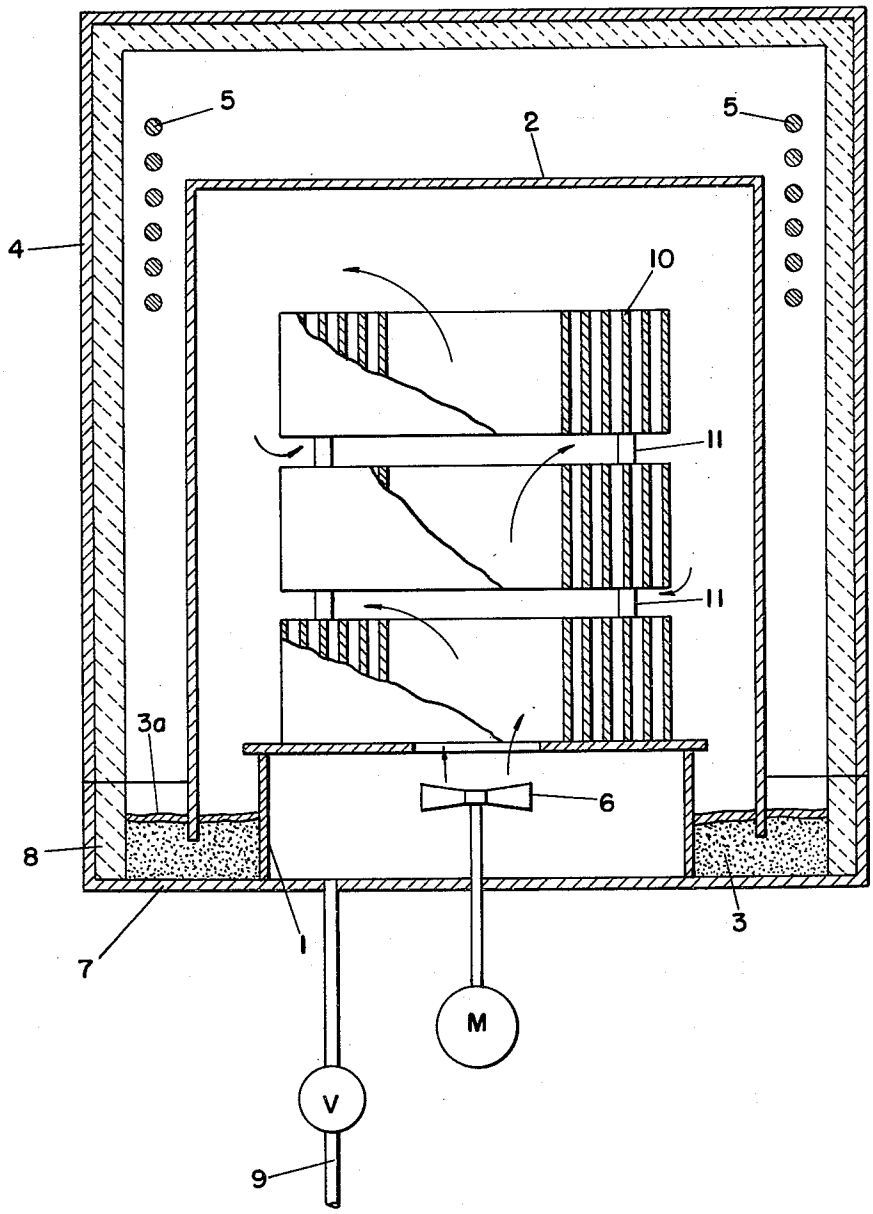
Oct. 18, 1960 C. J. BUNCZK 2,956,914

METHOD OF SEALING ANNEALING FURNACES

Filed Nov. 10, 1958



United States Patent Office 2,956,914 Patented Oct. 18, 1960

2,956,914

METHOD OF SEALING ANNEALING FURNACES

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Filed Nov. 10, 1958, Ser. No. 773,088

6 Claims. (Cl. 148—13)

This invention relates to a method for sealing annealing furnaces. More specifically, this invention relates to means for sealing the inner covers of annealing furnaces within which annealing gases circulate in order to prevent sand and other foreign solid particles being drawn up and suspended in the annealing atmosphere.

The present-day mill practice in the steel industry is to provide annealing furances for coils with fans to circulate annealing gas within the inner covers. The trend is toward the use of such powerful fans that sand is often sucked up from the base of the furnace, swirled around within the cover, and deposited on the coils to which it adheres firmly, thus often resulting in a high percentage of rejected coils after the annealing operation. There may, at times, be almost one hundred percent of rejects on the basis of adherent sand.

It is an object of the present invention to provide a method for eliminating the preceding cause for coil rejects in current steel mill annealing practices.

Further details and advantages of my invention will be apparent from the following specification and accompanying drawing, wherein

The figure is a diagrammatic vertical cross-sectional view of a conventional bell-type furnace used for annealing coils of steel by the batch process.

Referring to the drawing, the figure illustrates a conventional bell-type furnace used for annealing steel by the batch process. This type of furnace is variously known as a box-, coil-, pack-, or cover-annealing furnace. Steel coils **10** are stacked on a permanent stand or stool **1**, suitable separators **11** being placed between the coils in order to assist in distribution of the annealing gas. A light cylindrical inner shell or cover **2** is placed over the stack of coils so as to confine the annealing gas and is sealed at the bottom with comminuted inert material **3**, such as sand or other powdered refractory, such as periclase, olivine or clay. The furnace hearth may have from one to eight stands or stacks protected by such inner covers. A portable furnace shell **4** maneuvered by means of a crane, is dropped into place upon the hearth at the curb **8** completely enclosing the inner cover. The heating between the furnace shell and the inner covers may be by direct firing, indirect firing by means of radiant tubes, or by means of electrical resistance units indicated by numeral **5**. The heating elements **5** are born by the inside of the heating cover **4** which is built of refractory-lined steel. The inner shells **2** are preferably constructed of a heat-resisting alloy.

Natural gas or some other inert or reducing gas is supplied through line **9** and is circulated within the inner shell by means of a fan **6** located in the stool **1** below each stand. The inner shells **2** are usually cylindrical having a closed end and an open end. The outer heating covers may be either box- or bell-shaped.

In the annealing procedure now in current use, the coils **10** are placed on the stool **1** and the inner shell **2** is then placed with its open end on the sand **3** so that the edge sinks into the sand to provide a closed annealing

chamber in which the coils **10** are positioned. Loose sand **3** may then be piled at the exterior edge portion of the stand **1** to complete the seal to the annealing chamber. The outer shell **4** is then positioned over the inner shell **2**. When the annealing cycle is started after coils, inner covers, and outer shell are in place, convection currents from the fan **6** tend to suck loose sand **3** from the base, suspending it in the annealing atmosphere, and much of it subsequently becomes strongly adhered to the coils stacked therein.

I have now found that if the loose sand **3** serving as a seal on the base **1** is treated with a suitable amount of an aqueous solution of binder, such as sodium silicate, a sufficiently dense crust **3***a* is formed so as to prevent the sand from being drawn into the circulating gas in the annealing chamber formed by inner shell **2**. Thus, I prevent any sand or other foreign particles from being blown around and circulated within the inner covers when the fans are started or while they are in motion. If desired, I may also incorporate a polyphosphate to assist in this effect. Not only sand, but also refractory powder originating from gradual spalling of the refractory bases, curbs, walls, and roofs of the furnace, as well as other powdered refractory sealing materials, are prevented in this manner from being deposited on the steel coils when the fans are turned on or during the subsequent course of annealing.

In a comparative experiment, 338 coils were annealed by spraying the sand with a solution containing sodium silicate. Fifty-five percent of the coils showed no adhering sand whatsoever after annealing, as compared with only 5% which were sand-free when annealed in furnaces by the usual method without sand spraying. In these runs, the spray was applied by hand, using a sprinkling can of the type used in gardening. In carrying out these comparative tests, a furnace was used having four stacks; two were sand sealed without sodium silicate spray and two were sand sealed with sodium silicate spray. The remarkable decrease in percentage of rejects heretofore described was thus obtained under strictly comparable conditions. Approximately four gallons of sodium silicate solution were employed per stand. The sand area covered for each stack was approximately 50 square feet.

The sodium silicate solution used in the preceding example was obtained by dilution of one part of "Star Brand" sodium silicate solution supplied by Philadelphia Quartz Company, Philadelphia, Pa., with three parts of water. The solids content of the solution sprayed onto the sand was approximately 9.5% as combined sodium and silicon oxides, present in the ratio of 1/2.50 as hereinafter described. I spray a sufficient amount of sodium silicate solution to form a crust on the surface of the sand or to bond the sand particles so that they will not be drawn into the annealing gas atmosphere. For example, I may spray ¾ pound of the diluted "Star Brand" sodium silicate solution for each square foot of sand area exposed within the inner shell. In order to obtain a satisfactory seal, I find it advantageous to use from about ¼ pound to about 1 pound of the diluted "Star Brand" sodium silicate solution previously described for each square foot of sand exposed.

In another run, an aqueous solution containing 2% by weight of sodium tripolyphosphate and 50% by weight of "Star Brand" sodium silicate solution was employed with similar results.

In general, I may employ aqueous silicate solutions containing combined sodium and silicon oxides in the amount of from about 4% to about 40% by weight with or without sodium tripolyphosphate in an amount up to about 10% by weight of the solids content of the silicate.

A further advantage of my process is that the sand

sprayed with silicate can easily be reclaimed and reused after the annealing cycle.

The beneficial action of sodium silicate in my process is unique. The same effect is not obtained with any other adhesive which I have tried. I have, for example, sought to use urea-formaldehyde resin solutions, polyvinyl acetate emulsions, kelgin solutions, and solutions of sodium carboxymethyl cellulose, all without success.

Although I prefer to use sodium silicate solutions in my process, I may also employ corresponding potassium silicate compositions. In preparing my liquid sand sealer compositions for use according to the process of this invention, I prefer to employ commercially available aqueous solutions of sodium silicate such, for example, as that known under the trade name of "Star Brand" sodium silicate sold by the Philadelphia Quartz Company or that known commonly as "water glass." In general, dry powders dissolved in water are not as effective as such commercially available silicate solutions. I may, however, if desired, prepare my aqueous solutions from dry sodium silicate having a weight ratio of Na_2O to SiO_2 in the order of 1:3.22 such, for example, as "G Brand" sodium silicate solution supplied by the Philadelphia Quartz Company. In such cases, I dissolve from 4 to 25 parts by weight of said dry silicate in sufficient water to yield one hundred parts of solution.

The "Star Brand" sodium silicate solution herein employed possesses a weight ratio of Na_2O to SiO_2 of 1/2.50 and a specific gravity of 1.408. It contains about 38–40% of solids as combined sodium and silicon oxides. Although I prefer to use this grade of sodium silicate, I may if desired use any aqueous sodium silicate solution containing a weight ratio of sodium oxide to silicon dioxide ranging from about 1/3.75 to about 1/2.00. I may also use potassium silicate solutions containing molar ratios of combined K_2O and SiO_2 ranging from about 1/4.00 to about 1/3.00. The viscosity of the solution is correspondingly adjusted to permit ease of spraying and to attain adequate sealing. Under conventional annealing furnace operations the silicate solutions sprayed on the loose sand will serve to bond the particles to a sufficient extent so as to form a frangible seal at the joint of the inner shell and supporting base.

Although I prefer to spray the silicate solution on the surface of the sand after it is piled on the base at the joint between the inner shell and supporting base, I may first mix the sand and silicate solution in suitable proportions and suitably apply the prepared composition as a calking for the joint so as to seal same. During the annealing cycle, the sand particles are thus sufficiently bonded so that they will not be drawn within the annealing chamber and at the same time the seal is frangible so that it will not offer any substantial resistance in opening the inner shell after the annealing cycle is completed. Inasmuch as the seal is frangible, the sand can be easily reclaimed and reused.

I claim:

1. The method of sealing an annealing chamber formed by a removable shell having its open end supported on a base which comprises applying a sealing composition at the lower portion of said shell adjacent said base, said composition comprising sand and an alkali silicate solution.

2. The method of sealing an annealing chamber formed by a removable shell having its open end supported on a base which comprises applying a sealing composition at the lower portion of said shell adjacent said base, said composition comprising sand and sodium silicate solution containing from about 4 to about 40% by weight of combined sodium and silicon oxides.

3. The method of sealing an annealing chamber formed by a removable shell having its open end supported on a base which comprises applying a sealing composition at the lower portion of said shell adjacent said base, said composition comprising sand and sodium silicate solution containing from about 4 to about 40% by weight of combined sodium and silicon oxides and sodium tripolyphosphate in amount up to about 10% by weight of the solids content of said silicate solution.

4. The method of sealing an annealing chamber formed by a removable shell having its open end supported on a base which comprises applying a sealing composition at the lower portion of said shell adjacent said base, said composition comprising sand and sodium silicate solution containing from about 4 to about 40% by weight of combined sodium and silicon oxides and in amount from about ¼ pound to about 1 pound for each square foot of exposed sand in said composition.

5. A portable annealing shell having a closed end and an open end, said open end being supported on a base, a layer of refractory comminuted material carried on said base, the open end of said annealing chamber being buried and sealed by said comminuted material, the exposed surface of said comminuted material being bonded to prevent loose particles of said comminuted material from being blown around and circulating within the annealing chamber.

6. A portable annealing shell having a closed end and an open end, said open end being supported on a base, a layer of sand carried on said base, the open end of said annealing chamber being buried and sealed by said sand, the exposed surface of said sand being bonded by an alkali silicate to prevent loose particles of said sand from being blown around and circulated within the annealing chamber.

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