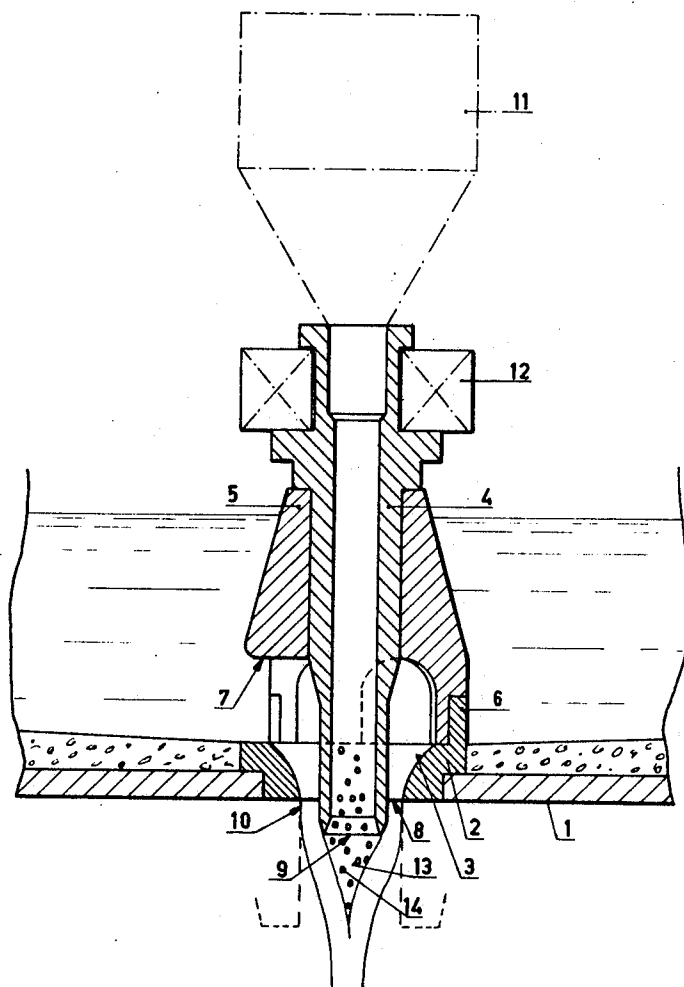


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METHOD FOR FEEDING ADDITIVE MATERIALS INTO
A STREAM OF MOLTEN METALS
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METHOD FOR FEEDING ADDITIVE MATERIALS INTO A STREAM OF MOLTEN METALS

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7 Claims

ABSTRACT OF THE DISCLOSURE

A method for feeding additive materials into a stream of molten metals in which a free-falling closed tubular stream is provided which contracts about the lower rim of a feeding chute without being able to penetrate into the chute. The surface tension in the stream is sufficiently strong to receive the increase in pressure caused by the evaporation of the additional material into the core stream without the stream exploding.

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a divisional application of my copending application Ser. No. 401,612, filed on Oct. 5, 1964, which was issued Dec. 12, 1967, as U.S. Pat. No. 3,357,692.

BACKGROUND OF THE INVENTION

This invention relates to a method for feeding additive materials into a stream of molten metals, which additive materials have lower boiling points and/or specific weights than the molten metals. More particularly, the invention is concerned with such a method for feeding magnesium or preliminary alloys thereof into a stream of molten iron for the preparation of nodular cast iron.

In alloying, magnesium and its allied metals present many problems, particularly so, because magnesium, for instance, will melt at 650° C. and will boil at 1120° C.

This is not only because, when fed into a melt having a higher temperature, they will prematurely evaporate and oxidize before they can be absorbed into the melting bath, but also because, due to their own low specific weight and to the high surface tension of the liquid metal, it is extremely difficult for them to penetrate into the bath. They are partially thrown back towards the bath surface and as to that part which is eventually absorbed into the bath, it is particularly difficult to obtain a homogeneous distribution in the cast iron products. Moreover, in consequence of the rapid evaporation and oxidation, there is a risk of great quantities of iron spattering away as well as a risk of explosions, which, besides being dangerous to the attendant personnel, renders the attainment of the required composition almost impossible.

A great many measures for obviating these problems have already been proposed. The additive material(s) may be placed on the bottom of a ladle and the liquid metal may be poured onto it (them). In a filled ladle, the additional material may be introduced by means of an immersion body, it may be thrown vigorously onto the bath by means of a rapidly revolving paddle wheel or it may be strewn on the bath surface and stirred in very intensively.

Further, the feeding-in may be effected while filling a ladle by dropping the additional material from a great height onto a stream of molten metals, or by adding it gradually on or in the stream.

In applying these methods use is often made of an airtight closed space or of a protective gas atmosphere under high pressure in order to prevent evaporation and oxidation. Further, a gas may be used as a carrier for the additional materials. Thus, pure magnesium can only be introduced in the bottom part of the molten mass, carried on a nitrogen stream, or on top of the molten mass in a closed-off space under a pressure of about 4.5–7 atmospheres.

All these methods have their own specific advantages but also their very great difficulties, particularly because the useful effect of the treatment often is very small. By way of example, we will now described two devices, which are used in feeding additional materials into a stream of molten metals and which come nearest to the method according to this invention.

There is known a device for adding aluminum to pig-iron, which is formed by a chamber which is closed at the top and is to be heated by a burner. This chamber is provided at its side with a supply pipe with a syphon for maintaining a constant and calm level on the bottom of the chamber. In the bottom, there is an overflow provided about a central drainage channel, the inlet portion of which has a gradually narrowing transverse cross section and the bottom of which shows a widened orifice. Under this, there is positioned a collector vessel having a discharge pipe at its side. This collector vessel is also closed on all sides and can be heated by a burner. A feeding chute for the additional material is provided through the cover of the chamber, which chute is coaxial to the drainage channel and reaches up to the overflow. The molten mass is supplied through the syphon in order to ensure that there will always issue a hollow, free-falling tubed stream from the drainage channel. Within the hollow of this tubed stream the additional material is supplied from the feeding chute as a free-falling, independent core stream which is not united to the tubed stream until far below the orifice of the drainage channel—substantially at the height of the bath level in the collector vessel. This device can not be used if magnesium or its preliminary alloys are employed, because, as the applicant has found, it entails serious danger from explosions.

Further, there is known a device for adding lead to iron alloys. This device is mounted on a steel ladle having a bottom provided with a drainage channel which can be closed by a stop rod. The device is formed by a storage container for the additional material(s), which is connected with a bore of the stop rod, which passes into a cylindrical chute extending into the drainage channel. The stop rod can seal on a conical seat in the drainage channel, or in a lifted position it can let a ring-like tubular stream of liquid metal flow into the further cylindrical part of the drainage channel, whereby a core stream of additional material can be fed through the chute.

By making the feeding chute of heat-resistant and insulating material and providing the stop rod at the upper side with a closing device, or by maintaining a high pressure in the bore of the feeding chute with the aid of gas or air, penetration by the molten mass of metal from the tubular stream into the feeding chute, there to form a lump of frozen fast sintered metal which obstructs the further supply of additional material, may be avoided.

When using magnesium and its preliminary alloys, this device has also proved to be useless on account of the occurrence of explosions.

SUMMARY OF THE INVENTION

The object of this invention is to provide a method which is of course free from the drawbacks referred to and which is perfectly reliable and will remain so for a long time. To this end there is according to this invention pro-

vided, in the bottom of a storage chamber for the melt, a mouth piece comprising an outlet channel having transverse cross sections gradually decreasing towards the orifice and which has substantially no cylindrical part, and mounted concentrically within this outlet channel a cylindrical feeding chute for the additional material, the preferably bevelled lower rim of the said chute projecting from under the orifice of the outlet channel.

According to this invention, the lower rim projects by more than a quarter of the diameter of the orifice of the outlet channel and the diameter of this lower rim is about one-half of the diameter of the orifice.

In a method according to this invention there arises a free-falling, closed tubular stream, which contracts about the lower rim of the feeding chute without being able to penetrate thereinto. It appears that hereby the surface tension in the stream is strong enough to receive the increase in pressure caused by the evaporation of the additional material into the core stream, without the stream exploding, whereas in the absence of a core stream the liquid metal does not penetrate into the feeding chute and obstructs it.

In view of this it is surprising to see the particularly homogeneous distribution obtained in the melt bath and in the castings.

If by some cause or other the lower rim of the feeding chute is worn or breaks off until far below the given value and comes to lie at substantially the same level with the orifice of the drainage channel, there will almost immediately occur obstructions and explosions, by which the feeding chute is flung out of the outlet channel.

Therefore, the feeding chute is preferably suspended so as to be readjustable, so that its lower rim can always be brought back to or be maintained at the right height to keep up with progressive wear.

BRIEF DESCRIPTION OF THE DRAWING

The single figure of the drawing is a transverse cross-sectional view, partially schematic, showing an embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to the figure, a mouth piece 2 of graphite is provided in the bottom 1 of a storage chamber to which the mass of molten metal is added. The mouth piece block 2 is provided with an outlet or drainage channel 3, the transverse cross section of which gradually and progressively narrows toward and up to its lower end, so that it is substantially without a cylindrical part.

A feeding chute 4 of graphite is mounted concentrically in the outlet channel 3 with the aid of a carrier 5 of graphite, which is centered in upstanding projections 6 of the block 2. Between the projections 6 and the carrier 5 there are formed gates 7, through which the melt from the storage chamber can enter the drainage channel 3.

The feeding chute 4 extends through the orifice 8 of the drainage channel 3 and the lower rim 9 of the feeding chute extends beyond the orifice 8 over a length, which is about equal to one-third of the diameter of the said orifice, that is into the free-falling and freely contracting stream 10 of liquid metal of the melt. Towards its lower end, the feeding chute 4 narrows from the outside and widens from the inside, and the diameter of the lower rim 9 then is about half the diameter of the orifice 8.

From a storage hopper 11, the additional material falls into the feeding chute 4, which can be kept at the right height with the aid of a heavy clamping holder 12 provided about the feeding chute 4 and which is thereby at the same time safeguarded against rising. Moreover, with the aid of this clamp it is possible to control the length of the projecting piece of the chute, by adjusting it to a higher or lower position.

A conical cavity 13 is created under the lower rim 9 in the freely contracting tubular stream 10, in which cavity

the falling particles of additional material 14 are caught before they are taken up into the stream 10 which has then becomes one massive whole. Up to the cavity 13, the additional material is free from the direct radiation of the melt and remains cool.

In a test plant, use was made of an orifice diameter of 36 mm. and a lower rim diameter of 18 mm., which projected about 12 mm. below the orifice 8. With this device, it proved to be possible to obtain a capacity of 20 tons/hour.

In some experiments, 450 kg. of cast iron containing 3.7% C, 1.2% Si, 0.3% Mn, less than 0.1% P and 0.045% S were introduced into the storage chamber of the device and were treated with 9 kg. of ferro-silicium-magnesium (30% Mg). The additional material contained 6 kg. having a particle size of 0.4-5 mm. and 3 kg. having a particle size of less than 0.4 mm. The adding operation took 110 seconds and the reaction was not marked by any particularly brisk development. An examination of test pieces, both such as were cast directly after treatment and such as were cast after 10 minutes' standing time, showed how a completely homogeneous spherical separation of graphite had arisen.

In a test immediately following upon this, 300 kg. of cast iron of the same composition were treated with 4.3 kg. of a mixture of Fe-Si-Mg particles and pure magnesium, about 1.2 kg. of which consisted of pure magnesium. This treatment took about 60 seconds and the development of the reaction was somewhat brisker. Here too, the graphite was separated completely in spherical form and evenly distributed.

After this, 340 kg. of cast iron were treated with 4.45 kg. of additional material, in which $\frac{3}{4}$ of the totally required amount of Fe-Si-Mg had been replaced by pure magnesium in granular form. The treatment took 83 seconds and the reaction developed, as was to be expected, in a much brisker way than in the previous experiments. However, no iron spattered from the ladle, into which the pouring from the storage chamber was effected and the stream remained closed. The graphite was again completely separated in the spherical form.

When this experiment was repeated, the same result was achieved.

Eventually, an experiment was made with 450 kg. of cast iron having a temperature of about 1425° C. with 5.1 kg. of pure granulated magnesium. The adding operation took 65 seconds. A little iron spattered from the ladle, but this was well within the limits of the permissible. The graphite had been separated practically entirely in the nodular form, with only a few crab formings.

When experiments were made in accordance with the method of the present invention in which an extension piece of 40 mm. length had been provided under the orifice 8, while the transverse cross sections of the drainage channel were in conformity to the contracting stream, so that no free contraction occurred, the feeding chute would be sintered shut if ferro-silicium was used. The magnesium would also obstruct the chute, but directly afterwards the device was destroyed by an explosion.

In a method in which a cylindrical extension piece of 40 mm. had been provided under the orifice 8 conformably to the dotted line in the figure, a number of minor explosions occurred when magnesium was used, by which explosions the liquid metal as well as the magnesium grains were flung far and wide, after which the feeding chute was partly sintered shut.

As has been ascertained by experiments, it is also possible, with the method according to the invention, successfully to add other additional materials to a mass of molten metal.

It will be understood that the above description of the present invention is susceptible to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

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I claim:

1. A method for feeding additive materials into a stream of molten metals, said method including the steps of:

causing molten metals to flow through an annular orifice having an outer wall which narrows progressively toward and up to its lower extremity and an inner hollow cylindrical wall which extends beyond said lower extremity, so that the annular stream flowing through said orifice closes to form a homogeneous stream below said orifice; and

adding additive material to the interior of said annular stream at a point just above the point where said stream becomes homogeneous, by allowing said additive materials to flow through said inner hollow cylindrical wall.

2. A method as defined in claim 1 for preparing castings with nodular graphite, wherein said additive materials have a particle size of less than 5 mm.

3. A method as defined in claim 2 wherein part of the additive materials have a particle size of less than 0.4 mm.

4. A method as defined in claim 1 wherein said additive materials have lower boiling points than the molten metals.

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5. A method as defined in claim 1 wherein said additive materials have lower specific weights than the molten metals.

6. A method as defined in claim 3, said additive materials containing magnesium.

7. A method as defined in claim 6, magnesium being present in said additive materials at at least 30%.

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