METHOD AND APPARATUS FOR PRODUCING METAL CASTINGS USING MOLTEN METAL COOLED BEFORE TEEMING

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Filed Jun. 13, 1966, Ser. No. 520,389

U.S. Cl. 164—57
Int. Cl. B22d 27/04, 27/20, 23/08

14 Claims

ABSTRACT OF THE DISCLOSURE

The present disclosure relates broadly to improved foundry practices, and in its more specific phases to the formation of metal shot and the use of same in the casting of metal.

Background of the invention

Conventional foundry practice for a great many years has involved the melting of metal in a cupola, withdrawing same into a suitable pouring ladle, and pouring it into conventionally prepared molds utilizing firmly packed molding sand in which a cavity has been formed through the use of a pattern which has been removed from the mold prior to the pouring of the molten metal into same. This molten metal is poured into the mold at a temperature considerably above the metal melting point, and where the finished casting is large or has heavy section portions, shrinkage flaws or holes commonly form as the casting outer surface solidifies first while the inner body of molten metal gradually cools and solidifies during which time it also shrinks.

To offset this shrinkage problem a common practice has grown up of placing metal chills in the mold, particularly at the heavy section points to quickly cool the whole molten metal body to the solidifying point and thus minimize the formation of shrinkage flaws in the finished casting. Some forms of these chills are provided with a pronged end which can be pushed into the molding sand to hold them up into the body of the mold cavity for internal chilling of the metal body rather than merely surface cooling of the metal which is used to provide special properties of the casting in the chilled surface area.

The use of inwardly projecting chills as noted presents the disadvantage of leaving end portions of the chills projecting out of the rough casting so as to require later removal of same. Moreover, the composition of the chills, at best, is only approximately like the metal poured into the mold so that there is non-uniformity of the metal in the final casting, with the inherent disadvantages well known to the art. It was a recognition of these and other problems in the foundry field and the lack of a wholly satisfactory commercial solution to same which led to the conception and development of the present invention.

Summary of the invention

Accordingly, among the objects of the present invention is the provision of an improved metal casting proc-
Refering more particularly to FIGURE 1 it will be noted that there is shown a conventional cuopula 1 lined with fire brick 2 and having a charging hole 3 at the base of the upper or chimney portion 1a of the cuopula 1 and which charging hole is elevated well above the bottom of the cuopula, as illustrated. Said charging hole 3 is preferably positioned above a loading deck or floor 4 over which the material to be charged into the cuopula 1 is transported, for instance, by means of a wheelbarrow 5 where hand operation is carried out in a small foundry set-up, or by means of conveyors (not shown) where the foundry bucket conveyor cuopula 1 would be charged conventionally with coke, limestone and iron with the coke being ignited at the bottom of the cuopula. Air for burning the coke to melt the iron would be supplied by a fan or the like (not shown) in accordance with standard practice through a wind box 6 from which conventionally extend air delivering tuyeres (not shown) directly into the cuopula at a suitable elevation above its bottom.

In older foundry practice the cuopula 1 would be operated until a sufficient body of molten metal had accumulated in its bottom for pouring into a ladle ready for transporting and filling the mold in which a casting is to be made. The cuopula would then be tapped, a suitable amount of the molten metal withdrawn through pluggable outlet 45 into the ladle (not shown), the outlet 45 of the cuopula again plugged, and the metal poured from the ladle into the mold for forming the casting. While the present invention can be used in this manner, it is contemplated that in an efficiently operating foundry continuous operation of the cuopula would be carried on as will be hereinafter set forth in detail.

Instead of drawing the molten metal from the cuopula into a ladle, and then plugging the cuopula outlet, an automated procedure would involve operating the cuopula 1 with the molten metal flowing continuously from the same, as much as possible, through an outlet 45. Here the molten metal would flow continuously from the cuopula (except when it was desired to temporarily stop such flow by conventionally plugging the cuopula outlet) into an open top trough-like, fire brick lined receiver 8. This receiver might be stationary, but preferably would be pivotally supported at its cuopula end and have its outer end supported by conventional means 9 for limited pivotal movement in a horizontal plane to better facilitate lining up its pluggable pouring outlet 10 with the inlet gate 11 of mold 7. Since the substantially continuous flow of moltenmetal out of cuopula 1 into open top receiver 8 would normally include some molten slag, the receiver 8 would be provided with an overflow notch 12 to permit the excess of such slag 13 to overflow into a suitable receiver such as a slag bucket 14.

One phase of the present invention is the production of metal shot 15 for use in the manner to be hereinafter set forth in detail. A convenient way to produce such shot 15, as diagrammatically shown in FIGURE 1, is to provide the open top receiver 8 with a pluggable metal outlet opening 16 through which a small stream 17 of molten metal will flow. A water jet 18 with nozzle 19 mounted in position to direct a stream of water 20, under suitable pressure against said molten metal stream 17, would, under operating conditions, result in said water jetting said molten metal stream into metal droplets or shot 15 which would fall into a tank 21 mounted, as illustrated, in the cuopula, as shown. This tank 21 is provided with a conveyor 23 of movable type which may be conventionally driven as by means of a geared down electric motor 46. Such conveyor is preferably a dewatering one with cross flights 24 which scrape the shot 15, as shown, to a discharge chute 25, the outlet end 26 of which delivers same to an elevator assembly 27 having a hoisting mechanism 28 which is mounted on a conventional bucket conveyor 29, driven, for instance, by a suitable geared down electric motor 30, or the like. This bucket conveyor conventionally delivers the shot 15, after elevating same, through a discharge chute 31 into the upper end of a diagrammatically shown shot 15 drop into a funnel shaped hopper 34, while the rough pieces 37 which were formed along with the small shot work their way down screen 33 and drop into a suitable receiver such as a wheelbarrow 5, ready for delivery to cuopula 1 through charging hole 3 for remelting. Shot 15 delivered through screen 33 into hopper 34 pass down through the outlet 35 of same into shot storage hopper 36 which preferably has a shot delivery tube 38 mounted by means of a pivot 39 on the lower or outlet end of same. This shot delivery tube 38 in turn is provided with a control valve 40 to control the amount and rate of delivery of shot 15 from the shot storage hopper 36 for a purpose to be hereinafter explained in detail.

The mold 7 with its cope 41 and drag 42 filled with molding sand (not shown) rammed firmly against an inlet gate or gates and suitable vents to a casting recess in same, is then ready for carrying out the casting procedure. The mold 7 is positioned on a platform 43 as shown in FIGURES 1 and 2, or in the place of such floor or platform the mold may be mounted on railroad cars, or other suitable mold transporting means, for moving the mold to and from the metal casting position, and it is intended that the drawing be considered as diagrammatically showing same. With the transportable mold system the molds, after having the molten metal poured into same, may be moved to a suitable storage area and allowed to stand until the casting has cooled sufficiently for removal from the mold. In accordance with standard practice the molding sand, after removal of the casting, is then reconditioned as described above.

The molten metal flowing from the cuopula 1, or any other source of same, into open top receiver 8 may well be at a temperature one hundred degrees or more above the solidifying point of the metal, and if delivered at this temperature into a mold 7, having a relatively large casting recess, the metal will first chill and solidify on the surface of the casting while the center will remain molten and contract as it cools. This causes shrinkage flaws or holes in the final casting. On the other hand, the castings must be rather rapidly made for economy of operation if competitive costs are to be met. Accordingly, one procedure of the present invention involves adding a suitable amount of metal shot to the body of molten metal in the open top receiver where they melt and reduce its temperature to a suitable point for pouring into mold 7 to substantially reduce or minimize shrinkage flaws or holes in the finished casting.

The above can be readily accomplished by checking the temperature of the molten metal in open top receiver 8 with a pyrometer to determine how much the temperature of the molten metal should be lowered before the molten metal is poured into mold 7. With this information as a guide, control valve 40 is then opened to deliver an appropriate amount of shot 15 into the molten metal in open top receiver 8 to drop the temperature of the molten metal to the desired pouring temperature as again determined through the use of a pyrometer. The metal thus cooled is then poured into the conventionally prepared mold 7 to form the casting.

Where the temperature of the metal to be poured into mold 7 is higher than desired for the particular casting involved, another procedure, as shown in FIGURE 2, involves adding shot 15 to the molten metal as it is poured into mold 7. The molten metal melts in shot 15 in which is contained the appropriate amount, so that the poured metal in the mold at the end of the pouring operation is relatively close to the metal solidify-
ing temperature so as to overcome or substantially mini-
mize the formation of shrinkage flaws or holes in the fin-
ished casting.

A combined casting operation can be carried out of if
desired wherein some shot are delivered into the molten
metal in the lower receiver 8 to be melted therein and
partially the temperature of the molten metal to a
point which is still higher than the desired casting tem-
perature, and then when this molten metal is poured
through gate 11 into mold 7, some additional shot, in
predetermined amount, may be added to the flowing
metal in accordance with the diagrammatic view shown in
FIGURE 2. This makes possible holding the molten metal
longer in the open top receiver 8, without solidification
danger, if the molds are not promptly in position for the
pouring operation, and which might readily happen in an
automated foundry where the molds would be moved on
railway cars, or the like, to filling position under
pouring outlet 10 of open top receiver 8.

While various forms and ways of carrying out the
present invention have been shown and described, other
forms will now be apparent to those skilled in the art.
Therefore, the embodiments of the invention shown in
the drawing and described herein have been set forth
primarily for illustrative purposes and as such for better
understanding the principles of the present invention, and
are not intended to limit the spirit and scope of the inven-
tion as above described and illustrated in the drawing.

Other modes of applying the principles of my inven-
tion may be employed instead of those explained, change
being made as regards the means and the methods herein
disclosed, provided those stated by any of the following
claims or their equivalent be employed.

I therefore particularly point out and distinctly claim
as my invention:

1. The method of making castings from molten metal
poured into a mold which comprises the steps of:
(a) providing a supply of molten metal,
(b) delivering said molten metal to a container,
(c) removing a portion of said molten metal from the
container and forming solid metal particles from
said portion,
(d) delivering said particles to a storage area,
(e) introducing a predetermined amount of said metal
particles to the molten metal in said container to
lower the temperature of the metal, and
(f) delivering a stream of cooled molten metal from
the container to the mold.

2. The method of making castings as set forth in
claim 1 wherein the molten metal is iron.

3. The method of making castings as set forth in
claim 2, including the further step of adding iron parti-
cles to the precooled molten iron stream as it is being
poured into the mold.

4. The method of making castings as set forth in
claim 1 wherein said portion of the body of molten metal
to be poured into a mold is withdrawn in the form of
a molten metal stream, shredding same with a water jet
into metal droplets largely in the form of shot which is
received in a tank of water to cushion and cool same,
separating said shot from said water, drying said shot,
screening said dried shot to predetermined maximum
size, and storing said shot ready for addition to said
molten metal used in making the casting.

5. The method of making castings as set forth in
claim 4, wherein the metal involved is iron.

6. The method of making castings as set forth in
claim 2, wherein same includes the step of melt-
ing said iron in a cupola, withdrawing same substan-
tially continuously from said cupola into said suitable tempo-
rary storage container, withdrawing a portion of said
molten metal from said container, and forming said iron
particles from said withdrawn molten metal portion.

7. The method of making castings as set forth in
claim 6, wherein some of said particles are added to the molten
metal in said container and melted therein, and the so
treated molten metal is then poured into said mold while
adding a further portion of said particles to said molten
metal at a point between said container and said mold.

8. A metal casting apparatus combination for produc-
ing metal castings in molds comprising:
(a) means supplying molten metal at a temperature
well above its melting point,
(b) a container means to receive said molten metal
from said supply means,
(c) means for delivering said molten metal from said
supply means to said container means,
(d) means forming metal particles from a portion of
said molten metal in said container means,
(e) a storage means for said metal particles,
(f) means delivering a predetermined amount of said
metal particles from said storage means to said
molten metal in said container means to lower the
temperature of the molten metal in the container
means, and
(g) means delivering a stream of cooled molten metal
from said container means to said molds.

9. A metal casting system as set forth in claim 8,
wherein said container means for the molten metal has
means for removing molten slag floating on said molten
metal.

10. A metal casting apparatus combination as set forth
in claim 8, wherein:
said particle forming means includes means for shred-
ding said molten metal to provide shredded particles and
said apparatus combination further including a tank
means containing a suitable liquid coolant, means deliver-
ing particles from said metal particle forming means to said tank means to cool said
particles, means for drying said shredded metal particles, means removing said shredded metal particles from
said coolant to said drying means, and means separating said dried shredded metal particles into a first portion for delivery to said storage means and a second portion to be scrapped.

11. A metal casting apparatus combination as set forth
in claim 8 wherein said particle delivery means for said molten metal supply means includes a readily
movable outlet and a particle flow cut-off means.

12. A metal casting apparatus combination as set forth
in claim 8 wherein:
said metal is iron,
said molten metal supply means is a cupola, and
said means for delivering a predetermined amount of
metal particles to said molten metal includes a
tubular member.

13. A metal casting apparatus combination as set forth
in claim 12, wherein said tubular member includes a valve for controlling the flow of said metal particles therethrough, and a pivot connection for operably joining said tubular member to said storage means for said metal
particles.

14. A metal casting apparatus combination as set forth
in claim 13, wherein:
said particle forming means includes means for shred-
ding said molten metal to provide shredded particles,
said apparatus combination further including a tank
means containing a suitable liquid coolant,
means delivering particles from said metal particle forming means to said tank means to cool said
particles, means for drying said shredded metal particles, means removing said shredded metal particles from
said coolant to said drying means, and means separating said dried shredded metal particles into a first portion for delivery to said storage means and a second portion to be scrapped.

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