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METHOD FOR THE MANUFACTURE OF A MOLD FOR CENTRIFUGAL CASTING TUBULAR METAL ARTICLES

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Fig. 1

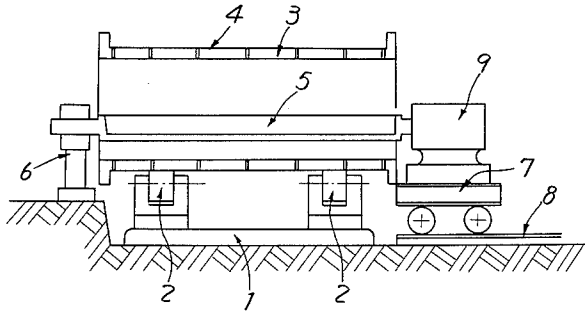


Fig. 2

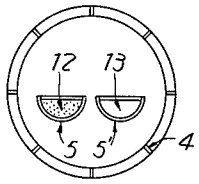


Fig. 3

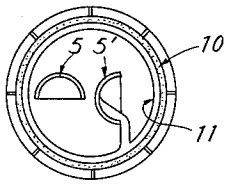


Fig. 4

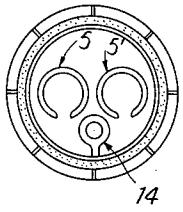
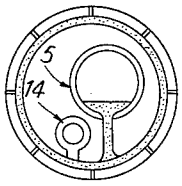


Fig. 5



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Attys.

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METHOD FOR THE MANUFACTURE OF A MOLD FOR CENTRIFUGAL CASTING TUBULAR METAL ARTICLES

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The present invention relates to the manufacture of a mold for centrifugal casting tubular metal articles wherein a metal mold is supported in a horizontal position and neither a pattern nor a sand mold formed by ramming green sand is required. More particularly, the invention relates to the manufacture of a metal mold for centrifugal casting of tubular metal articles without recourse to the known process of manufacturing a conventional casting mold.

In general, the principal body of a casting mold is formed by ramming a foundry sand consisting of silica flour with a binder added, and the facing of the mold is provided with a refractory protective coating, such as graphite.

Various materials have been heretofore employed for the binder, for example, such minerals as clay and bentonite, such a vegetable drying oil as linseed oil, and such cereal flours as corn starch and dextrin, all of which are employed either separately or combined together. Recently the application of thermosetting synthetic resins, such as phenolic and acrylic resins as a new binder has been introduced.

In disclosing the present invention, the foundry sand bonded with a thermosetting synthetic resin is called, "resin-sand," as a general technical term hereinbelow.

In the manufacture of a conventional sand mold bonded with clay, it is necessary to pour and ram the sand into the space between the flask and the pattern assembled on the stool. For example, a wet sand mold is formed by applying either clay or bentonite thereto as a binder through the above steps. A firm and strong sand mold adapted for centrifugal casting of a metal tube is completed after it has set by drying. However, an elongated sand mold for casting a cast iron pipe formed by the use of either vegetable oil or corn flour as a binder has proved unsatisfactory, because despite ramming it does not hold a proper shape due to its humidity.

On the other hand, when the phenolic synthetic resin-sand used as a foundry sand is spread on an iron plate preheated to a temperature of, say, from 200 to 300° C., it sets almost instantly and adheres to the iron plate if the sand thickness is as thin as about 3 mm., which is due to the presence of the thermosetting synthetic resin. The process of this principle is known to the industry as "shell-molding" or "Croning process," and is carried out extensively.

In the present invention, a metal mold for centrifugal casting in the form of a metal pipe is used in place of the above iron plate. The metal mold preheated to the above suitable temperature is supported on the centrifugal machine. A resin-sand is prepared by thoroughly mixing silica sand having a fineness of from 65 to 150 mesh and a thermosetting phenolic synthetic resin powder having a fineness of more than 200 mesh, the two ingredients being mixed together in proportions of from 92 to 97% by weight of sand and from 3 to 8% by weight of resin. Then, the metal mold preheated to the desired temperature is rotated while a measured quantity of resin-sand is introduced into the interior of the mold and distributed uniformly by means of a trough with the result that the resin-sand mixture sets instantly to adhere to the mold. Thus, the metal mold in a horizontal position is lined with a coating of any desired thickness,

say, from 3 to 10 mm. thick. However, in this manner, the inner facing of the metal mold is provided with the sand lining only, which cannot be accepted as an excellent lining for the casting mold.

The facing consisting of a thin shell mold layer thus obtained in the manner described when it comes in contact with the molten metal will not exhibit a smooth and satisfactory surface required for the mold. In order to meet the requirements for the mold, the finish surface should be formed by applying the second lining layer consisting of a refractory material onto the first lining layer.

In accordance with the invention, graphite powder, ground coke, silica flour, and zircon powder, having a fineness of from 100 to 270 mesh, respectively, each mixed with bentonite, may be employed for the refractory material for use in the second lining layer. For example, to this end, a slurry consisting of a mixture of silica flour and bentonite with a sufficient amount of water added to impart fluidity thereto may be employed. The slurry of the above composition is subjected to the action of centrifugal force to produce a mirror-like smooth finish on the second lining.

Briefly stated, the invention comprises rotating slowly the centrifugal casting metal mold heated to the suitable temperature in a horizontal position, lining the interior surface of the mold over the full length thereof with the shell mold layer comprising the mixture of 97–92% by weight of refractory powder having a fineness of from 65 to 150 mesh and 3–8% by weight of a phenolic thermosetting resin as its first lining layer in an even and uniform manner by means of a movable and reversible feeding trough inserted into the metal mold, and again lining the thus lined surface of the mold with the second refractory layer comprising a slurry of a mixture of refractory particles having a fineness of from 100 to 270 mesh, clay, and water in an even and uniform manner by means of the above-mentioned trough while the mold is slowly rotated. On completing the delivery of this refractory material into the mold, the mold is rotated at a high speed to form a mirror-like smooth finish having a circular section by the pressing and separating action resulting from the strong centrifugal force.

An important feature of the present invention lies in the formation of a smooth surface layer consisting of the slurry refractory and having a circular section in the interior of the metal mold by the action of centrifugal force. The facing of a sand mold provided with a refractory coating has been heretofore employed, and an object of this refractory coating is to prevent adherence from fusion between the molten metal and the sand. However, an object of the present invention is to obtain an accurate section of the mold facing due to the combined action of the fluidity of the slurry refractory plus the centrifugal force.

A refractory material slurry of a good fluidity is prepared by agitating the mixture of silica particles, 5–15 parts by weight of bentonite, and 50–100 parts by weight of water, the fineness of said silica particles being of 100–270 mesh and of more than 270 mesh, preferably 20 parts by weight passing a 150 mesh and 30 parts by weight passing a 270 mesh in order to provide the whole lining layer in which the change of the fineness of refractory particles from the first lining layer to the second lining layer is continuous.

Thus, a metal mold is provided with a first lining consisting of resin-sand while it is rotated on a centrifugal machine in a horizontal position, and thereafter the mold lined with this resin-sand coating is provided with a second lining consisting of the refractory slurry prepared by the method described hereinabove while it is rotated

slowly, say, at 50 r.p.m. In this case, the refractory slurry is distributed over the rough resin-sand coating by the action of a slight centrifugal force to hold a predetermined thickness of coating. However, a perfect circular section of the mold is not formed by merely pouring the refractory slurry into it, particularly at a section parallel and perpendicular to the rotating axis of the mold. This surface is not even and smooth. When the mold is rotated at a much higher speed, say, at 400 r.p.m., the composition of the refractory slurry is subjected to the centrifugal separation resulting from the strong centrifugal force. Consequently, coarse silica particles move outwardly while fine silica particles as well as bentonite including water move inwardly. In addition, the fluidity of the refractory slurry in the inner and outer zones thereof is controlled by the centrifugal separation, hence the fluidity of the slurry precipitated on the inner surface of the mold is very good.

Further, the surface of the above slurry is subjected to a pressing action resulting from the centrifugal force with the result that the uneven surface of the slurry delivered during the slow rotation described hereinabove is leveled so that it is even and smooth. Thus, in a vertical section to the rotating axis of the mold, the uneven surface of the slurry is leveled into a perfect circle while a straight line is obtained in the parallel section to the above axis. Accordingly, by the combined action of fluidity and centrifugal force, the slurry forms a perfect circular as well as straight and smooth lining of the same concentric circle as the metal mold on the first lining, no matter how uneven the first lining may be.

A typical centrifugally cast metal tubular article is a centrifugally cast iron pipe. The description of the manufacture of the mold for centrifugal casting of an iron pipe may be equally applied to other types of tubular articles. In a conventional manufacture of the mold, the metal flask and the pattern must be assembled in an upright position. Therefore a clearance space is formed in a vertical direction between the flask and the pattern. The vertical space is most suitable for foundry sand to be delivered, and ramming the sand is easily carried out due to the vertical direction.

The cast iron pipe must be uniform in its thickness in its longitudinal as well as its circular section, hence an accurately machined pattern has been heretofore employed in order to meet the above requirements. In centrifugal casting of an iron pipe, casting is performed in a horizontal position because the metal flask is rotated in the same horizontal position, yet the manufacture of the mold is carried out in a vertical position. Accordingly, it is necessary to erect or knock down the flask in the course of the casting operation, which is a conventional method of centrifugal casting of an iron pipe.

In accordance with the invention, the inner surface of the preheated metal flask is provided with a thin first coating of the mixture of silica sand and thermosetting resin by the use of centrifugal casting. Thus, the flask is provided with a coating of resin-sand by the Croning process. This uneven first coating is leveled so that it is even and smooth by providing a second coating of the refractory slurry through the action of centrifugal separation. Thus, a refractory mold of a perfect section is ready for use.

The invention is characterized in that a mold is manufactured in a horizontal position, and a mold of a perfect circular section is obtained without the use of a pattern. The thickness of the lining can be made as thin as 3–10 mm., because no ramming of the sand is required. As the lining thickness is very small, the solidification speed of the molten iron is accelerated, which results in an improved quality of the cast iron pipe, and also in an increase of production.

Further, the difficulty heretofore encountered in centrifugal casting of a tubular article of a copper-base alloy containing tin is a defective product resulting from the precipitated tin of a low-melting point on the surface of the product during the slow cooling step. However, the precipitation of tin can be prevented by the process of the invention, because the quenching effect is attained through the close contact between the molten metal and the metal mold for centrifugal casting.

Referring to the accompanying drawings:

FIG. 1 is a longitudinal section of apparatus adapted to carry out the invention.

FIG. 2 is a horizontal section of FIG. 1.

FIGS. 3–5 show the steps in carrying out the invention.

Referring to FIG. 1 in more detail, 1 shows a centrifugal machine for either casting or manufacturing a mold. Four rollers 2 are rotated by an electric motor, and a metal flask 3 for casting is supported on the rollers 2 in a horizontal position. The metal flask 3 is of either cast iron or is a steel cylinder machined precisely so as to hold a balance in its entire construction. It is to be understood that the metal flask 3 is provided with a plurality of vents 4 as it holds the lining. The metal flask 3 is heated to a temperature of 200–300° C., thereafter it is supported on the rollers 2, and then a trough 5 is introduced into the interior of the metal flask 3. Prior to the introduction of the trough 5, a measured quantity of resin-sand containing thermosetting resin as a binder has been uniformly distributed in the trough 5, and another measured quantity of slurry consisting of the mixture of silica flour and bentonite has been uniformly distributed in the other trough 5' over their full length, respectively. One end of the trough 5 and also one end of the trough 5' are supported on the bearing 6 while the other ends are held by the trough car 7 which moves horizontally on railroad 8. The trough car is provided with a rotating means 9 by which the trough is turned over to deliver the contents thereof into the interior of the metal mold in order to provide a first lining therein. When the metal flask and the trough are placed in a position as shown in FIG. 1, the flask is rotated slowly at 30–90 r.p.m. Then the trough 5 containing resin-sand 12 is slowly turned over to deliver the sand into the flask, which resin-sand sets immediately and adheres to the flask to form the first lining 10 as shown in FIG. 3. Subsequently, the trough 5' containing the silica slurry 13 is turned over to deliver the material for the second lining 13 onto the first lining. The metal flask is rotated at the same speed as described hereinabove until the supply of the second lining material is completed. However, upon the completion of the supply thereof, the metal flask 3 is rotated at a higher speed, say, at 200–800 r.p.m. Fluidized material for the second lining is uniformly distributed over the entire surface of the rough first lining to form an even, smooth and uniform second lining 11 of a straight as well as perfect circular section by the action of centrifugal separation described hereinbefore. Thus, the centrifugal casting mold of a perfect shape and contour having a flat, smooth and mirror-like inner surface finish is completed. Finally, the troughs 5 and 5' are withdrawn from the flask, and then the second lining is dried by a fire flame or hot air supplied thereinto to produce a complete metal mold for centrifugal casting of a cast iron pipe.

The sectional views of the troughs 5 and 5' are merely embodiments of the present invention. It is understood that other forms may be used. Further, one trough may be used instead of two.

An instrument 14 shown in FIGS. 4–5 is a rule for use in precise engineering of the metal mold, and may be installed as desired.

I claim:

1. An improved method of centrifugally casting hollow metal articles, comprising slowly rotating a metal mold preheated to about 200 to 300° C. in a horizontal position at a speed of 30 to 90 r.p.m., inserting into the preheated rotating mold a mixture of refractory particles and a thermosetting synthetic resin, said resin form-

ing a binder for the refractory particles, thereby producing a first lining which is about 3 to 10 mm. thick and the surface of which is roughened, then, while still rotating said mold slowly, inserting into the mold a slurry consisting of a mixture of 20 parts by weight of refractory particles which will pass a 150 mesh, 30 parts by weight of refractory particles which will pass a 270 mesh, 5 to 15 parts by weight of bentonite and 50 to 100 parts by weight of water to provide the second lining layer in which the change of fineness from the first lining to the second lining is continuous, immediately thereafter rotating said metal mold at a high speed of 200 to 800 r.p.m. to make the second layer closely adhere to the first layer by centrifugal force, to make the second layer substantially cylindrical and to make its surface smooth, and then drying the second layer.

2. In a method of centrifugally casting hollow metal articles in which a metal mold preheated to about 200 to 300° C. is slowly rotated at a speed of 30 to 90 r.p.m. in a horizontal position and a mixture of refractory particles and a thermosetting synthetic resin is inserted into the preheated mold to produce the first lining and thereafter, while the mold is still being rotated, a slurry of refractory particles is inserted into the mold to form the second lining, the metal mold is then rotated at a high speed of 200 to 800 r.p.m. and the second lining is then dried, the improvement in which the slurry inserted to form the second lining consists of a mixture of 20 parts by weight of refractory particles which will pass a 150 mesh, 30 parts by weight of refractory particles which will pass a 270 mesh, 5 to 15 parts by weight of bentonite, and 50 to 100 parts by weight of water.

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