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METHOD OF CASTING COPPER

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This invention relates to the production of end-cast copper cakes and provides a method by which sound cakes having substantially parallel sides are readily cast in an upright, water-cooled mold.

That improvement in the copper cakes themselves would go a long way toward the production of perfect copper sheets by the mills has long since been recognized by workers in the art and the passing years have witnessed the gradual disappearance of both the old flat cake and its successor the edge cake in favor of a cake cast on its end and having sides which are parallel or, at most, only slightly tapering.

By casting the cakes on end, the impurities and the oxidized or set surface are confined to the top end of the cake which permits either the removal of the set with a minimum of sawing before rolling or its ready removal, with a minimum amount of scrap, by cropping only one end of the rolled sheet. This is a distinct advantage over the edge cake which, in rolling, results in a sheet having an imperfect marginal portion along the entire side of the sheet corresponding to the set edge and which must be removed, as well as over the flat cake which, in rolling, necessarily imparts imperfections to the entire sheet from the set surface.

A common difficulty encountered in the casting of copper cakes is the "sweating" on the sides and bottom of the cakes which is the formation thereon of fine particles like drops of copper and which is commonly attributed to the shrinkage of the cake at its outside while the interior is still molten and the exudation of droplets of copper through to the surface of the cake. The resulting irregularities on the cakes, if removed, increase the cost of production and reduce the efficiency of the casting operation and, if not removed, impart imperfections such as blisters, slivers and the like to the rolled sheet.

Aside from the imperfection of the cakes or the sheets rolled therefrom, sweating may also cause the cakes to stick in the molds particularly if the mold is deep and has parallel or only slightly tapering sides. Inasmuch as a cake cast on end and with little or no taper is desired by reason of the advantages which it possesses as heretofore noted as well as by reason of the advantage in rolling which a cake of uniform width possesses over a wedge-shaped cake as is produced in molds having a substantial taper to facilitate release of the cake therefrom, it will be appreciated that the sweating difficulty is most acute in the production of end-cast cakes.

Among other features, the present invention provides a method of casting copper cakes by which the sweating of the cakes is virtually eliminated.

In accordance with the invention, the cakes are cast in water-cooled, copper molds, the interiors or cavities of which have been previously coated with a mold wash or dressing of at least a minimum thickness, it having been found in actual practice that if the mold wash or dressing is sufficiently thick, the objectionable sweating of the cakes will be virtually eliminated. Thus, with respect to known practice of casting copper by pouring the molten metal into a vertically-disposed copper mold having parallel or slightly tapering sides, the cavity of which has received a thin coating of mold wash to prevent the metal from adhering to the walls of the cavity, the present invention may be said to consist essentially in applying such a thick coating of mold wash or dressing that sweating of the cakes is precluded.

The importance of this discovery is amply evidenced by the fact that whereas it is positively stated by some workers in the field that cakes of high grade and uniform character throughout cannot be produced by cooling the molds with water from the ordinary service pipe supply (50° F.—60° F.) sound end-cast cakes with at most only slightly tapering sides have been commercially produced by employing the present invention and using only ordinary tap water as the cooling medium for the molds.

In practicing the invention the cavities of the water-cooled, copper molds, at a proper temperature, are coated with a mold dressing which is built up to a minimum critical thickness as by flushing or spraying. Bone ash and water in suitable proportions make a very good mold dressing although it will be appreciated that equivalent mold dressing compositions which will yield the desired result, i. e., prevent sweating of the cakes may be utilized.

Following the application of mold dressing of the proper thickness the molten copper is poured into the top of the mold and cooled by circulation of cooling fluid through the passageways in the mold wall. The rate at which the molten copper is introduced into the mold is a factor to be considered as it has been found that by pouring the metal slowly perfect cakes are obtained by minimizing shrinkage cavities producing a more level set, etc., all of which contribute to improved cakes and better sheets. Accordingly, for a 600 pound cake the pouring period is from one

to two minutes as contrasted to earlier practice of say, 25 to 50 seconds. The cake is dumped from the mold following solidification and being free from sweat and of substantially uniform width with the set confined to one end, it constitutes an ideal product for the mill. By rolling and cropping off the end of the sheet corresponding to the set end of the cake, and which must be trimmed anyway, there is produced a sheet of copper of exceptional soundness.

The tests next described and the results obtained will serve to illustrate the invention and manners in which it may be practiced.

A series of molds were taken from service and the walls of the cavities were brushed with a steel brush until the surfaces were thoroughly clean. The mold cavities measured in each instance 30" x 18" x 4" which may be regarded as standard size. A series of mold washes were prepared by mixing bone ash with water so that a series of mixes ranging from 15° Bé. to 45° Bé. gravity were obtained. Coatings of bone ash were built up on the walls of the cavity of each mold to predetermined thicknesses, until no further application of the bone ash could be practically made. The molds were maintained at definite temperatures and the minimum thickness of the coating was determined for each temperature that would give castings free from sweating. It was found to be necessary for the bone ash coating to be uniform in thickness and free from irregularities of surface. It was found that if the mold walls became too hot, the coatings were blistered and irregular, due to the imperfect evaporation of the water employed in the mold washes in contact with the hot surfaces of the mold. The weight of the bone ash in the coatings used was determined by cleaning the coatings from the mold, accurately collecting the bone ash forming each coating, and weighing accurately the collected bone ash.

In the following tables, the "condition of mold coating" indicates the degree of smoothness and evenness of the coating of the mold dressing on the surfaces of the mold cavity. The results of the tests are summarized as follows:

Mold wash—45° Bé. gravity

Temperature of mold	Weight of bone ash	Condition of mold coating	Condition of cast cake
° F.	Grams		
170	130	Excellent.....	Free from sweat.
194	144	do.....	Do.
210	300	Good.....	Do.
246	343	Bad (surface pitted and irregular).	Free from sweat, but rejected for bad surface.

Mold wash—35° Bé. gravity

° F.	Grams	Condition of mold coating	Condition of cast cake
160	45	Fair.....	No sweat but irregular surface.
180	41	Good.....	Slight sweating; approximately low limit of permissible amount of mold coating.

Mold wash—35° Bé. gravity

° F.	Grams	Condition of mold coating	Condition of cast cake
207	76	Good.....	Free from sweat.
242	59	do.....	Do.
300	33	Bad (surface pitted and irregular).	Sweet and bad surface.

Mold wash—25° Bé. gravity

° F.	Grams	Condition of mold coating	Condition of cast cake
190	25	Bad (surface thin in spots and heavier in others).	Sweat and bad surface.
220	34	Good.....	Cake sweated.
242	36	do.....	Do.

Mold wash—15° Bé. gravity

° F.	Grams	Condition of mold coating	Condition of cast cake
160	4	Bad (molds imperfectly covered).	Sweat and bad surface.

In each of the above tests, the mold dressing was applied by flushing the bone ash-water composition onto the surfaces of the mold cavity. The mold walls were heated to the specified temperatures by steam before the mold dressing was applied. The tests indicated that if sweat occurs on the cakes, the remedy is to thicken the coating of bone ash.

When a clean new mold is taken, it is desirable to flush it with a dressing of not less than 35° Bé. gravity. As the use of the mold is repeated, a thinner mixture may be used, as the previous additions of bone ash are not completely removed.

As a further test, castings were made using what was previously considered to be the standard mold wash. A 10° Bé. mixture of bone ash and water was sprayed over the surfaces of a thoroughly cleaned mold cavity, the mold temperature being from 245° to 250° F. The weight of the coating was 21 grams. The coating had a good smooth surface, but was thin, and the cake had a sweated surface.

The tests indicate that the coating of mold dressing, in order to prevent sweating of the cakes, should be preferably at least substantially twice as thick as the coating employed in accordance with what has been referred to as standard practice, the above figures indicating that a minimum thickness of the bone ash dressing corresponding to approximately at least 4.24 grams of bone ash uniformly distributed over each square foot of mold surface, is required to uniformly prevent sweating of the cast cakes.

It may be mentioned that the operation of the present process in the manner described enables the utilization of a wide range in the temperature of cooling water employed for cooling the walls of the mold during casting operations. Good cakes have been made using ordinary so-called tap water from any conventional supply thereof and at the usual ranges of temperature of such tap water.

Although certain embodiments of the invention have been described above in considerable detail, yet it is not to be understood therefrom that the invention is restricted to the particular embodiments disclosed, and it is understood that various modifications may be made by those skilled in the art without departing from the spirit of the invention, it being intended and desired to embrace within the scope of the invention such modifications and changes as may be necessary to adapt it to varying conditions and uses.

The present application is a continuation-in-part of Lindner and Poland, Serial No. 741,276 filed August 24, 1934.

What is claimed is:

1. A method of casting copper which comprises pouring molten copper into a mold, the cavity of which is coated with a layer of bone ash mold

dressing applied at a predetermined temperature range of from substantially 180° F. to substantially 245° F. and of a thickness corresponding to at least that obtained by uniformly spreading at least approximately 41 grams of bone ash over the surfaces of a mold cavity of the dimensions of substantially 30" x 18" x 4".

2. A method of casting copper which comprises applying to a mold cavity a dressing of bone ash and water of not less than substantially 35° Bé. gravity until there is formed a coating of sufficient thickness to prevent sweating of a copper cake cast in the mold, the said thickness being equivalent to at least the thickness obtained by spreading approximately 4.24 grams of bone ash over each square foot of mold cavity surface, and pouring molten copper into the mold.

3. A method of casting copper which comprises heating a mold to a temperature not exceeding approximately 245° F., applying to the cavity of the mold a dressing of bone ash and water of not less than substantially 35° Bé. gravity until there forms a coating of sufficient thickness to prevent sweating of a copper cake cast in the mold, the said thickness corresponding to at least that obtained by spreading at least approximately 4.24 grams of bone ash over each square foot of mold surface, and pouring molten copper into the mold.

4. A method of casting copper cakes to prevent sweating thereof which comprises pouring copper into a mold provided with a heavy coating of bone ash mold dressing, the said coating being in proportions of substantially at least 41 grams of bone ash uniformly distributed over the surfaces of a mold cavity having the dimensions of substantially 30" x 18" x 4".

5. A method of preparing copper sheets which comprises pouring molten copper into the open end of a vertically disposed mold, the cavity of which is provided with a heavy smooth-surfaced and uniform coating of bone ash mold dressing to form cakes free from sweat, the said coating being equivalent to at least approximately 4.24 grams of bone ash per square foot of mold surface, and rolling the said cakes into sheets of desired dimensions.

6. A method of producing rolled copper sheets by first casting copper into elongated cakes by pouring into an upright mold cavity through the open top thereof, the said cavity being provided with a heavy, smooth-surfaced and uniform coating of bone ash mold dressing to produce sweat-free cakes, the said dressing being of a thickness equivalent to at least that obtained by uniformly spreading at least approximately 4.24 grams of bone ash over each square foot of mold surface, chilling the cast metal to shrink it free from the walls of such cavity by circulating tap water at the usual temperatures thereof through the walls of the mold, removing the cake from the said cavity whereby is produced a cake having its oxidized portion confined to its end corresponding to the open top end during casting, rolling said cake and cropping off the oxidized end thereby forming a sheet free from imperfections.

7. A method of casting sweat-free copper cakes which comprises pouring molten copper into a mold provided with a bone ash mold dressing of a

thickness corresponding to at least approximately 4.24 grams of bone ash per square foot of mold surface, and solidifying the resulting cake.

8. A method of casting copper which comprises flowing a slurry of bone ash and water into a mold cavity until there is produced a thickness of mold dressing equivalent at least to the thickness obtained by spreading at least approximately 4.24 grams of bone ash over each square foot of mold cavity surface, and pouring molten copper into the thus prepared mold cavity thereby producing a copper cake free from sweat.

9. A method of casting a copper cake which comprises applying a mold dressing to the surface of the mold cavity of a copper mold in such amount that the coating is at least as thick as would result from 4.24 grams of bone ash evenly distributed over one square foot of surface, slowly pouring molten copper into the mold so that at least one minute is consumed by the pouring operation, solidifying the cake and removing the cake from the mold.

10. In the vertical casting of copper cakes, the improvement which consists in coating the mold cavity with a mold dressing of bone ash and water of not less than 35° Bé. and introducing the molten copper into the mold during a time interval of between one and two minutes for a 600 pound cake.

11. A method of vertically casting copper cakes having parallel or at most only slightly tapering sides which comprises coating the mold cavity with a mold wash sufficiently thick to prevent sweating of the cake, same being equivalent to at least approximately 4.24 grams of bone ash per square foot of surface, introducing the molten copper into the mold at a sufficiently low rate to produce a level set and prevent shrinkage cavities, solidifying the cake by cooling and removing the cake from the mold.

12. In the vertical casting of copper cakes, the improvement which consists in pouring the molten copper into a water-cooled mold, the cavity of which is dressed with not less than 4.24 grams of bone ash or equivalent per square foot of cavity surface, at a rate of not less than one minute or more than two minutes for a 600-pound cake and solidifying the cake by introducing water at approximately ordinary tap temperature into the water passageways of the mold.

13. A method of casting copper cakes which comprises applying to the surfaces defining the cavity of a water-cooled copper mold a dressing of sufficient thickness to exhibit an insulating effect at least as great as that exhibited by 4.24 grams of bone ash uniformly distributed on one square foot of such a surface, the application of said dressing being effected in conjunction with a sufficiently high mold temperature to dry the dressing, pouring molten copper into the mold cavity thus prepared within a period of time equivalent to at least one minute and not more than two minutes for a 600 pound cake, and solidifying the copper by circulating water through said mold at a temperature within the range of room temperatures.

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