METHOD OF COOLING OF CENTRIFUGAL SLEEVE MOLDS

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1 Claim. (Cl. 22—200.5)

The present invention relates to the timing of cooling and of the molten metal cast in a centrifugal mold.

The casting of sleeve castings in cylindrical molds, which are in general located horizontally and rotated about their longitudinal axes, has raised many problems in connection with cooling the metal after the molten iron has been in the mold for a short time and also cooling it properly, that is, with an avoidance of uneven or localized over cooling of parts of the mold which results in mold distortion. Also in connection with timing the operation of the mold, its cooling and charging, so that a substantially continuous repetition of cycles of casting may be followed, using one mold only for a specified size of casting as distinguished from using several duplicate molds, one of which only at a time is receiving molten metal and the others are having the casting removed and let to cool to a proper temperature at which to again start a casting cycle therewith.

It is an object and purpose of the present invention to keep a tubular centrifugal metal mold at proper operating temperature without causing undue distortion of the mold or otherwise impairing its life. Such molds in general with each casting cycle is lined with a refractory material which, either in a liquid or semi liquid or viscous form, is deposited on a mold in order to eliminate chilling and prevent any fusing or welding of the casting to the mold. Such lining having vaporizable liquid in it when it is applied to the interior of the mold must have such liquid driven off rapidly. This is accomplished by depositing the fluid lining material within the rotating mold and with the mold at a temperature sufficiently high that the liquid is quickly dissipated and the lining is left in a dry condition. The temperature of the mold must not be too high as it results in poor coverage of the interior of the mold and in large vapor or steam formed holes through the lining; nor too low a temperature as there is an incomplete evaporation of the liquid from the lining with a sticking of the lining to the mold wall.

One process to control the mold temperature necessitates the use of several molds for each casting size. A mold, after molten metal has been entered into it and a centrifugal casting formed by rotating such mold about its longitudinal axis, is removed from the rotating or spinning mechanism to a station at which the casting is ejected from the mold. When this occurs the mold is at too high a temperature for beginning a succeeding cycle of casting and is in need of air cool until its proper temperature is reached. To continue the casting operations, additional molds are required. Another method is remove the mold from the rotating or spinning machine and subject it to a water bath, with an attempt to control the temperature by regulation of water flow. The first or air cooling method is cumbersome as molds must be removed from spinning position with each casting cycle and just the mols to maintain one mold constantly in production on a particular casting size while the rest or remaining six are cooling. In many cases short production runs of single size casting are made. The mold cost must be spread over the relatively small number of castings made, resulting in altogether too high a cost. The use of full or partial immersion of molds in water cools the cast metal too rapidly and in general requires subsequent heat treatment to obtain a machinable casting. Also there is danger of warping and distorting the mold through too rapid cooling.

With my invention the objections of the other methods are overcome through a use of a series of precisely controlled water spray jets. It has been found that less cooling is required in some areas of the molds than others. The jets are provided with individually valve controls so that each nozzle from which water is sprayed onto the mold may be properly and precisely regulated to give the exactly required water flow. The nozzles used provide fan spray patterns. Each of the tubes carrying a nozzle of the type noted may be adjusted as to distance toward or from the mold. Alternate or selected tubes may be completely shut off and start a uniform water coverage of the mold surface may be obtained by moving the remaining spraying nozzles farther from the mold surface. Such water applied as a spray and precisely controlled is applied only while the mold is rotating at casting speed, accomplishing uniform cooling throughout the mold with substantially little or no warpige or distortion. The ejection or passage of the water from the spray nozzles is controlled so that the spray from all nozzles starts and stops simultaneously.

Further with my invention the mold is cooled while the hot casting is still contained therein.

In the casting operation molten metal is poured into a lined tubular mold while it is spinning or rotating rapidly about its longitudinal axis. Such lining of the mold is partly disclosed in my pending application, Serial No. 368,352, filed July 16, 1953, being directed to end protectors of the mold, the lining at the inner curved surface of the mold being disclosed therein generally but not as to its specific composition. This forms the subject matter of a separate and distinct application.

The mold at a desired operating temperature, which in practice may be between 550° and 1000° F. for proper lining with a dry lining, after such lining receives molten metal while its rotation or spinning continues. As soon as the molten metal is poured into the spinning or rotating machine the operator starts the timing control which controls the length of time that the mold rotates before it stops to permit removal of the centrifugal casting therefrom. Two timers are used, the first timing the total length of the mold rotation. The other times when the water sprays are turned on and the length of time that such sprays will flow before they are shut off. There is a simultaneous mold cooling and casting freezing which greatly speeds up the casting production rate. When, through the automatic operation of the first timer, the mold rotation is stopped, the casting is ready for removal, may be removed without taking the mold and casting from the spinning or rotating machine and is at its proper temperature to immediately begin a succeeding casting cycle.

One mold only is used for any particular size of casting. A continuous production is attained using one mold without loss of time. The mold is at a temperature such that the liquid carrying lining deposited therein is very quickly dried and due to the spray water cooling the casting with the lining around it, shrinks sufficiently that it is quickly and easily removed from the mold, the lining accompanying and adhering to the casting so that the mold is ready for an immediate repeating of the casting cycle for the succeeding casting.

Further, in conjunction with my invention and in
the maintenance of an exactly desired flow rate of cooling water from each of the nozzles from which water flows upon the mold, visual flow meters are used one for each nozzle being located in the water line carrying the water thereto. Such flow meters in conjunction with the individual manual control of the water flowing to each spray nozzle aid the operator in properly regulating the spray from each nozzle so that the mold and casting therein are uniformly cooled. The flow meters are each equipped with a calibrated indicator card placed in conjunction with such flow meters and having thereon indicating lines at which the flow meters should be adjusted. The operator may not only adjust the flow from each of the nozzles correctly, but at all times can see if such water flow from each of the nozzles is being maintained and if not can instantly make the necessary adjustment.

It is of course apparent that the rate of water flow and size of the spray nozzles will vary with the sizes and weights of the castings produced, the larger sizes requiring greater flow than the smaller castings. With any casting the proper flow of water from each of the nozzles to and about the mold may be quickly determined by trial and a calibrated card in accordance therewith made. Such card thereafter will be used for its particular associated casting when such casting is to be produced.

The water cooling time will be less than casting freezing time and the water application will be substantially sufficient to exactly maintain the desired mold temperature. The water strikes the hot mold in a fine spray. Rapid evaporation occurs and heat from the mold is dissipated through absorption theretofrom to the water as it is converted to vapor. There is a prevention of uneven or overcooling with consequent mold distortion.

My invention has for its object and purpose the attainment of the beneficial results and effects recited, in a particularly effective and easy manner.

An understanding of the invention may be had from the following description taken in connection with the accompanying drawings, in which

Fig. 1 is a plan view illustrating the relative position of the water cooling apparatus with respect to the rotating or spinning machine.

Fig. 2 is a side elevation thereof.

Fig. 3 is a front elevation.

Fig. 4 is an elevation, similar to Fig. 2, showing the use of visual flow meters in association with a calibrated card for accurately and precisely controlling the amounts of water sprayed from each of the nozzles to and upon the mold.

Fig. 5 is an enlarged elevation partly in vertical section of one of the flow meters used.

Like reference characters refer to like parts in the different figures of the drawings.

The mold 1 of hollow cylindrical form has a central opening at its rear end and an opening at its front end which is closed by a closure 2 having a central opening therethrough, and which is detachably secured to the front end of the mold by arms 3 on such closure 2 adapted to be received underneath keepers 4 secured at the front end of the mold. The specific detail of the novel mold closure structure is fully disclosed in my pending application, Serial No. 365,627, filed July 2, 1951, now Patent No. 2,783,581, granted February 19, 1957, and the mold structure and its closure need not be further described. Such mold rests upon spaced rotating wheels 5 mounted upon horizontal shafts which are in practice motor driven to turn the mold at a desired rate of rotational speed about its longitudinal axis.

The water, from the water manifold 6 for which water is delivered by a pipe 7. The water is under pressure and its entrance into the manifold is controlled by an automatic solenoid operated water valve automatically turned on and off as hereinafter described.

At the upper side of the common reservoir or common manifold 6 for the water a series of vertical pipes 8, spaced apart from each other and disposed at one side of the mold in the length thereof, extend upwardly above the upper side of the mold. Each of the pipes is equipped with a manually operable opening and closing needle valve 9. Each pipe at its upper end through suitable elbows or other pipe connections has secured thereto a generally horizontal pipe 10 which extends over the mold 1, terminating in a spray nozzle 11 which directs water passing therethrough downwardly in a fan spray against the upper side of the mold. It is apparent, as shown in Fig. 3, that each pipe 10 with its attached nozzle may be adjusted by swinging the pipe about a horizontal axis in connection with the elbow coupling which connects the pipes 8 and 10 so that the distances that a spray nozzle 11 is from the upper side of the mold is variable and within the control of the operator.

With such construction, when the automatic valve opens, flow of water under pressure through the inlet pipes 7 to the reservoir manifold 6 occurs, water is forced upwardly through the pipes 8 and passes downwardly from the pipes 11 downwardly directed fan sprays in amounts in accordance with the extent which the individual valves 9 are opened. Molten iron having been introduced into the mold through the central opening of the front end closure 2, and with the mold rotating or spinning about its longitudinal axis, heat from the iron is absorbed by the mold with a resultant rise in temperature thereof. After the mold with the molten iron therein has turned for a predetermined length of time the solenoid operated valve opens for the flow of water to and through the pipes 8 and outwardly from the nozzles 11. Such water in a fine spray impinges against the mold which is continuously cooled. The mold receives the water spray at all of its outer surface portions causing a rapid cooling of the mold. The length of time that the spray operates is also automatically controlled as hereinafter described, being shut off before stopping the rotation or spinning of the mold. The mold is reduced in temperature to an extent that the molten iron freezes and through shrinkage sufficiently separates from the mold that when the mold has stopped its rotation, and the front end closure 2 is removed, the casting may be readily pushed out from the back leaving the mold in the position which it occupies upon the driving wheels 5 and at the desired temperature, as determined as approximately between 550° and 1000° F. for lining the mold for the next casting cycle.

With the structure shown in Figs. 1 to 3 inclusive, the position of the nozzles 11 at greater or less distances above the mold and also the extent of opening the valves 9 may be found by trial for any particular casting in a short time. Preferably however the visual flow meter structure of Figs. 4 and 5 is used.

In the flow meter arrangement of the water cooling apparatus, the reservoir manifold 6 is located at a lower level. At the upper portions of each of the vertical pipes 8, in which the manual needle valves 9 are disposed, a transparent, vertically positioned, downwardly tapered glass tube 12 is held and secured in place by rods 13 around it connecting flanges 14 at the upper ends of the pipes 8 and the lower ends of the pipes 10 which have horizontal sections extending over the upper side of the mold. The mold is interiorly equipped with metal bodies 15 of the type shown in Fig. 5 which rise to variable heights in the tubes 12, depending upon the rate of water flow. A calibrated card 16 shows the rate of flow or the gallons of water per minute which pass from each nozzle. Each centrifugal mold needle valve may be used with a separate card made out for it properly identified. A visual line 17 is plotted from previous experience or experimental data showing the rate of flow desired through each cooling jet. By manual manipulation of the needle valves 9, the flow of water through each of the visual flow meter tubes 12 may
be controlled so as to lift the associated body 15 to the section of the line 17 immediately associated with such flow meter and its associated nozzle. It is apparent that the quantity of water desired to pass from each of the nozzles 11 may be accurately and precisely controlled and that the hot mold 1 will receive the precise and accurate amounts of water needed to substantially uniformly and precisely cool the mold to a desired uniform temperature.

It is of course to be understood that the heavier castings and those of larger size require a greater water flow than smaller castings. This is controlled by the valves at 9. The length of time for water flowing is varied for different sizes of castings. The quantity of water and time of water application are quickly and easily established upon a few trials for any casting size. In all cases the water cooling time is less than casting freezing time, and the rate and time of water application are controlled to attain a desired end mold temperature. Rapid vaporization of the water occurs as it contacts the mold in a fine spray. The control of the water application prevents uneven or localization of cooling and subsequent mold distortion.

The invention described has proven exceptionally useful, particularly in the quantity production of centrifugally cast tubular castings, with far greater speed and resultant economy and elimination of mold cost than, so far as known, has heretofore taken place.

I claim:

The improvement for cooling a rotating, horizontal, cylindrical, metal mold after deposit of molten metal therein, comprising a plurality of pipes connected with a source of water supply, said pipes each terminating in a spray nozzle, said nozzles being aligned lengthwise of and above the upper side of said mold in spaced relation to each other, manually operable valves, one interposed in the length of each pipe for selectively independently regulating the amount of water flow through each of said pipes and for independently selectively closing said pipes against water flow, each of said pipes being located generally vertically at a side of said mold, and a visual flow meter interposed vertically in each pipe between the valve therein and the spray nozzle at its free end.

References Cited in the file of this patent

UNITED STATES PATENTS

1,630,045  Yeomans  May 24, 1927
1,776,543  Carrington  Sept. 23, 1930
1,796,645  Carrington  Mar. 17, 1931
1,949,433  Russell et al.  Mar. 6, 1934
1,989,752  Salzman  Jan. 15, 1935
2,058,448  Hazelett  Oct. 27, 1936
2,252,219  Trotzke  Aug. 12, 1941
2,290,286  Leckie et al.  July 21, 1942
2,657,440  Myers  Nov. 3, 1953