in contact with the sheet surface. When this does take place, there is always present sufficient oxygen in the form of some oxide of iron to prevent carburization.

After annealing, the sheets are brushed to remove any loosely adhering talc. The sheet now exhibits a smooth satin-like surface and may be used as such or further treated with varnishes having high dielectric characteristics. However, for many purposes the sheets need no further treatment in that the resulting surface possesses a high electrical resistivity. Furthermore, when such sheets are sheared or punched, the adhering synthetic refractory talc or synthetic magnesium silicate coating above identified does not impair the life of the dies, since talc is one of the softest refractory minerals known exhibiting no gritty or cutting tendencies, and the synthetic magnesium silicate refractory talc-like coating bonded to the surface of the sheet metal (in the presence of an excess of the magnesium and its oxide) is very thin, hardly ever more than one ten-thousandth of an inch in thickness, so that its effect on the cutting edge of the tool, such as a shear, would be practically negligible.

While I have specifically stated that this separating medium is especially desirable for silicon-bearing sheets, it would likewise be effective when applied to low carbon sheets.

While I have described a specific embodiment of the present invention, it will be seen that I do not wish to be limited exactly thereto, since various modifications may be made without departing from the scope of the invention, as defined by the following claims.

I claim:

1. A refractory paint to prevent sticking of steel sheets during annealing at high temperatures comprising essentially talc, magnesium acetate and water.

2. The method of treating steel sheets to prevent sticking of said sheets when annealed at high temperatures which comprises applying a coating including talc, magnesium acetate and water to the surface of said sheets to provide a smooth adhering film upon the surface thereof, subjecting the coated sheets to high annealing temperatures to decompose the magnesium acetate and removing the loosely adhering talc and magnesium oxide formed by the decomposition of the magnesium acetate from the surface of said sheets.

3. A refractory paint for the surface of electrical steel sheets including talc, magnesium acetate and water, said paint having characteristic properties which provide a high electrical resistivity of the surface of the sheet after it has been subjected to high annealing temperatures.

4. A refractory composition adapted to adhere firmly to the surface of electrical silicon-iron sheets under atmospheric conditions and adapted to prevent the sticking together of such sheets in overlapping relation at relatively high annealing temperatures as high as 1200° C., said composition including approximately five parts by volume of a talc-water suspension and one part of a saturated solution of magnesium acetate $Mg(C_2H_3O_2)_2$.

5. A refractory composition adapted when dry under atmospheric conditions to firmly adhere to the surface of sheet steel containing silicon dioxide and iron, and adapted to prevent said sheet from becoming bonded together with other sheets when placed in stacked relation and subjected to relatively high annealing temperatures of approximately 1200° C., said composition including a suspension of finely divided magnesium silicate in a water vehicle, and a solution of magnesium acetate whereby at the relatively high annealing temperatures the silica and magnesium interact to form a synthetic magnesium silicate surface coating for the sheets having a relatively high surface resistivity.

6. A refractory composition adapted to form at normal atmospheric conditions a smooth bright satin-like adherent coating for high quality electric sheet silicon steel, which coating will serve to prevent sheets of such steel from sticking together when stacked and subjected to annealing temperatures suitable to such electric silicon steel, said composition including a solution of magnesium acetate and a liquid suspension of an ortho-inorganic salt of magnesium, the magnesium component of the organic salt of said composition interacting with the siliceous-like component of the electric sheets at the relatively high annealing temperatures to form a synthetic magnesium silicate-like coating integrally heat-bonded to said sheets, and having the smooth bright satin-like appearance characteristic of the natural magnesium silicate talc composition.

7. A refractory composition adapted to form at normal atmospheric conditions a smooth bright satin-like adherent coating for electric sheet silicon steel, which coating adheres firmly and permits of normal handling of the sheets without damage to the coating prior to annealing and will serve to prevent sheets of such steel from sticking together when stacked and subjected to annealing temperatures suitable to such electric silicon steel, said composition including a solution of magnesium acetate and a liquid suspension of finely divided natural talc, the magnesium component of said composition interacting with the siliceous-like component of the electric sheets at the relatively high annealing temperatures to form a synthetic talc-like coating heat-bonded to said sheets, and having the smooth bright satin-like appearance characteristic of the natural magnesium silicate talc composition.

8. A refractory composition including a solution of magnesium acetate and adapted to adhere firmly to the surface of metal sheets when applied at atmospheric temperatures to form a smooth bright satin-like coating and adapted to form a continuous protective coating when dried on said sheets and to withstand handling during stacking of said sheets prior to annealing without danger of said dried coating rubbing or brushing off.

9. A refractory composition including a solution of an organic salt of magnesium acetate and an inorganic salt of magnesium held in suspension therein adapted to adhere firmly to the surface of metal sheets when applied at atmospheric

temperatures to form a smooth bright satin-like continuous protective coating when dried on said sheets and to withstand handling during stacking of said sheets prior to annealing without danger of said dried coating rubbing or brushing off, said composition including finely divided magnesium silicate having the formula

$$H_2O.3MgO.4SiO_2$$

and decomposing below a temperature of 850° C., said organic salt including an acid organic radical and a basic metal which functions as a vehicle when of liquid or plastic consistency, and as a binder for the inorganic salt suspension when dry at normal atmospheric conditions.

10. A temporary low temperature protective covering for iron or steel including a composition including acetate salt of magnesium and an inorganic ortho-silicate salt of magnesium.

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