United States Patent [19]

McAfee et al.

[11] **3,851,700**

[45] **Dec. 3, 1974**

[54] **METHOD OF INOCULATING NODULAR CAST IRON**

[75] Inventors: **Donald A. McAfee**, Defiance; **Thomas P. Newcomb**, Wauseon, both of Ohio

[73] Assignee: **General Motors Corporation**, Detroit, Mich.

[22] Filed: **Aug. 20, 1973**

[21] Appl. No.: **389,482**

[52] **U.S. Cl.** **164/57**

[51] **Int. Cl.** **B22d 27/20**

[58] **Field of Search** 164/55–59, 164/358, 363

[56] **References Cited**

UNITED STATES PATENTS

3,658,115	4/1972	Ryntz et al.	164/57

FOREIGN PATENTS OR APPLICATIONS

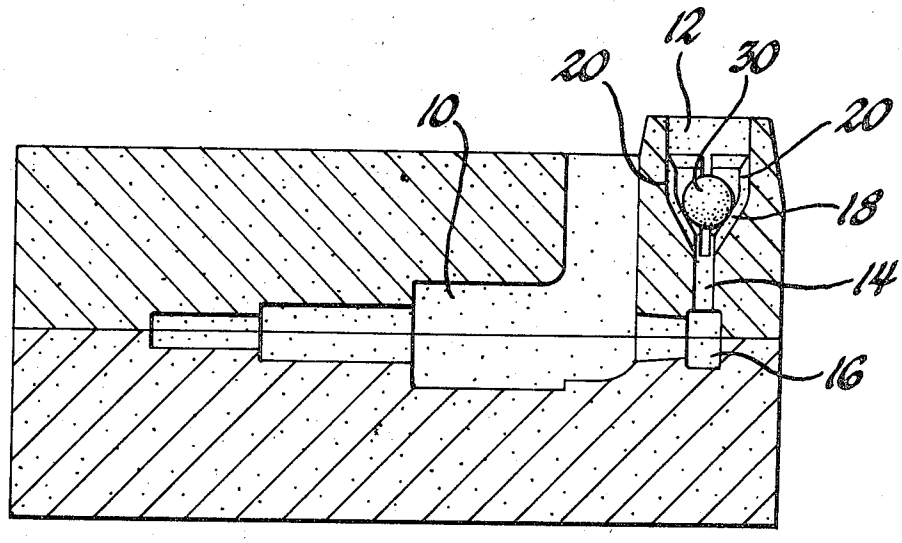
1,132,055	10/1968	Great Britain	164/55
1,132,056	10/1968	Great Britain	164/55
1,901,366	8/1970	Germany	164/55
162,468	4/1955	Australia	164/57
6,908,444	7/1970	Netherlands	164/55

Primary Examiner—James L. Jones, Jr.
Assistant Examiner—Robert C. Watson
Attorney, Agent, or Firm—Peter P. Kozak

[57] **ABSTRACT**

An improved method of inoculating nodular cast iron to obtain uniform and thorough inoculation of nodular iron simultaneously with the casting thereof. A preformed inoculant agent body in the shape of a ball is dropped into a stationary position at the base of the pouring basin of the gating of the mold and the molten metal is poured over the ball whereby it flows over and around the ball and into the mold cavity through passages provided in the gating wall about the ball. The molten metal uniformly dissolves the ball shaped inoculant agent as it flows about it and is uniformly inoculated thereby just prior to the casting thereof.

7 Claims, 3 Drawing Figures



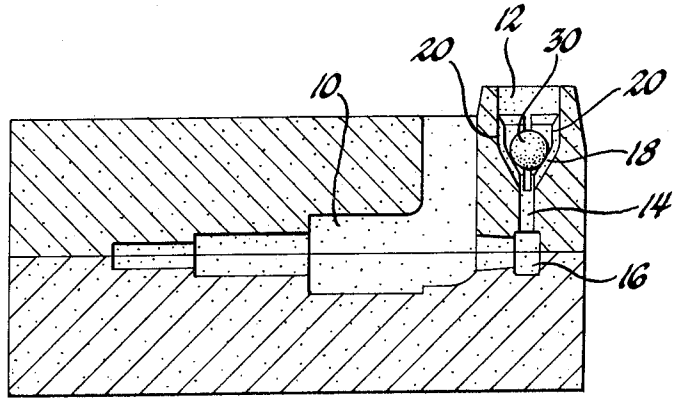


Fig. 1

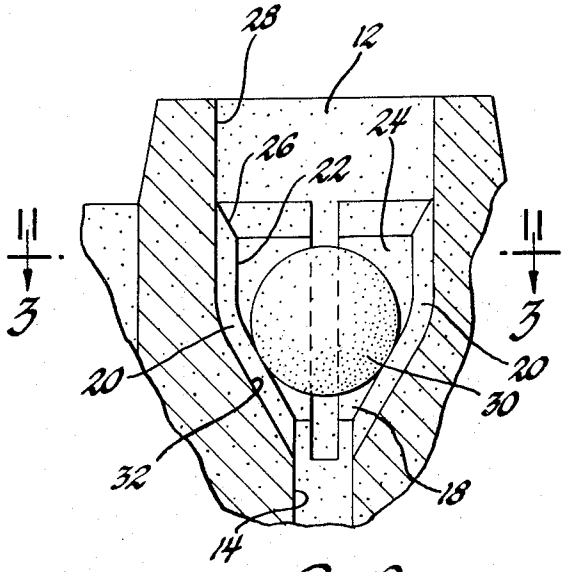


Fig. 2

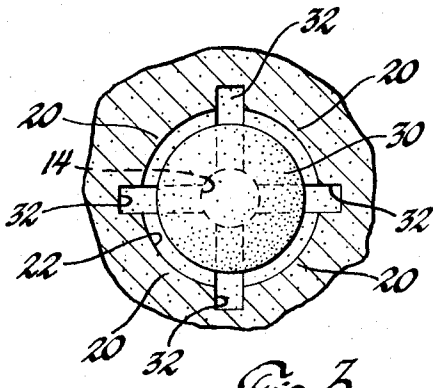


Fig. 3

METHOD OF INOCULATING NODULAR CAST IRON

This invention relates to the production of nodular cast iron and, more particularly, to an improved method of inoculating nodular iron to obtain uniform and thorough inoculation of the nodular iron simultaneously with the casting thereof.

In current production practice, relatively soft base gray iron is rendered nodular by a small addition of magnesium which changes the shape of the flake graphite to a nodular or spheroidal form. However, magnesium also strongly promotes the formation of cementite (Fe_3C) which is detrimental to the impact strength and ductility of nodular iron castings. If the nodular iron is to have good ductility without subsequent costly heat treatments, a silicon inoculation must be made to the melt after the magnesium treatment to eliminate this carbide-forming tendency in the treated iron. Alloys typically used for inoculation include the ferrosilicons containing either 75 or 85 percent silicon, calcium-bearing ferrosilicons with 85% silicon, or various combinations of these alloys. The use of ferrosilicon inoculants has the advantages of eliminating carbides in small castings or thin sections in the as-cast components, of increasing the ferrite content of the as-cast components, and of increasing the graphite nodule count and attaining a more uniform nodule size to obtain improved mechanical properties in addition to those resulting from elimination of carbides and from increased ferrite counts.

However, the effectiveness of the post inoculation treatments is subject to the phenomenon known as "fade" whereby the effectiveness of the inoculant addition is rapidly decreased as the time period is increased during which the metal is held molten before casting. To overcome the loss of inoculation effect with the passage of time various techniques have been devised for adding the inoculating agent as late in the pouring process as possible. These techniques include mold inoculation, instantaneous ladle inoculation and the use of inoculant mold inserts.

Mold inoculation involves placing in the gating system of the mold a small quantity, usually on the order of a few grams, of ferrosilicon fines which are effective to inoculate the molten iron as the casting is poured. The disadvantage of this method is that the initial portion of the metal charge entering the mold dissolves most of the ferrosilicon fines and is effectively treated, but the subsequent portion of the metal receives little treatment which results in undesirable microstructural variations throughout the casting. A more consistent microstructure can be obtained by instantaneous ladle inoculation wherein a solid ferrosilicon rod positioned against the lip of the pour ladle is dissolved by the stream of molten metal as it flows from the ladle into the mold. Dissolution of the inoculant thereby occurs throughout the casting process eliminating the variation which occurs with the use of ferrosilicon fines in the mold. A further improvement in post-inoculation effectiveness has been found in the use of preformed inoculant mold inserts. Inoculant mold inserts are preformed, perforated cores of ferrosilicon particles bonded with sodium silicate or similar binder to form a hardened insert of the inoculant agent. The hardened inoculant insert is placed in a desired position in the gating system of the mold whereby the iron on casting

flows through the perforations or holes in the insert dissolving the ferrosilicon particles on contact. This late inoculation just prior to solidification of the casting results in the desired microstructures. The use of stationary mold inserts is described in British Pat. No. 1,132,055 and a variation thereof is described in British Pat. No. 1,132,056, both issued on Oct. 30, 1968. An improved insert is described in the U.S. Pat. No. 3,658,115 issued on Apr. 25, 1972.

The principal problem encountered with the use of ferrosilicon mold inserts of the type described in the aforementioned British patents is one of two rapid dissolution or catastrophic break-up of the insert by the molten iron flowing therethrough. When this occurs, an irregular distribution of ferrosilicon particles in the melt results which produces a variation in the microstructure of the casting similar to that found when the mold inoculant with ferrosilicon fines method is employed. This problem becomes particularly acute when the quantity of metal poured is large, e.g., greater than 100 pounds, as typically occurs in production foundries, or when the pour rate is extremely slow or fast. The improved mold insert described in the U.S. Pat. No. 3,658,115 overcomes the problem of rapid dissolution and catastrophic break-up of the preformed inoculant agent on casting but is relatively expensive.

We have found that the problem of rapid dissolution and catastrophic break-up of the preformed inoculant agent during casting can be effectively and relatively inexpensively overcome by the provision of a ball-shaped inoculant insert supported within the pouring basin of the mold gating so that molten metal poured into the pouring basin flows about and under the ball and into the sprue and hence into the mold cavity. The ball is supported within the pouring basin so that molten metal flows about and under it to uniformly inoculate the metal and is of a size so that the inoculation continues substantially throughout the entire pour.

Preferably the pouring basin is cup-shaped and merges at its bottom into a downwardly extending smaller dimensional sprue portion forming a region or seat portion at its junction with the smaller dimensional portion of the gating for supporting the ball insert. The gating structure in the region includes preferably a plurality of radially inwardly directed projections formed with the gating wall in this region to form a seat for supporting the ball insert and also a plurality of relatively small passageways between the projections and about the ball for providing molten metal communication between the pouring basin and the smaller dimensional sprue portion when the ball is seated in the pouring basin. This arrangement permits the molten metal to flow about the contact the insert throughout the duration of the pour which results in uniform microstructure throughout the resultant casting. The projections are preferably shaped to provide a funnel shaped space therebetween so that the ball insert need only be dropped into the pouring basin and the ball will wedge and seat on the projections.

Other features and advantages of our invention will become more apparent from the following description, reference being had to the accompanying drawings in which:

FIG. 1 is a cross-sectional view of a mold embodying a ball insert;

FIG. 2 is an enlarged fragmentary portion of the mold structure shown in FIG. 1; and

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2.

Referring to the drawings the nodular iron inoculating system of this invention is associated with a conventional green sand mold shown in FIG. 1 suitable for casting ferrous metal articles. The mold includes the cavity 10 and the gating system including the pouring basin 12, the smaller dimensional downsprue 14 and the runner 16 leading to the cavity 10. The gating system may be of any suitable cross-sectional dimension such as circular, oval, rectangular and flat. For convenience the invention will be described in terms of circular or round cross-sectional configurations.

The pouring basin 12 merges into the smaller diameter downsprue 14 in the throat-like region 18 wherein the gating walls have the vertically elongated radially, inwardly directed projections 20 having curved surfaces 22 which together define a funnel-like space 24 therebetween. The projections 20 have the slanted sides 26 merging into the side wall 28 of the pouring basin and the surfaces 22 of the projections 20.

The ball insert 30 is merely dropped into the pouring basin and slanted walls 26 and funnel-like shape of the space 24 insures that the ball insert will descend and seat firmly into the throat-like region 18. The grooves or passages 32 between the projections 20 as shown in FIG. 3 provide conduits around the ball insert for molten metal communication between the pouring basin 12 and the downsprue 14. Alternatively the throat-like region 18 may be viewed as having funnel-shaped wall surfaces 22 with spaced grooves 32 formed therebetween.

The projections 20 are of sufficient number to firmly support the ball insert and the passages 32 are of sufficient volume to readily permit passage of the molten metal from the pouring basin 12 to the downsprue 14 while holding the molten metal back sufficiently so that it uniformly contacts the insert 30 as the charge of molten metal is poured into the pouring basin.

The inoculant agent insert 30 is formed by pressing particles of inoculant agent, which may be any of the wellknown agents and alloys used for inoculation of modular cast iron, along with a suitable binder in a die to form a body of desired configuration. Typically used nodular iron inoculant agents useful in this invention are generally the ferrosilicon alloys containing up to about, by weight, 50 percent iron, 2 percent calcium, 10 percent magnesium and balance silicon. A suitable inoculant agent is a 75 percent calcium-bearing ferrosilicon. In one preferred embodiment, the ball insert agent is made by pressing together particles of a size from about 20 to 80 mesh (Tyler scale) with about 12 percent, by weight, sodium silicate binder. A suitable binder is Type O sodium silicate, a commerical product of the Philadelphia Quartz Company. After forming the body is cured in a furnace at a temperature of about 300° – 400° F for about 10 minutes or is microwave cured for several minutes to form a hardened body.

The ball insert is preferably designed to show that it may be used in a range of pour volumes. For example, a ball weighing about 42 grams and having a diameter of about 1¼ inch may be used to inoculate a pour ranging from about 40 to 80 pounds. The binder is of a type which will withstand the typical pouring temperature of 2,500° to 2,600° F. The binder content of the ball insert is adjusted to provide a ball insert dissolution rate such at about one-half to three-fifths of the ball dissolves during the pour to insure uniform inoculation of the metal. The ball is preferably spherical because it is less subject to break-up in this form.

In the practice of the method of this invention the mold is formed by usual methods using a suitable pattern to form the cavity and gating system. Mold assembly problems involving the mold insert are avoided. The ball insert is merely dropped in the pouring basin. This may be done manually. However, an important advantage of this invention is that the ball may be dropped automatically into a series of molds mounted on a suitable mold conveyance by a suitable metering and conveyor device.

The molten metal is then poured into the pouring basin on top of the ball insert. The molten metal holds the ball insert in place and flows around the ball and through the passages 32 into the mold cavity. The molten metal is substantially uniformly exposed to the ball insert throughout the pour to produce uniform casting microstructures.

The post inoculant system of this invention is effective so as to improve machineability and castability, increase toughness and eliminate heat treatments due to its effectiveness in reducing pearlite formation and using more carbon to form the nodular carbon. The effectiveness of the ball insert in eliminating carbides and in promoting a ferritic matrix allows for decreasing the amount of post-inoculant added to the pour ladle which permits increased silicon levels in the base iron, allowing for the use of higher silicon scrap materials in the furnace charge. In addition, furnace refractory life is extended by higher silicon levels in the melt.

Although our invention has been described in terms of certain specific embodiments, it will be recognized that other forms may be adopted within the scope of our invention. For example, if desired the ball insert may be used in the horizontal gating of the mold with the ball insert being supported within the gating by means similar to the projections 20 with the grooves or spaces therebetween serving as conduits in contact with and around the ball insert.

What is claimed is:

1. A mold for inoculating molten nodular cast iron and immediately casting articles therefrom comprising

a mold including a mold cavity and a gating system communicating therewith,

said gating system including an open bottom pouring basin with the said bottom merging into a downwardly extending sprue passage of smaller cross-sectional dimensions at a throat-like region thereof,

a ball shaped inoculant insert having a greater dimension than said passage disposed in said region,

said region having a plurality of spaced radially inwardly extending projections supporting said ball insert and forming a plurality of passageways therebetween for conducting the molten metal from said pouring basin about said ball insert, to said passage and thence to said mold cavity.

2. A mold for inoculating molten nodular cast iron and immediately casting articles therefrom comprising

a mold including a mold cavity and a gating system communicating therewith,

said gating system including an open bottom pouring basin with the said bottom merging into a down-

wardly extending passage of smaller dimension at a throat-like region thereof,

a ball shaped inoculant insert having a greater diameter than said passage disposed in said region,

said region having a plurality of vertically elongated spaced radially inwardly extending projections supporting said ball insert and forming a plurality of passageways therebetween for conducting the molten metal from said pouring basin about said ball insert, to said passage and thence to said mold cavity.

3. A mold for inoculating molten nodular cast iron and immediately casting articles therefrom comprising

a mold including a mold cavity and a gating system communicating therewith,

said gating system including an open bottom pouring basin with the said bottom merging into a downwardly extending passage of smaller dimension at a throat-like region thereof,

a ball shaped inoculant insert supported in said region,

said region having a cross-sectional dimension which is smaller than the dimension of said insert forming a seat for supporting said insert, said region having a plurality of spaced passageways in the wall thereof for conducting the molten metal from said pouring basin about said ball insert, to said passage and thence to said mold cavity.

4. A mold for inoculating molten nodular cast iron and immediately casting articles therefrom comprising

a mold including a mold cavity and a gating system communicating therewith,

said gating system including a cup-like open bottom pouring basin with the said bottom merging into a downwardly extending passage of smaller dimension at a funnel shaped region thereof,

a spherical inoculant insert supported in said region,

said region having a cross-sectional diameter which is smaller than the diameter of said insert forming a seat for supporting said insert, said region having a plurality of spaced passageways in the wall thereof for conducting the molten metal from said pouring basin about said ball insert, to said passage and thence to said mold cavity.

5. A method of inoculating molten nodular cast iron while casting articles therefrom comprising

providing a mold including a mold cavity and gating system communicating therewith, said gating system including an open bottom pouring basin with the said bottom merging into a downwardly extending passage of smaller cross-sectional dimension at a throat-like region thereof,

dropping a ball shaped inoculant insert having a greater cross-sectional dimension than said passage into said region,

supporting said ball insert within said region by means of projections extending radially inwardly into said region,

introducing said molten iron into said pouring basin and causing said molten iron to flow over and about said ball insert through the passageways formed between said projections,

said ball insert being uniformly dissolved by the molten metal flowing therearound and said metal being inoculated thereby and causing said molten metal to flow into said passage and thence into said mold cavity.

6. A method of inoculating molten nodular cast iron while casting articles therefrom comprising

providing a mold including a mold cavity and gating system communicating therewith, said gating system including a cup-like open bottom pouring basin with the said bottom merging into a downwardly extending passage of smaller cross-sectional dimension at a throat-like region thereof,

dropping a spherical ball inoculant insert having a greater cross-sectional dimension than said passage into said region,

supporting said ball insert wedgingly within said region by means of vertically elongated projections extending radially inwardly into said region forming a funnel-like space therein for receiving said ball insert,

introducing said molten iron into said pouring basin and causing said molten iron to flow over and about said ball insert, through the passageways formed between said projections to said passage and thence into said mold cavity, said ball insert being uniformly dissolved by the molten metal flowing therearound and said metal being inoculated thereby.

7. A mold for inoculating molten nodular cast iron and immediately casting articles therefrom comprising

a mold including a mold cavity and a gating system communicating therewith,

said gating system including a bottom pour basin with the said bottom merging into a passage of smaller cross-sectional dimensions leading to said mold cavity,

a ball shaped inoculant insert disposed in a region of said passage,

said region having a plurality of spaced radially inwardly extending projections supporting said ball insert and forming a plurality of passageways therebetween for conducting the molten metal from said basin about said ball insert and thence to said mold cavity.

* * * * *