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PROCESS OF CASTING IRON IN PERMANENT MOLDS AT A REGULATED COOLING RATE.

No Drawing. Continuation of application Serial No. 609,145, filed December 26, 1922. This application filed March 3, 1923. Serial No. 622,675.

The object of this invention is to define a procedure which if followed will enable any foundryman to produce from a permanent mold every one, two or three minutes a machineable casting superior to those produced in ordinary sand molds.

This application is a continuation of my application, Serial No. 609,145, filed by me on the 26 of December, 1922.

In order to produce homogeneous castings (i. e. castings of uniform hardness or softness) in permanent molds I have found it necessary to protect the surface of the mold with a refractory, inert and heat-insulating paint which is very adhesive and having protected it cover it between each casting with a thick renewable coating of lampblack, whereby a fresh coating of lampblack is presented to the metal each time the metal is poured into the mold.

The molds themselves are made of cast iron having substantially the same composition as the iron cast therein, for the reasons set forth in my co-pending application Serial No. 576,632, filed 21 July, 1922.

This application describes the use of a cast iron mold in which the cast iron has very little combined carbon. In other words, the mold is made of soft gray iron.

Briefly my process consists in regulating the following factors, which I find determine the success of the process:—

1. The temperature of the iron poured.

2. The temperature of the molding surface of the permanent mold.

3. The thickness of the walls of the permanent molds when made of cast iron.

4. The provision of an insulating refractory adhesive inert lining for the purpose of retaining the heat within the metal cast as set forth in my Patent #1,453,593, fi'ed Angust 11th, 1922, issued May 1st, 1923.

5. The application of a thick pulverulent coating of lampblack as set forth in my co-pending application, Serial No. 579,927, filed 5 August 1922.

6. The thorough cleaning of the walls of the molds before applying the lampblack, as set forth in the co-pending application of J. L. Dostal, Serial No. 568,405, filed 15 June 1922.

7. Yielding means for holding the molds together, whereby the enormous pressure developed when iron freezes in a confined space is avoided, as disclosed in United States patent to McWane, #1,083,122, dated December 30, 1913.

8. The prevention of leaks by providing a narrow bead or rim around the molds so that the molds contact on a relatively narrow edge as disclosed in the United States patent to Phillips, #1,099,997, dated June 16, 1914.

9. When large castings are produced continuously cooling means may be arranged as shown in the co-pending application of De Forest W. Candler, Serial No. 558,396, filed 4 May 1922.

10. The composition of the iron cast.

11. The composition of the metal molds.

In order to make the continuous casting of gray iron castings in permanent molds a commercial success it is obviously necessary to eject them at the earliest practical moment. That is to say at a temperature of about 1650° F., which is 200° F. above the critical temperature. By so doing the rate of cooling is checked at this temperature and the problem of providing cooling means for the permanent molds is greatly simplified, except with large castings, and thus a greater production per mold may be obtained.

In order to get clear definition the iron must be poured at a good yellow heat. That is to say it should be poured at a temperature in excess of 2200° F. These conditions are quite severe and great difficulty has been experienced heretofore on this account on commercially producing castings where hot iron is repeatedly poured into the permanent molds at short intervals of time, the specific difficulty encountered being that the coating flakes off, volatilizes or is otherwise washed off by the molten iron.

While the actual casting operations must necessarily follow each other in quick succession it is necessary to avoid the sudden chilling of the iron in the molds as, if this is not done, the castings produced will be unmachineable. The effect of a sudden chill is to solidify the outer surface and leave the core liquid. It is a fact well known in the art that the cooling of the molten interior will not provide sufficient heat to soften the

skin by annealing, as it has been found that once the hard spots have been formed on the surface of the casting due to chilling, that these hard spots are extremely difficult to correct even when heated for a long time so as to give a prolonged annealing.

The process I have invented consists as follows:—

The molds may be produced in any suitable manner, e. g. from a dry sand mold and a dry sand core. The mold surface of the dry sand mold and core may be protected by an adequate coating of lampblack and is preferably dusted with a lycopodium powder. A rib or bead may be cast around the iron molds so as to facilitate the machining of the surface as matched together, as set forth in the United States patent to Phillips cited above. These molds may well be cleaned with a small hand grinder to remove the outer skin. Obviously the molds themselves may be cast in a permanent mold.

The molds may then be heated for about one hour to about 1500° F. to relieve the strains which would otherwise result in distortion. The molds are then painted at a temperature of about 500° F. The paint which I prefer to use consists of a 10% saturated solution of sodium silicate in water mixed with an equal weight of finely ground fire clay. The quantity of fire clay, however, may be reduced somewhat where the mold having the coating applied thereto is designed for the casting of complicated castings when a somewhat thinner paint is desirable, as set forth in my co-pending application, Serial No. 581,239 filed 11 August 1922.

When it is necessary to apply a thick coating the cast iron mold is raised to a temperature above 1000° F., after each layer of approximately .01″ is applied in order to bake on each layer as it is applied. By so doing I have succeeded in building up a coating having a thickness of ¼″. After the desired thickness is attained a final application of heat is applied in order to make the lining of fire clay permanent.

Over the coating of refractory fire clay referred to above a relatively thick layer of lampblack is applied. In order to determine that the right thickness of lampblack has been applied, the test is to note whether after the casting has been ejected and before the mold has been cleaned with a blast of air, it is substantially intact.

In the commercial production of two pound castings having sections varying from $\frac{3}{16}$″ to ¾″ in thickness I have obtained excellent results by using hollow cast iron molds having a ½″ wall protected with a $\frac{1}{64}$″ refractory lining with a superimposed coating of lampblack $\frac{1}{32}$″ renewed between each casting. When running the molds so as to pour iron in the molds every 1½ or 2 minutes, the surface of the molds attain a temperature of approximately 1000° F., the castings ejected having a bright red color. When larger castings are produced conditions must be adjusted so that the period taken to solidify does not greatly exceed 30 seconds and with smaller castings the conditions must be modified so that the period taken is not much less than this 30 seconds.

The rate of pouring, or rather the periods between successive operations of each mold, is regulated by the heating effect of the molten iron upon the mold, hence with larger castings a longer period of time should be allowed in order to keep the temperature of the face of the mold below 1150° F., which is the highest temperature at which it is commercially possible to carry on this process. Above 1150° F. the lampblack will not adhere and hence the process cannot be practiced as described in this application. With large castings I may also make use of the air cooling means described in the application of De Forest W. Candler, Serial No. 558,396, filed 4 May 1922, in order to hold the temperature of the molds within the desired limits.

The molds are mounted upon a horizontal rotating table with dividing planes vertical and normal to the axis of rotation as set forth in the co-pending application of De Forest W. Candler, Serial No. 504,988, filed 3 October, 1921. The pressure between the molds on their matching face is limited and determined by springs as set forth in the United States patent to McWane, #1,083,122.

Before any iron is poured in the molds they are heated to a temperature in excess of 212° F. as a precaution against the possibility of any water being left on the surface which would cause a blowback. The first few castings are rejected as scrap, the purpose of pouring these castings being merely to raise the temperature of the molds to the lowest temperature at which soft castings can be secured which is about 650° F. The molds are opened slightly a few seconds before the molds are opened wide for the ejection of the casting, thus relieving all pressure between the molds at the earliest possible moment which is after about 15 seconds.

After the casting is ejected by mechanism substantially equivalent to that disclosed in the co-pending application of De Forest W. Candler, Serial No. 504,988, filed 3 October, 1921, a blast of air is directed onto the working surface of the mold, etc., for the purpose of removing any loose dirt, as disclosed in the co-pending application of J. L. Dostal, Serial No. 568,405, filed June 15, 1922.

The lampblack is then reapplied after each

casting operation by means of a burner which is carried with the molds and automatically released and carried by the next succeeding mold, as shown in the co-pending application of J. L. Dostal, Serial No. 590,913, filed the 27th of Sept., 1922. The type of burner used is that shown in this application, which is the subject matter of a divisional application, Serial No. 619,557, filed 17 February, 1923.

The iron cast in the iron molds may preferably be somewhat higher in silicon than many commercial cast irons, thus corresponding to the higher grade of cast iron known commercially as #1 foundry iron. This iron has a silicon content greater than 2.75%, a manganese content between .4% and .6%. The total carbon content in this iron runs from 2.50% to 3.50% and the combined carbon of the pig is less than 0.7%. Sulphur, oxygen and phosphorus are held at a low figure as they are objectionable for the same reasons as in sand castings. However, owing to the sudden cooling of the iron there is less time for segregation in the mold and hence the danger of the formation of manganese sulphide in the iron whilst it is solidifying in the molds is lessened as compared with sand castings. The composition of the iron cast and the cast iron molds are preferably the same, as set forth in my co-pending application, Serial No. 576,632, filed 21 July, 1922.

In melting this #1 foundry iron it is preferable not to add more than 10% low carbon steel scrap (.20% to .30% carbon), and very satisfactory results can be obtained without any steel scrap at all. The cupola blast is regulated so that the melting zone is confined to a few inches and thus the iron does not have any appreciable oxygen (iron oxide). The percentage of combined carbon is also reduced by avoiding the chilling effect of a strong blast of cold air, it being always remembered that it is much easier to form combined carbon than it is to anneal so as to release the combined carbon. That is to say, to correct the trouble once it has been created. A mixture of 50% scrap and 50% pig is satisfactory providing the scrap has a similar composition to that given above.

By retaining the heat of the molten iron in the molten iron long enough to permit the silicon to precipitate all the carbon and not retaining the heat long enough to permit the large crystalline growth so characteristic of ordinary sand cast, I produce an improved product described in my co-pending application Serial No. 618,715, filed 12 February 1923, which is a continuation of my co-pending application, Serial No. 559,463, filed 8 May 1922.

By the use of a gray cast iron mold having little or no combined carbon I obtain an adherent coating of fire clay. The fact that the gray iron has a more open grain structure than either steel or white iron probably enables the coating to be so adherent.

What I claim is:

1. The process of producing self-annealed gray iron castings in metal molds, which consists in first coating the molding surfaces with an adherent inert insulating refractory lining in order to provide a permanent lining, then superimposing a renewable coating of amorphous carbon, then pouring the iron into the mold, the said layer of amorphous carbon being sufficiently thick so that it will be substantially intact after the casting is ejected.

2. The continuous process of producing self-annealed gray iron castings in metal molds which consists in heating the molds then painting the surface of the mold with a wash in which a heat-resisting adhesive is dissolved and an inert refractory substance is suspended in order to provide a permanent lining, then coating the mold with a relatively thick renewable coating of amorphous carbon, holding the molds closed by a yielding pressure, pouring iron into the molds, ejecting the castings above the critical temperature and maintaining at all times an excess of lampblack so that at all times after the ejection of the casting the coating of lampblack remains practically intact.

3. The continuous process of producing self-annealed gray iron castings, which consists in heating the molds to 500° F., then painting the mold surfaces with a permanent coating of an adherent inert insulating refractory substance in order to provide a permanent lining, then applying a thick renewable coating of amorphous carbon of such a thickness that it is practically intact after the ejection of the casting, so that at all times the castings are cast in an excess of lampblack, then permitting the temperature of the molds to range from 650° F. to 1150° F. and ejecting the castings whilst they are still above the critical temperature of 1450° F.

4. The continuous process of producing self-annealed gray iron castings in permanent molds, which consists of first heating the metal molds to a temperature in excess of 400° F., then painting the metal molds with a refractory inert insulating coating mixed with a temperature-resisting adhesive in order to provide a permanent lining, then applying a thick coating of amorphous carbon and maintaining the carbon coating at such a thickness that it is substantially intact at all times, second, melting iron of from 2.50% to 3.50% total carbon and of from 1.75% to 2.75% silicon, pouring the iron into the molds and finally ejecting the castings from the molds the moment they have sufficiently solidified.

5. The continuous process of producing self-annealed gray iron castings in permanent molds having substantially the same composition as the iron cast therein, consisting first of heating the cast iron molds to above 400° F., then painting the molds with a refractory inert insulating wash containing a little soluble silicate in solution and a considerable quantity of a refractory powder in suspension in order to provide a permanent lining, then coating with a renewable coat of lampblack and maintaining the lampblack by frequent applications sufficiently thick so that it will be substantially intact after the castings are ejected from the molds, second, melting iron of from 2.50% to 3.50% total carbon and from 1.75% to 2.75% silicon, pouring the iron into the molds and finally ejecting the castings from the molds at a temperature greater than 1450° F. and permitting the molds to reach a temperature between 650° F. and 1150° F.

6. The process of producing self-annealed gray iron castings in permanent molds, which consists in pouring iron at over 2200° F. into molds protected by a permanent adherent inert refractory insulating lining and a super-imposed renewable coating of amorphous carbon sufficiently thick so that it will be substantially intact when the casting is removed, whereby the heat of the metal cast is retained within the casting and the solidification of the casting is delayed.

7. The process of producing self-annealed gray iron castings in permanent molds, which consists in pouring iron substantially free from oxygen at a temperature in excess of 2200° F. into molds protected by a permanent adherent inert refractory insulating lining and a super-imposed renewable coating of amorphous carbon sufficiently thick so as to be substantially intact when the casting is removed, whereby the heat of the metal cast is retained within the casting.

8. The process of producing self-annealed gray iron castings in hollow metal molds, which consists in first heating the molds to 500° F., then applying a thin permanent lining of an inert refractory insulator made adherent by a heat-resisting binder, then super-imposing a renewable coating of amorphous carbon sufficiently thick so that it will be substantially intact when the casting is removed, then pouring iron into the mold at over 2200° F., holding the casting within the mold and then removing the surplus lampblack by means of a compressed gas so that only a thin coating of lampblack remains on the mold, renewing the lampblack coating with fresh lampback, closing the molds, again pouring the iron and repeating the cycle sufficiently frequent so that the temperature of the molds is between 650° F. and 1150° F.

9. The process of producing self-annealed gray iron castings in iron molds having relatively thin walls, which consists in protecting the molds by means first of a relatively permanent refractory insulating adherent lining, then coating the molds with a pulverulent coating of lampblack, then pouring in iron having a temperature in excess of 2200° F., allowing the casting to solidify, then ejecting the casting, then cleaning the molds of residual lampblack and dirt, then renewing the lampblack coating, closing the molds again, pouring the iron in the molds and repeating the cycle of operation until the temperature of the mold attains a temperature of between 650° F. and 1150° F., whereby the castings remain liquid in the molds for from 25 to 35 seconds.

10. The process of producing self-annealed gray iron castings, which consists in casting a mold of iron with a wall thickness of approximately ½", applying a permanent adherent inert refractory insulating lining of approximately $\frac{1}{64}$", then superimposing a renewable coating of lampblack approximately $\frac{1}{32}$" thick, pouring in iron at a temperature above 2200° F., ejecting the castings at a temperature above 1450° F. and repeating the cycle of operation sufficiently frequently whereby the molds attain a temperature of above 650° F. and below 1150° F.

11. The process of producing self-annealed gray iron castings in permanent metal molds which consists in first protecting the molding surfaces with an adherent inert refractory insulating lining which is permanent, superimposing a coating of amorphous carbon sufficiently thick so that it will be substantially intact when the casting is removed, pouring iron into the mold at a temperature above 2200° F., opening the molds immediately the casting has solidified, ejecting the casting whilst its temperature is still above 1450° F., removing the surplus carbon with a blast of air and then recoating with lampblack, whereby a fresh coating of amorphous carbon is presented to the iron each time iron is poured into the mold, repeating the cycle of operation sufficiently frequently so that the temperature of the molding surfaces exceeds 650° F. and is less than 1150° F.

12. The process of producing self-annealed gray iron castings in permanent metal molds which consists in first protecting the molding surfaces with an adherent inert refractory insulating coating which is permanent, super-imposing a renewable coating of amorphous carbon, pouring iron into the mold at a temperature in excess of 2200° F., opening the molds and ejecting the castings, removing the surplus carbon and replacing with a fresh coating of

lampblack, repeating the cycle of operation sufficiently frequently so that the temperature of the molding surfaces does not exceed 1150° F. and does exceed 650° F.

13. The method of pouring gray iron into a smoke protected refractory mold, ejecting the casting formed therein, repeating the operation so as to maintain the temperature of the mold surfaces at such a point as will cause the iron cast therein to freeze in from twenty to forty seconds, whereby the carbon is all precipitated as finely divided graphite.

In testimony whereof I affix my signature.

DANIEL H. MELOCHE.