Nov. 23, 1954 M. N. ORNITZ ET AL 2,695,248

FURNACE CONVEYER ELEMENT AND MANUFACTURE THEREOF

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Fig. 1.

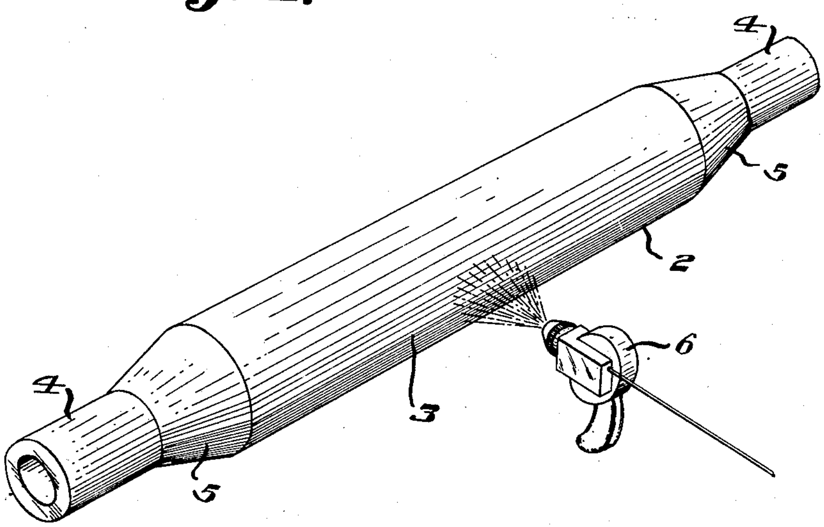
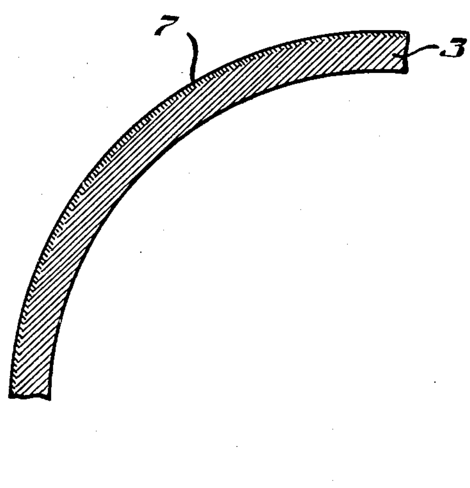


Fig. 2



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FURNACE CONVEYER ELEMENT AND MANUFACTURE THEREOF

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6 Claims. (Cl. 117—65)

This invention relates to furnace conveyor elements and the manufacture thereof. It has to do with furnace conveyor elements on which work is supported and advanced through heating furnaces to be heated therein and to the making of such elements. A purpose of the invention is to provide furnace conveyor elements which are superior in that they have no deleterious effect upon the work carried thereby in the presence of the furnace atmosphere at temperatures above 1200° F., as, for example, in the annealing of sheets at about 1600° F., yet are of relatively simple construction and economical to manufacture.

Our invention is applicable to furnace conveyor elements and the manufacture thereof generally but for purposes of explanation and illustration the invention will be described as embodied in a furnace conveyor roll and as practiced in the manufacture of such a roll. We shall describe the structure and manufacture of a roll for conveying sheets through an annealing furnace.

Those skilled in the art are aware of the difficulties encountered in the use of metallic conveyor elements in heating furnaces. For example, conveyor rolls used in sheet annealing furnaces tend to collect accretions of material from the sheets which dent the sheets passing thereover. The problem is particularly acute in the treatment of high silicon steels and other steels requiring high annealing temperatures. The phenomenon of accretion formation is complex and is influenced by the composition of the sheets carried by the rolls and the composition and temperature of the furnace atmosphere as well as the character of the roll surface. The problem and one solution of it are explained in Patent No. 1,951,766. That patent teaches the use of refractory inserts such as inserts of silicon carbide in furnace conveyor elements, the refractory inserts engaging the work passing through the furnace. While no oxide coating forms on silicon carbide inserts and such rolls are satisfactory for certain steels, it has been found that accretions do form on the surface of silicon carbide inserts when used in the annealing of high silicon steels. Furthermore, the provision and application of the refractory inserts entail substantial labor and expense. The present invention is an improvement rendering refractory inserts unnecessary.

We provide a furnace conveyor element having an oxidized surface which has the advantages of refractory inserts as in Patent No. 1,951,766 but can be fabricated at materially reduced cost, provides a generally superior construction and has wider application. We provide a metal conveyor element body having silicon in the range 30–70% at a surface portion thereof and oxidize that surface portion to form on the conveyor element a work-engaging portion consisting chiefly of a stable saturated ferrous silicate which in the presence of the furnace atmosphere does not adversely affect the work. Our rolls of this character have proven satisfactory for carrying high silicon steel sheets through annealing furnaces without accretion formation and consequent damage to the steel sheets.

Our furnace conveyor element may be made by applying ferro-silicon to a surface portion of a metal conveyor element. The silicon in the ferro-silicon should be between about 30% and about 70% by weight, the remainder being substantially all iron. If the percentage of silicon or the percentage of iron is raised substantially above 70% the results obtained are not fully satisfactory. The best results are obtained if the percentages of silicon and iron are approximately 50% each, or held to the range between 40% and 60%.

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The ferro-silicon may be applied to the conveyor element body in any suitable way. We find it convenient to spray the ferro-silicon onto the conveyor element body using any metalizing spray gun as well known in the art. The thickness of the ferro-silicon coating should be between about .005″ and about .030″. To be desirably effective the thickness of the coating should be not less than .005″, while if the thickness of the coating is increased materially beyond .030″ the coating is subject to spalling. The coating is brittle and is effective when maintained within the thickness limits indicated. We prefer to apply the ferro-silicon to the conveyor element body in a thickness of about .015″.

The conveyor element body with the ferro-silicon applied to the surface thereof is slowly heated to a temperature in the neighborhood of 1600° F. to bond the coating to the body and to oxidize the coating. The body is brought up to temperature slowly to prevent spalling of the coating due to difference between the thermal expansion of the roll and the thermal expansion of the brittle coating and is held at 1600° F. in an oxidizing atmosphere for a sufficient time to form a stable oxide. Conveniently the heating may be effected in stages at successively higher temperatures until a temperature of about 1600° F. is reached, at which temperature the roll is held for about two hours.

The heat treatment of the coating converts it to a large extent into a stable oxide and also bonds it to the roll surface by alloying at the interface between the roll surface and the coating. A very stable ferrous silicate saturated with iron and silicon is formed. Excess iron and silicon may be present in the form of an alloy. It is critical to the general application of our roll to high temperature annealing of ferrous sheets that both iron and silicon be present and that the oxidized coating or ferrous silicate surface be saturated with both iron and silicon, under which conditions the surface of the roll is stable or noble with respect to the surfaces of sheets carried by the roll and accretion formation on the roll surface does not occur. The ratio of each of iron and silicon in the coating is in the range 30–70%. The best results are obtained with about 50% each of iron and silicon, within a tolerance of 10% either way, or within the range of 40%–60%.

In the accompanying drawings we have illustrated a present preferred method of practicing the invention and have shown a present preferred form of furnace conveyor element prepared in accordance therewith, in which

Figure 1 is a perspective view of a furnace conveyor roll shown as having its work-engaging surface sprayed with ferro-silicon;

Figure 2 is a diagrammatic fragmentary cross-sectional view to enlarged scale through the body of the roll;

Figure 3 is a diagrammatic and fragmentary plan view of a lower portion of a sheet steel annealing furnace having rolls therein of the kind illustrated in Figures 1 and 2, said plan view being taken generally along line III—III of Figure 4; and

Figure 4 is a diagrammatic and fragmentary view in elevation of the furnace portion shown in Figure 3 taken generally along line IV—IV thereof.

Referring now more particularly to the drawings, a hollow furnace conveyor roll is designated generally by reference numeral **2**. The roll comprises a body or work-engaging portion **3**, necks **4** and conical portions **5** joining the necks to the roll body. The roll may be a steel or alloy roll of known composition. There is provided means for spraying finely divided ferro-silicon onto the roll body **3**, such means being shown diagrammatically in Figure 1 as a metalizing gun **6** by which the finely divided ferro-silicon is melted and applied. Preferably the roll is rotated and the gun traversed along the roll until the roll body **3** is covered to the thickness desired.

The rolls **2** may be rotatably mounted by their journals **4** in bearings **8** set just outside refractory walls **9** of an annealing furnace **10**.

The roll body is covered with ferro-silicon to a depth approximating .015". Preferably the ferro-silicon contains 50% iron and 50% silicon. The roll with the ferro-silicon thereon may then be heated slowly to a temperature of about 1600° F., taking several hours to reach that temperature, to bond the coating to the roll without spalling, and the temperature of the roll may then be held at 1600° F. for about two hours in air to oxidize the silicon. The coated and treated roll is cooled in the furnace; the cooling may take about eight hours. By this treatment the coating is alloyed to the roll face and there is formed a very stable ferrous silicate saturated with iron and silicon with excess iron and silicon probably also present. Each of iron and silicon is present in the coating in the range 30–70%.

Figure 2 shows the roll body at 3 and the coating at 7. Due to the extreme thinness of the coating it is difficult to illustrate, but Figure 2 is intended to indicate in more or less diagrammatic fashion the ferrous silicate coating and the bonding of the coating to the roll body.

When conveyor elements other than rolls are made the process employed is generally the same, the coating being applied to the surface portion or portions of the conveyor element normally coming in contact with the work during operation of the furnace.

While we have shown and described a present preferred embodiment of the invention and have illustrated a present preferred method of practicing the same, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

We claim:

1. A method of making a furnace conveyor element comprising depositing ferro-silicon containing between about 40% and about 60% by weight of silicon onto the surface of a metal conveyor element body to form thereon a coating of ferro-silicon having a thickness between about .005" and about .030", gradually heating the surface of the metal conveyor element body and the coating of ferro-silicon thereon to raise them slowly to a temperature in the neighborhood of 1600° F. to bond the ferro-silicon to the body and holding the same in the presence of oxygen at the said temperature in the neighborhood of 1600° F. to oxidize the ferro-silicon to a ferrous silicate compound, whereby in the use of such conveyor element the formation of accretions thereon may be avoided.

2. A method of making a furnace conveyor roll comprising depositing ferro-silicon containing about 50% by weight of silicon onto the peripheral surface of a metal roll body to form thereon a coating of ferro-silicon having a thickness of about .015", gradually heating the surface of the roll and the coating of ferro-silicon thereon to raise them to a temperature in the neighborhood of 1600° F. to bond the ferro-silicon to the roll body and holding the same in the presence of oxygen at the said temperature in the neighborhood of 1600° F. to oxidize the ferro-silicon to a ferrous silicate compound, whereby in the use of such conveyor element the formation of accretions thereon may be avoided.

3. A conveyor element for a metal heat-treating furnace or the like, comprising, in combination, a metallic conveyor element body, a coating on the surface of said body to engage work and to inhibit accretions, said coating consisting essentially of ferrous silicate saturated with iron and silicon, the weight of silicon in said coating relative to the combined weights of iron and silicon being between about 30% and about 70%, said ferrous silicate being a deposit of iron and silicon on said surface of

said body which has been oxidized in place, said coating further having a thickness of not less than about 0.005 inches, said coating still further being firmly adherent to said surface of said body and having a smooth outer surface extending over the work-supporting area of said body.

4. A conveyor element for a metal heat-treating furnace or the like operative at about 1200° F. or above, comprising, in combination, a metal conveyor element body, a coating bonded to the surface of said body to engage work and to inhibit accretions, said coating consisting essentially of ferrous silicate saturated with iron and silicon, said ferrous silicate being formed by depositing and oxidizing ferro-silicon on said surface of said body to form a firmly adherent coating in situ, the weight of silicon in said ferrous silicate relative to the combined weights of iron and silicon therein being between about 30% and about 70%, said coating having a smooth outer surface extending over at least the work-supporting surface portion of said body, said coating further having a thickness of not less than about 0.005 inch.

5. A conveyor roll for a metal heat-treating furnace or the like operative at about 1200° F. or above, comprising, in combination, a roll body of steel or alloy, a coating adhering to the surface of said body to engage ferrous work and inhibit accretions, said coating consisting essentially of ferrous silicate saturated with iron and silicon, said ferrous silicate being formed by depositing ferro-silicon on said surface of said body and oxidizing said ferro-silicon in place, the weight of silicon in said ferrous silicate relative to the combined weights of iron and silicon therein being between about 30% and about 70%, said coating having a smooth outer surface extending over at least the work-supporting portion of said surface of said body to a thickness of at least about 0.005 inch, said coating being firmly bonded to said surface of said body at the interface between said coating and said surface.

6. A method of making a furnace conveyor element comprising depositing ferro-silicon containing about 30% to about 70% by weight of silicon onto the surface of a metal conveyor element body to form therein a coating of ferro-silicon having a thickness between about .005 inch and about .030 inch, gradually heating the surface of the metal conveyor body and the coating of ferro-silicon thereon to raise them slowly to a temperature in the neighborhood of 1600° F. to bond the ferro-silicon to the body, and holding the same in the presence of oxygen at the said temperature in the neighborhood of 1600° F. to oxidize the ferro-silicon to a ferrous silicate compound, whereby in the use of such conveyor element the formation of accretions thereon is inhibited.

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