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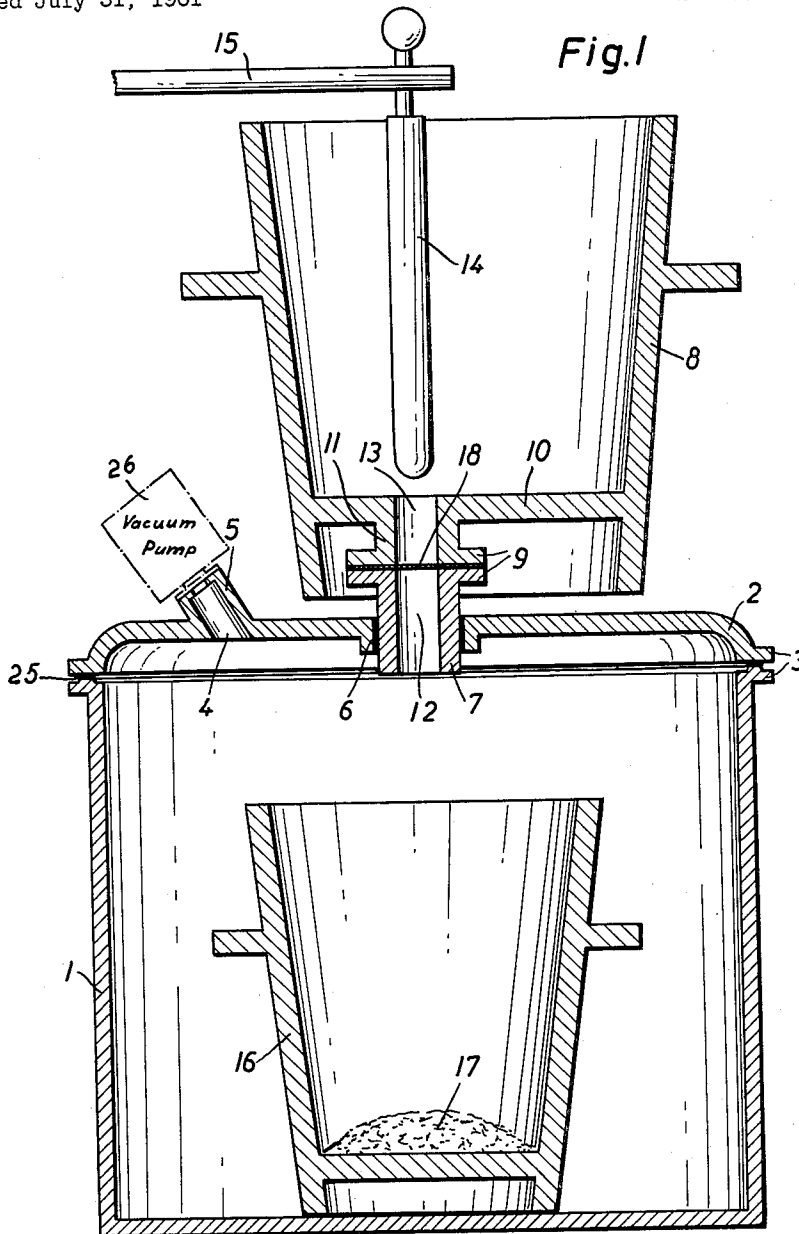
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METHOD OF POURING CAST IRON

Filed July 31, 1961

2 Sheets-Sheet 1



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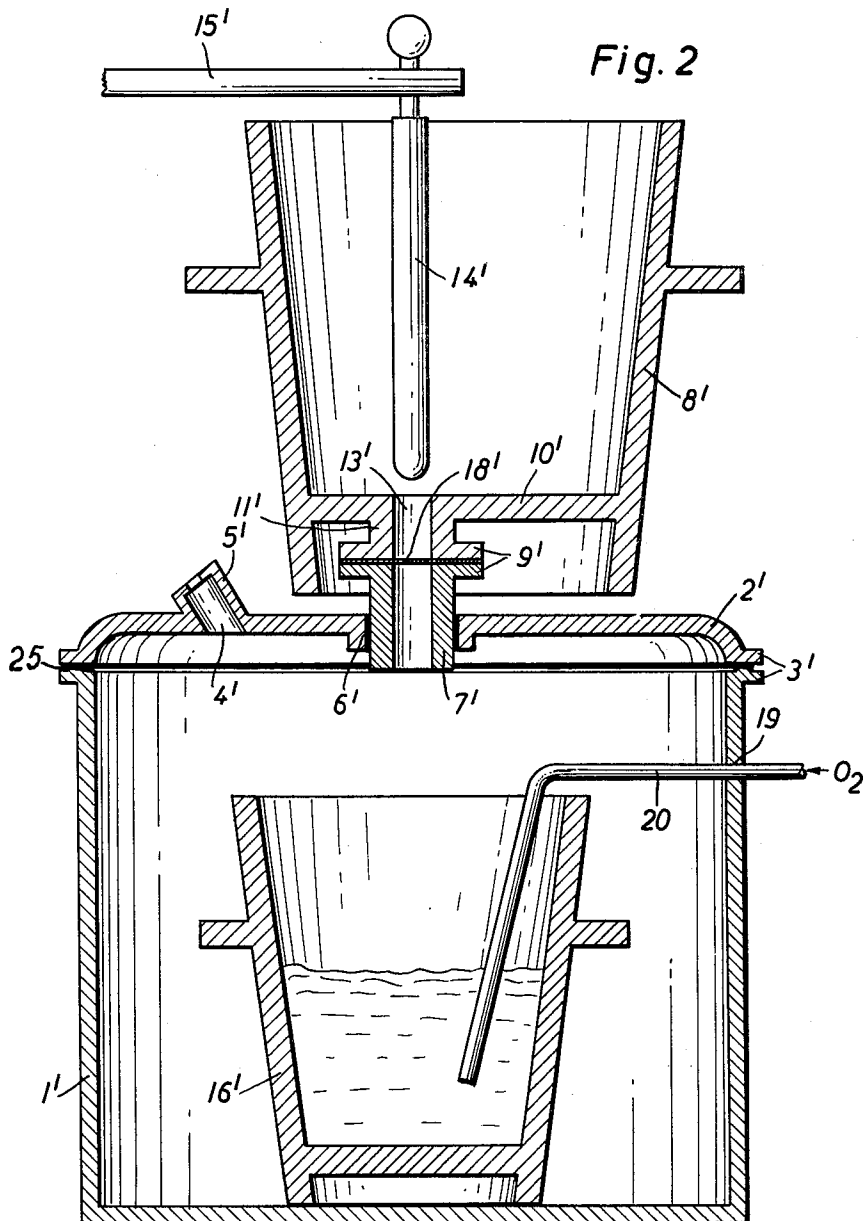
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METHOD OF POURING CAST IRON

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5 Claims. (Cl. 75-56)

The present invention relates to a method of and apparatus for casting cast iron. In connection with steel casting it is known to pass the liquid steel through a vacuum in order to obtain a degasification and a separation of harmful ingredients.

According to a heretofore known apparatus for carrying out this method, an empty casting ladle is inserted into a vacuum container which is tightly closed by a lid. A second casting ladle is then tightly placed upon the ladle of the vacuum container. The lid of the vacuum container has a passage for the liquid steel which passage is closed by a diaphragm. After the vacuum has been produced, the steel is poured in, whereby the diaphragm melts so that the steel will without loss in time enter the vacuum chamber.

It has already been known in conformity with this known principle to pass cast iron through a vacuum. In connection with this method, it was found that a reduction in the strength and the hardness of the pig iron occurred. Numerous tests have proved that the strength is reduced by 20% and that the hardness is reduced by 13%. In this connection, reference may be had to a paper delivered by Otto Nekas and Robert Kaminski, dated October 1959, and issued by Eisenwerke Vitkovice. In this paper a test has been described concerning the passage of cast iron similar to the above mentioned passage of cast steel, through a vacuum.

For the reasons described in the said paper, the casting art has refrained from treating cast iron in a vacuum because the reduction of the strength by 20% is prohibitive.

It is, therefore, an object of the present invention to provide a method of and apparatus for casting cast iron, which will overcome the above mentioned drawbacks.

It is another object of this invention to provide a method of and apparatus for casting cast iron in connection with a vacuum treatment thereof which will for all practical purposes not result in a reduction in the strength.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

FIG. 1 illustrates a diagrammatic section through an apparatus for carrying out the method according to the present invention.

FIG. 2 is a section through a modified apparatus according to the present invention.

General Arrangement

The present invention is based on applicant's finding that the reduction in the strength of the cast iron by vacuum treatment is caused by the reduction in the oxygen content of the melt. The inventor was able to ascertain a reduction in the oxygen content from 40 to 70%. The reduction in the strength of the cast iron depends on the separation of the carbon dissolved in the melt which carbon separates in the form of graphite during the solidification of the casting. Only if the carbon is separated in a certain form, the strength will be assured. This separation depends on the so-called nuclei. In connection with technical melting operations, only those foreign

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nuclei are of importance which consist to the major extent of silicates or oxides, i.e. of metallic or non-metallic compounds with oxygen. Such oxygen compounds can be present only if sufficient oxygen is present. If, however, not sufficient nuclei of this type are present, sub-cooling and other mis-formations of graphite crystals will occur which will at any rate produce a reduction in the strength.

The lack in nuclei is also a result of the loss in oxygen which is produced by the vacuum treatment of the melt because the melt due to the loss in oxygen loses its ability to form oxides.

From the above finding, the inventor drew the conclusion that the lack or low content in nuclei which is unavoidable during a vacuum process must be remedied.

Therefore, according to the present invention, following the degasification in a vacuum, the melt is again enriched with oxygen in order thus to produce a favorable nucleus condition. In this way, the reduction in strength will be safely avoided.

The method according to the present invention was practiced by an apparatus according to the present invention in the following manner:

In a normal light arc of from 100 to 150 kilograms capacity, the cast iron melt was produced. The charge may consist of pig iron, scrap, waste, and chips. The liquid melt was poured into a plug ladle (Stopfenpfanne) and in this ladle was tightly placed upon a vacuum container. By opening the plug, the iron was discharged while melting an aluminum foil between the vacuum container and the plug ladle which aluminum foil had previously sealed the vacuum container. Thus, the iron passed into the vacuum chamber. The melt passes through the vacuum chamber in a free flow and is collected in a casting ladle mounted below the vacuum chamber in a vacuum-tight container.

In order to assure that in conformity with the invention, following the degasification in the vacuum, the cast iron will again be enriched with oxygen, it is possible in conformity with a special embodiment of the invention, already prior to passing the melt through the vacuum, to introduce a substance, which gives off oxygen, into the casting ladle below the vacuum chamber. Such substance may consist for instance of scale or the like. Instead, also oxygen may be introduced into the collecting ladle.

As numerous tests have proved, the cast iron again enriched in the above mentioned manner with oxygen will, following the degasification, maintain a sufficiently favorable nucleus condition and will retain its strength.

In addition to the giving off of oxygen by means of which the melt is again enriched after having passed through the vacuum, the melt will also give off hydrogen and nitrogen. As a result thereof, a reduction in the hardness will take place which, even after the enrichment with oxygen following the discharge from the vacuum, will be retained because the hardness is, in view of the gases, dependent on the carbide stabilizing effect and not on the oxygen content. In addition to the increased strength of the cast iron in conformity with the method according to the present invention, the hardness is reduced. This is favorable because the construction of machines favors a soft easily machinable cast iron with high strength.

A further advantage of the cast iron according to the present invention consists in that due to the reduction in hydrogen and nitrogen, the tendency to hard edges, bubbles and blow holes will be reduced.

Finally, due to the degasification in a vacuum, the heat conductivity of the cast iron is increased.

Above all, it is to be mentioned that it is the present invention which for the first time has made it possible to

carry out the degasification of the cast iron melt in a vacuum because the heretofore known method for treating steel casting in a vacuum could not be employed for cast iron in view of the reduction in strength of the cast iron.

Due to the increase in the heat conductivity of the cast iron which is obtained when melting in a vacuum, and which is a result of the degasification in the vacuum, the density of the cast pieces is considerably increased. The conductivity of lamellar cast iron is increased by the vacuum treatment, as found by the inventors, up to 25%. Thus, by means of the vacuum treatment, a cast iron with high heat conductivity may be produced which is better suited than ordinary cast iron for thermally stressed cast pieces. This is extremely important for instance for molds of steel plants. The inventors found that the durability of such molds is considerably affected by the heat conductivity thereof. Also when making grates, oven doors, cast iron shafts etc. the increase in the heat conductivity is of great importance.

If parts are involved for which the strength is of secondary importance, the enrichment with oxygen after passing the melt through the vacuum may, of course, be omitted.

The invention may also be employed for making cast iron with spheroidal graphite. Cast iron with spheroidal graphite is produced in a manner known per se by adding magnesium to the melted liquid iron.

The particular advantage of this known method consists in that the employed magnesium alloys are extremely inexpensive. For instance, when melting in acidic furnaces, 20% of an alloy is employed which contains 15% magnesium and 85% nickel. A ton of such alloy costs approximately \$2,500.00.

The present invention makes it possible considerably to reduce the costs of this rather expensive method. In this connection, it should be kept in mind that by the magnesium alloy the following will be obtained:

A portion of the sulphur present in the melt is removed while another portion binds the gases and more particularly oxygen and nitrogen. A further portion of the magnesium will have to remain in the iron in solved condition.

In conformity with the features of the present invention, the melt is passed through a vacuum prior to the magnesium treatment.

As a result thereof, the oxygen and nitrogen will be removed from the melt and also a certain de-sulphurization (approximately 10%) will be obtained. The inventors have ascertained that due to the vacuum treatment of the melt, approximately up to 40% of the magnesium alloy will be saved because the removal of oxygen and nitrogen and also of a portion of the de-sulphurization when passing the melt through the vacuum is already obtained and therefore no magnesium is required any longer.

The decrease in costs which is obtained by the treatment of the melt in conformity with the present invention is very considerable. Moreover, the vacuum treatment of the cast iron with ball or spheroidal graphite has a number of other advantages. The heat conductivity of the iron increases by the vacuum treatment up to 25%. Due to the fact that the graphite stabilized gases hydrogen and nitrogen are removed already prior to the magnesium treatment, the cast iron with ball graphite in casting condition has a considerably greater toughness and considerably better strength properties which otherwise could be obtained only by tempering. As has been found out by the inventors, the expansibility in cast condition increases up to 75% and the bendability up to 200%. It has been found that the bending product (product of bending strength and bending) at 80 to 100% spherolite formation increases by from 200 to 500%.

Cast iron with ball graphite treated in conformity with the present invention does not produce any cementite, and the perlite component is reduced in favor of the ferrite component. According to the ordinary method, however, cementite is produced, and the perlite component is high.

Referring now to the drawings in detail, the apparatus illustrated in FIG. 1 has a vacuum container 1 provided with a lid 2 at its upper end. Lid 2 and vacuum container 1 are by means of flanges 3 and an interposed seal 25 connected in an air-tight manner, for instance by bolts not shown in the drawing.

Lid 2 has an opening 4 with an outwardly extending connection 5 for connection with a vacuum pump 26 by means of which a vacuum may be produced and maintained in the vacuum container 1.

Furthermore, lid 2 is provided with a second seal 6 substantially centrally located in lid 2. Extending through this seal in an air-tight manner is a discharge connection 7 of a plug ladle 8. The discharge connection 7 is by means of a flange 9 fixedly connected to a connection 11 which is arranged below the bottom 10 of the plug ladle 8 and extends downwardly. Between the flanges 9 and discharge connection 7 there is clamped an aluminum foil 18 or a foil of another easily meltable material which closes the discharge passage 12 in an air-tight manner so that after the plug ladle has been placed upon lid 2 of the vacuum container 1, no air will be able to enter the interior of the vacuum container.

The discharge opening 13 of the plug ladle 8 may be closed by means of a plug 14. For purposes of withdrawing and inserting said plug 14 there is provided a gripper member 15 or the like. Arranged in the interior of the vacuum container 1 is a casting ladle 16. This ladle is so arranged that it rests in the vacuum container substantially vertically below the mouth of the discharge connection 7. The arrangement of the casting ladle in the interior of the container 1 has the advantage that no separate seal will be required for connecting the casting ladle to the container. It is, of course, also possible to connect the casting ladle in an air-tight manner by means of a seal to the bottom side of an opening in the bottom of container 1.

In order to assure that following the degasification, oxygen will again be introduced into the cast iron, the arrangement with the apparatus according to FIG. 1 is such that when inserting the casting ladle into the vacuum container 1, a substance 17, as for instance scale, adapted to give off oxygen is introduced into the casting ladle.

The apparatus illustrated in FIG. 1 operates in the following manner:

The casting ladle is inserted into the vacuum container 1, and the substance 17 adapted to give off oxygen is introduced into the casting ladle 16. Thereupon, lid 2 is connected to container 1 by means of flange 3 and by interposing a seal or gasket 25.

Depending on the local conditions, the plug ladle 8 is first placed on lid 2 of the vacuum container 1 and then is filled with molten cast iron. However, it may also be filled at another station and then placed upon lid 2. At any rate, prior to filling the plug ladle 8, the discharge opening 13 in the bottom 10 of the plug ladle is closed by plug 14 by means of the gripper member 15.

After the ladle has been filled and placed upon the lid 2 of the vacuum container 1, first by means of the vacuum pump 26 the required vacuum is produced in container 1. Then plug 14 of plug ladle 8 is lifted by means of the gripper member 15. The cast iron melt will then flow through the discharge opening 13 and will melt the aluminum foil 18 which is provided in the discharge passage 12 and so far has acted as a vacuum seal. Thereupon, the melt will then in a free flow pass through the chamber of the vacuum container 1 and will collect in the casting ladle 16. While the melt passes through the

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free space of the vacuum container 1, the cast iron melt will be degasified by the influence of the vacuum. As soon as the said melt enters the casting ladle, oxygen will be given off by the substance 17 to the melt so that the melt will be enriched with oxygen. As a result thereof, the cast iron will, following its degasification, obtain a favorable nucleus condition and will thus retain its strength.

Referring now to FIG. 2, the apparatus illustrated therein for carrying out the method according to the present invention corresponds to a great extent to the device according to FIG. 1. Similar parts have, therefore, been designated with the same reference numerals as in FIG. 1 but have been primed, so that a description of these parts would appear to be superfluous.

The apparatus according to FIG. 2 differs from that of FIG. 1 primarily in that no substance giving off oxygen is introduced into the casting ladle 16'. Instead, during or following the filling with the cast iron melt, oxygen or an oxygen containing gas is introduced into the melt which is in the casting ladle 16'. To this end, the wall of the vacuum container 1' is connected to a source of oxygen not shown in the drawing. Into the interior of the vacuum container 1' there is introduced a gas conduit 20 which leads into the casting ladle 16' and has its mouth spaced from the upper level of the melt relatively slightly so that a good intermixing effect of the entire cast iron melt in the interior of the ladle with oxygen will be assured. The oxygen may be blown through conduit 20 into the cast iron melt in the interior of the ladle 16'. However, it is also possible to draw oxygen through the bath of the melt by means of a vacuum pump (not shown) connected to the connection 5'.

Advantageously, the feeding of oxygen is effected following the filling of the casting ladle 16' with cast iron. However, it may also be effected already during the filling operation. In this connection, however, it should be borne in mind that in spite of the feeding of oxygen into the interior of the vacuum container, a sufficient vacuum must be maintained. In other respects, the apparatus ac-

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cording to FIG. 2 operates in the same manner as that described above in connection with FIG. 1.

It is, of course, to be understood that the present invention is, by no means, limited to the particular constructions shown in the drawings but also comprises any modifications within the scope of the appended claims.

What I claim is:

1. In a method of casting cast iron, the steps of: passing the cast iron melt through a vacuum, and subsequently enriching said melt with oxygen.
2. A method according to claim 1, which includes the step of enriching the melt with oxygen by introducing oxygen in gaseous form into said melt.
3. In a method of casting cast iron, the steps of: passing the cast iron melt through a vacuum, and subsequently intermixing said melt with a substance adapted in contact therewith to free oxygen for absorption by said melt.
4. In a method of casting cast iron, the steps of: passing the cast iron melt in a free flow through a vacuum chamber, subsequently collecting said molten cast iron in a ladle and introducing into said ladle a substance adapted to free oxygen when contacting the molten iron in said ladle.
5. A method of making cast iron with spheroidal graphite, which includes the steps of: passing the cast iron melt through a vacuum, and subsequently adding magnesium to said cast iron melt.

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