METHOD AND APPARATUS FOR COOLING AND CLEANING A CENTRIFUGAL CASTING

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3 Claims

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ABSTRACT OF THE DISCLOSURE

A method and apparatus for cooling and cleaning a centrifugal casting. The hot casting is placed on a support and is moved into an enclosed walled chamber. The casting is slowly rotated and a cleaning media, for example ambient air, is introduced through a passageway defined by a double wall of the chamber. An arm, having a rotary brush at its outer end, is reciprocally mounted along one longitudinal wall of the chamber and is effective to clean the exterior periphery of the casting. Waste particles and the heat transfer air are discharged from the upper part of the chamber.

This invention relates to a method and apparatus for cooling and cleaning a centrifugal casting and, more particularly, to a method and apparatus for uniformly cooling and cleaning a casting after it has been removed from a mold.

The cooling and cleaning of large centrifugal castings, for example, castings in the order of 20 to 40 inches in diameter and 20 to 30 feet in length poses several problems in the centrifugal casting art which are not present in small size centrifugal casting operations.

When a large casting, of the size described above, is cast in a permanent mold, the permanent metal mold in which molten metal is to be centrifugally cast is customarily coated on its interior surfaces with a refractory material which is termed a mold wash. A typical mold wash composition is disclosed in Schuh et al. U.S. Patent 2,399,606 and apparatus for applying the mold wash is disclosed in Burden U.S. Patent 3,130,077. After the molten metal is introduced into the permanent mold, the mold continues to rotate around its longitudinal axis at various rates of speed which are determined by the size of the casting and the composition of the alloy. After a predetermined length of time, rotation of the permanent mold is stopped and the casting is pulled or otherwise removed from the mold. The removal temperature of the casting depends partly upon the alloy from which it is cast, however, removal temperatures of approximately 1200°F. are not unusual. At such a temperature, the outer diameter of the casting has a cherry red glow and the radiant heat emitted from the casting is such that a foundry worker may only approach the casting for a short period of time.

After the hot casting is removed from the mold, it must be cooled at a uniform rate and the mold wash waste removed from its outer diameter. Because of their size, particularly the length to diameter ratios, uniform cooling of these large castings is a problem. If the casting is not uniformly cooled, it tends to bow and if this bowing or run-out is great enough, the casting must be scrapped. It is obvious that the roughing of a casting of this magnitude is extremely expensive.

One of the prior art methods of cleaning the outer surface of a large centrifugal casting is to have one or several men clean the surface with wire brushes. However, the men must wait until the centrifugal casting has cooled to between 200°F. and 300°F. before they may comfortably approach the casting and clean its exterior surface. When the exterior surface of a casting is brushed to remove the mold wash waste, the small mold wash particles, which are comprised basically of silica flour, are dispersed into the foundry atmosphere and create a health hazard. Furthermore, while the time required to cool the casting to the cleaning temperature varies with the size of the casting such time is at least a few hours.

It is the primary object of the present invention to provide a method and apparatus for cooling and cleaning a casting wherein the casting is uniformly cooled.

It is a further object of the present invention to provide apparatus for cooling and cleaning a casting wherein such operation is performed in a shortened length of time.

It is a still further object of the present invention to provide apparatus for cooling and cleaning a centrifugal casting which eliminates a health hazard found in prior art methods.

Further objects and advantages of the present invention will become apparent from the following specification and drawings in which:

FIG. 1 is a partially diagrammatic, elevational view of centrifugal casting operation, and showing in particular cooling and cleaning apparatus according to the present invention;

FIG. 2 is a vertical sectional view, drawn on an enlarged scale and with parts removed for clarity, taken along the line 2—2 of FIG. 1;

FIG. 3 is a view similar to FIG. 2, shown on a further enlarged scale, and showing in particular various positions of a brush arm according to the instant invention;

FIG. 4 is a vertical sectional view, with parts removed for clarity, taken along the line 4—4 of FIG. 3; and

FIG. 5 is a top plan view of cleaning apparatus according to the instant invention, taken along the line 5—5 of FIG. 3.

Briefly, the present invention is a method and apparatus for cooling and cleaning a centrifugal casting. A centrifugal casting is removed from the mold and placed upon support means and then moved into an enclosed operational zone of a walled chamber. The casting is slowly rotated around its longitudinal axis and a heat transfer media is introduced into the operational zone through a fluid inlet means adjacent the lower portion of the chamber. Cleaning means are mounted in the chamber adjacent a wall of the chamber. The cleaning means includes a brush arm having at least one rotary brush which engages the exterior periphery of the casting. Waste particles and the heat transfer medium are discharged from an upper portion of the operational zone through a discharge duct system which is in fluid communication with the chamber. After the casting has been cooled and its exterior cleaned, the casting is removed from the operational zone.

Referring to FIG. 1, a centrifugal casting processing line is generally indicated by the reference number 10. The line 10 includes a permanent mold apparatus 11, a pull cart 12, and a cooling and cleaning chamber 13.

The permanent mold apparatus 11, includes a permanent mold 14 which is supported by a plurality of motor driven rollers 15. A casting 16 is shown in FIG. 1 in a partially extracted position with respect to the mold 14. During a normal casting operation, the interior of the mold 14 is first coated with a mold wash composition comprising a refractory material such as graphite, finely divided alumina, silica flour, and similar materials. The mold 14 is then rotated around its longitudinal axis, by the motor driven rollers 15, and molten metal is introduced into a first end of the permanent mold 14. The temperature of the molten metal varies, however, temperatures of approximately 2,000°F. are not unusual. As is well known in the art, the mold wash composition prevents the adherence
3,442,706

When the casting 14 cools to approximately 1,200°F, it is extracted from the mold.

In the present embodiment, a pair of rails 17 are mounted upon the floor and extend from in front of the permanent mold apparatus 11 through the chamber 13 to a point (not shown). The pull cart 12 has a plurality of wheels 18 which are mounted for movement along the rails 17. Referring to FIGS 1, 2, and 3, the pull cart 12 includes a frame structure 19 which is generally rectangularly shaped.

The main frame structure mounts depending wheel brackets 20, which in turn rotatably mount the wheels 18. A plurality of motor driven rollers 21 are mounted along one side of the main frame structure 19. The rollers 21 have an axis of rotation which is longitudinally extending and parallel to the longitudinal axis of the pull cart 12. Referring in particular to FIG. 2, the motor driven rollers 21 are driven by a motor 22 and a connecting drive system 23. However, the motor driven rollers 21 may be driven by a plurality of air motors (not shown) or any other suitable means. In the present embodiment, a plurality of idler rollers 24 are mounted along the opposite side of the main frame structure 19 in opposed parallel relationship to the motor driven rollers 21. As illustrated in FIG. 3, the idler rollers 24 may be moved inwardly and outwardly toward and away from the longitudinal center line of the pull cart. The lateral spacing of the idler rollers 24 with respect to the motor driven rollers 21 is dependent upon the relation of the pull cart to the casting 16.

Referring to FIG. 1, the motor 22 also drives a winch 25 having a winch cable 26. When it is desired to extract the casting 16 from the mold 14, the pull cart 12 is moved into a position adjacent the mold 14 (as shown in FIG. 1). The cable 26 is connected by suitable means to a winch 25, and the motor 22 is actuated. The casting 16 is pulled from the mold 14 and the motor 22 is actuated. As the casting 16 is pulled from the mold 14 it is supported by a plurality of transverse rollers (not shown) which are also mounted on the pull cart and the cable 26 is retracted by the winch 25 until the casting 16 is completely extracted from the mold 14 and is supported upon the pull cart 12. The transverse rollers are then lowered until the casting 16 is supported by the motor driven rollers 21 and the idler rollers 24. The motor driven rollers 21 are actuated and the casting 16 is slowly rotated. The entire pull cart 12, which now supports the casting 16, is then moved to the right frame structure 19 through an entrance door 27 into the cleaning and chamber 13.

As has been mentioned previously, centrifugal castings of the size contemplated in the present invention present problems not found in small centrifugal castings. If the casting 16 is allowed to cool without being rotated, the bottom of the casting 16 tends to dissipate heat faster than the upper portion, therefore, differential cooling occurs and the casting 16 has a tendency to bow.

Referring to FIGS. 1 and 3, the cooling and cleaning chamber 13 is constructed upon, for example, a concrete floor 30. The floor 30 has a step-down portion defining a subfloor 31. A plurality of vertically extending, and longitudinally spaced, steel reinforcing members 32 are mounted to the concrete floor 30 by angle brackets 33. A plurality of longitudinally spaced top reinforcing members 34 extend between the upper ends of the opposed side reinforcing members 32. A chamber floor 35, consisting of truss steel plates, is spaced vertically above the subfloor 31 and is connected to opposed side reinforcing members 32 by angle brackets 33. A plurality of longitudinally spaced, and generally trapezoidal shaped truss members 37 are connected to opposed side wall reinforcing members 32 at their lower ends and extend upwardly and are preferably connected to the horizontal reinforcing members 34 at their upper ends.

Sheeting material, for example, relatively heavy gauge steel, is welded or otherwise connected to the outside surfaces of the side reinforcing members 32 to form an exterior wall 38. The exterior wall 38 extends from the floor 30 to the intersection with the horizontal reinforcing members 34. A top exterior wall 39 of sheet metal is welded to the horizontal reinforcing members 34.

Similarly, sheeting material is welded to the interior sides of the side reinforcing members 32 from a lower limit defined by the floor 35 to a point in the diameter of the casting 16. In this embodiment, the fluid inlets 57 are defined by the subfloor 31 and the chamber floor 35. The fluid inlets 57 discharge coolant ambient air into the operational chamber 51 at a position below the casting 16 which is supported by the pull cart 12.

In a normal operation, after the pull cart 12 is moved into the operational chamber 51 of the cooling and cleaning chamber 13, the casting 16 continues to rotate along its longitudinal axis as it is supported on the pull cart 12. The entrance door 27 located in the end wall 49 of the chamber 16 is closed. Heat which is extracted from the casting 16 moves generally upwardly and is discharged through the duct openings 44 and 45 and the discharge conduit 47. Cooling fluid medium, which may be ambient air, conditioned air, or other conditioned gases, is discharged through the fluid inlets 57 and moves upwardly in the operational chamber 51 providing a heat exchange interface for the heat being extracted from the casting 16. It has been found that this method of cooling the casting 16 is both faster and more uniform than prior art methods. The cooling and cleaning chamber 13 also serves as a heat shield to entrap at least a portion of the radiant heat from the casting 16 thereby reducing an objectionable temperature condition in, for example, a foundry.

Referring to FIGS. 2–5, a brushing apparatus, according to the present invention, is generally indicated at 60. The brushing apparatus 60 generally comprises horizontal guide means, carriage means movably mounted on the horizontal guide means, and a vertically pivotable brush arm mounted on the carriage means.
The horizontal guide means are generally indicated by the reference number 61, and include a horizontal longitudinally extending upper support member 62 which is connected to the body 67, and a lower connecting bracket 63. Similarly, a lower support member 64 is connected to the sidewall reinforcing members 32 by lower connecting brackets 65. An upper rail 66 is welded, or otherwise secured, to the bottom of the upper support member 62 and is located along a top of the lower support member 64. The upper rail 66 is vertically spaced from the lower rail 67 and the two rails lie in the same vertical plane. The rails 66 and 67 extend horizontally along the interior wall 40 between the opposed end walls 49 and 50.

A traveling carriage, generally indicated by the reference numeral 68, is mounted for horizontal movement along the rails 66 and 67. Referring in particular to FIG. 4, the traveling carriage 68 includes a carriage frame 69, a counterbalance frame 70, and a brush arm frame 71.

The carriage frame 69 comprises a lower horizontal support 72, an upper horizontal support 73, opposed vertical side supports 74 and 75, and a vertical intermediate support 76. The side supports 74 and 75 and the intermediate support 76 are fixedly secured at their ends to the opposed lower and upper supports 72 and 73. A pivot plate 77 is pivotally mounted by a pivot pin 78 to the upper horizontal support 73 at a location adjacent the side support 74. The other end of the pivot plate 77 rotatably mounts a wheel 79 which rides on the upper rail 66. The pivot plate 77 is also pivotally connected to a vertical biasing member 80. The lower end of the vertical biasing member 80 mounts a telescoping collar 81 which is spring biased downwardly by a spring 82. A series of adjusting holes 83 are provided in the vertical biasing member 80 and are adapted to receive a lock pin 84 of the telescoping collar 81. By placing the lock pin 84 in varying ones of the adjusting holes 83, the force exerted against the wheel 79 may be adjusted whereby the traveling carriage operates smoothly. Similarly, a pivot plate 85 is pivotally mounted to the upper support 73 by a pivot pin 86. The outer end of the pivot plate 85 mounts a wheel 87 and a vertical biasing member 88. The biasing member 88 functions in a manner identical with the biasing member 80.

Wheels 89 are rotatably mounted on brackets 90 which depend from the roller horizontal support 72 of the carriage frame 69. The wheels 89 ride on the lower rail 67 of the horizontal guide means 61.

Referring to FIGS. 4 and 5, a mounting shaft 91 is fixed to the side supports 74 and 75 by bracket 92. The brush arm frame 71 is pivotally mounted on the mounting shaft 91 by mounting bearings 93 and 94. The brush arm frame 71 comprises a diagonal bearing member 95 which mounts the bearing 93, an outwardly extending bearing member 96 which mounts the bearing 94, a structural member 97 extending between the bearing members 95 and 96, a structural member 98 which is parallel to the bearing member 96 and extends outwardly from the structural member 97, an outer structural member 99 which extends between the structural member 98 and the bearing member 96, and a diagonal reinforcing member 100.

The brush arm frame 71 mounts on its outer end a brush motor 101, a gear reduction box 102 and a brush 103 which is mounted for rotation around an axis parallel to the longitudinal axis of the chassis 13. In the present embodiment, the brush motor 101 is shown as an air motor with air supplied by a conduit 104; however, the brush motor may also be an electric motor or the like.

Referring to FIG. 3, a double acting cylinder 105 is pivotally connected at its base to a connecting arm 106 which extends outwardly from the lower horizontal supports 72 of the carriage frame 69. A rod 107 of the cylinder 105 is pivotally connected at its upper end to a connecting bracket 108 which depends from the bearing member 96 of the brush arm frame 71. As the rod 107 of the cylinder 105 is retracted, the brush arm frame 71 is pivotally downwardly in front of the casting 16 which is in position on the pull cart 12.

Referring to FIGS. 3 and 4, the counterbalance frame 70 comprises opposed side members 111 and 112 which are fixedly mounted at their lower ends to the carriage frame 69. A top member 113 extends between the upper ends of the side members 111 and 112 and has a support bracket 114 depending therefrom. A bearing 115 on the side member 111, and the support bracket 114 mount a counterbalance assembly 116 which includes a counterbalance spring 117 and a pulley 118. A cable 119 is wound around the pulley 118 and has an end 120 which is connected adjacent the structural member 98 of the brush arm frame 71. The counterbalance assembly 116 exerts a force on the cable 119 which tends to hold the brush arm frame 71 in a static position. Movement of the brush arm frame 71 occurs when the cylinder 105 is actuated, as was described above.

A motor platform 121 is mounted on the top exterior wall 39 of the chamber 13 adjacent the end wall 50 (see FIG. 2). A low speed motor 122 and a high speed motor 123 are mounted on the motor platform 121. The low speed motor 122 is operatively connected to a gear reduction box 124, through a pillow block 125, a clutch 126, and to a main drive sprocket 127. Similarly, the high speed motor 123 is operatively connected through a gear reduction box 128, a pillow block 129 and to the clutch 126 and the main drive sprocket 127.

The sidewall 38 adjacent the brushing apparatus 60 mounts a short horizontal rotatable shaft 130. The shaft 130 mounts an exterior idler sprocket 131 on its exterior end and an interior idler sprocket 132 on its other end. A drive chain 133 extends between the main drive sprocket 127 and the exterior idler sprocket 131. An interior idler sprocket 134 is mounted adjacent the end wall 49 (see FIG. 1) in horizontally spaced relationship to the interior idler sprocket 132. A plurality of support idler sprockets 135 are mounted on the sidewall of the chamber 13 at locations intermediate of the interior idler sprockets 132 and 134. The interior idler sprockets 132 and 134, and the support idler sprockets 135 mount a carriage drive chain 136. The carriage drive chain 136 is connected by a mounting bracket 137 (see FIG. 5) to the intermediate support 76 of the carriage frame 69. Therefore, the motors 122 and 123 are operatively connected to the traveling carriage 68 whereby one of the motors is actuated, the traveling carriage 68 is moved horizontally along the horizontal guide means 61. The motors 122 and 123 are both reversible motors, or have mechanical reversing mechanisms, whereby the traveling carriage 68 may be moved in either direction longitudinally of the chamber 13.

Preferably, observation ports are provided in the chamber 13 adjacent the brushing apparatus 60 for use by the personnel who are controlling the cooling and cleaning operation upon the casting 16. Also, a plurality of lamps 140 are provided in the diagonal portions 42 of the interior wall 40 for illuminating the chamber 13.

After the casting 16 is moved into the chamber 13, the door 27 in the end wall 49 is closed and the casting 16 is slowly rotated around its longitudinal axis by rotating means, which in the instant embodiment, comprise the motor 22 which is operatively connected to the motor driven rollers 21 on the pull cart 12. At this time, the rod 107 of the cylinder 105 has been extended and the brush arm frame 71 is in the "park" position indicated by the dashed lines and the reference number 71a in FIG. 3. The fluid medium is introduced through the fluid medium entrance ports 56 and travels downwardly through the fluid medium passageway 55 until it is discharged through the fluid inlets 57 below the casting 16. The fluid medium moves upwardly against the outer periphery of the casting 16 and uniformly cools the casting. The fluid medium, as
it is heated by the heat dissipated by the casting 16, moves upwardly through the discharge duct 46. When the casting 16 reaches a cleaning temperature of approximately 400° F. to 500° F., the high speed motor 101 is actuated and the travel carriage 68 is moved to a position adjacent the end wall 49. The rod 107 of the cylinder 105 is then retracted and the brush 103 is moved into position against the outer surface of the casting 16 (see FIG. 3). The brush motor 101 is actuated and the brush 103 begins to rotate. Preferably, the brush 103 exerts a predetermined pressure on the casting 16. This pressure is dependent to some extent upon the alloy of which the casting 16 is composed. Normally, the brush pressure is between 15 and 25 p.s.i. and preferably is approximately 20 p.s.i. The predetermined brush pressure may be adjusted by varying tension in the counterweight spring 117. Counterweight spring tension is controlled by adjusting a worm gear 141 which causes a worm pinion 142 to rotate the counterweight spring shaft of the counterbalance assembly 116. Finer brush pressure adjustments may be made by moving metal slugs or weights (not shown) which are positioned on the brush arm frame 71. The low speed motor 122 is then actuated and the traveling carriage 68 begins to move toward the far end of the chamber 13. The rate of travel of the carriage 68 is determined by the characteristics of the casting 16 itself and also the relationship between the rotational speeds of the brush 103 and the casting 16. When the brush 103 has completed its longitudinal travel, a limit switch (not shown) is actuated and the low speed motor 122 is de-energized. The rod 107 of the cylinder 105 is extended and the brush arm frame 71 is moved to the “park” position indicated at 71a. Preferably, the brushing operation is completed during the longitudinal pass of the brush 103; however, it is sometimes necessary to make more than one pass. If this is necessary, the traveling carriage 68 is returned to a position adjacent the end wall 49 and the above operation is repeated. Upon completion of the brushing operation, an entrance door in the chamber 13 is opened and the pull cart 12 is removed from the chamber 13.

During the brushing operation heavier mold waste particles fall downwardly upon the chamber floor 35 and are periodically removed. The fine waste particles, which are injurious to health, are suspended in the upwardly moving fluid medium and move upwardly through the duct 46, through the discharge conduit 47, and into the dust collecting and filtering apparatus 48. Therefore, the objectionable waste particles are removed from the foundry atmosphere.

It has been found that while the time cycle of the above described method varies depending upon the size of the casting 16, on an average, the time cycle is approximately one-half to three-fourths of the time cycle of prior art methods.

While the present invention has been disclosed with a specific arrangement of parts, it should be expressly understood that numerous modifications and changes can be made without departing from the spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. A casting cleaning apparatus comprising, in combination, a longitudinally extending walled chamber having at least one entrance door, discharge duct means in communication with said chamber for removing waste particles from said chamber, said chamber defining at least one fluid medium passageway, said chamber having an outer vertical wall and a spaced inner wall, said fluid medium passed between said vertical wall and said inner wall, fluid inlet means adjacent a lower portion of said chamber, said fluid inlet means being in fluid communication with said fluid medium passageway, means for supplying a cooling gas to said fluid medium passageway, support means movable between a first position outside of said chamber and a second position interiorly of said chamber, for supporting a longitudinally extending casting, said support means including means for rotating such casting around its longitudinal axis, and said second position being adjacent a sidewalk of said chamber, said cleaning means including horizontal guide means mounted adjacent said sidewalk, a traveling carriage mounted for reciprocating movement along said guide means, drive means operatively connected to said traveling carriage for moving said traveling carriage along said guide means, a brush arm pivotally mounted on said traveling carriage, and a rotatable brush mount adjacent an end of said brush arm, said brush arm being movable between a cleaning position whereby said brush engages the exterior surface of such casting and a park position whereby said brush is spaced from the exterior surface of said casting.

2. A casting cleaning apparatus according to claim 1 wherein said drive means for moving said traveling carriage comprises a continuous drive chain adjacent said guide means, said drive chain being connected to said traveling carriage, and at least one drive motor operatively connected to said drive chain for moving said traveling carriage along said guide means at predetermined rates of speed.

3. A casting cooling and cleaning apparatus, according to claim 1, wherein said support means comprises a longitudinally extending walled pull cart, said pull cart including a frame, plurality of longitudinally spaced motor driven rollers mounted adjacent a first side of said frame, said driven rollers being mounted on axes parallel to the centerline of said frame, motor means for driving said rollers, and a plurality of longitudinally spaced motor driven rollers mounted on transversely opposed relationship to said driver rollers.

4. A casting cooling and cleaning apparatus, according to claim 1, wherein said horizontal guide means comprise first and second longitudinally extending parallel rails, said first rail being vertically spaced from said second rail, said traveling carriage having a first pair of wheels adapted to ride along said first rail and a second pair of wheels adapted to ride along said second rail, and counterbalance means mounted on said traveling carriage and operatively connected to said brush arm whereby said brush arm tends to remain in a static position.

5. A casting cooling and cleaning apparatus comprising, in combination, a longitudinally extending walled chamber, said chamber having a generally vertical outer wall and a spaced inner wall, said outer wall and said inner wall defining a fluid medium passageway, means for supplying a cooling gas to said fluid medium passageway, at least one inlet adjacent the lower end of said chamber for discharging such cooling gas into said chamber, support means interiorly of said chamber structure effective to support a longitudinally extending casting in a predetermined position, said support means being capable of rotating such casting around its longitudinal axis, cleaning means located interiorly of said chamber effective to clean the exterior of such casting, said cleaning means including a brush and means for moving said brush in a path parallel to such longitudinal axis of such casting and discharge means in said chamber for removing such cooling gas and waste particles from said chamber.

6. A method of cooling and cleaning a centrifugal casting in a chamber having an outer double wall which defines a passageway and a traveling carriage mounted on a sidewalk thereof, the traveling carriage having a vertically movable brush mount thereon, comprising the steps of moving the casting into an operational zone defined by the chamber, rotating the casting around its longitudinal axis, introducing a cooling gas through such passageway into the operational zone at a location beneath the casting, drawing the cooling gas upwardly along the sides of the casting, whereby the cooling gas provides
a heat exchange interface for the heat being extracted from the casting, lowering the temperature of the casting to a predetermined brushing temperature, moving the brush into contact with the exterior surface of the casting, rotating the brush, moving the brush along a path parallel to the longitudinal centerline of the casting, withdrawing the brush to a position spaced from the casting, discharging the cooling gas and waste particles from the operational zone at a location above the casting and removing the casting from the operational zone.

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