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PROCESS AND APPARATUS FOR INTRODUCING FINE-GRAINED ADDITIONS BELOW THE SURFACE OF METAL MELTS

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Fig. 1

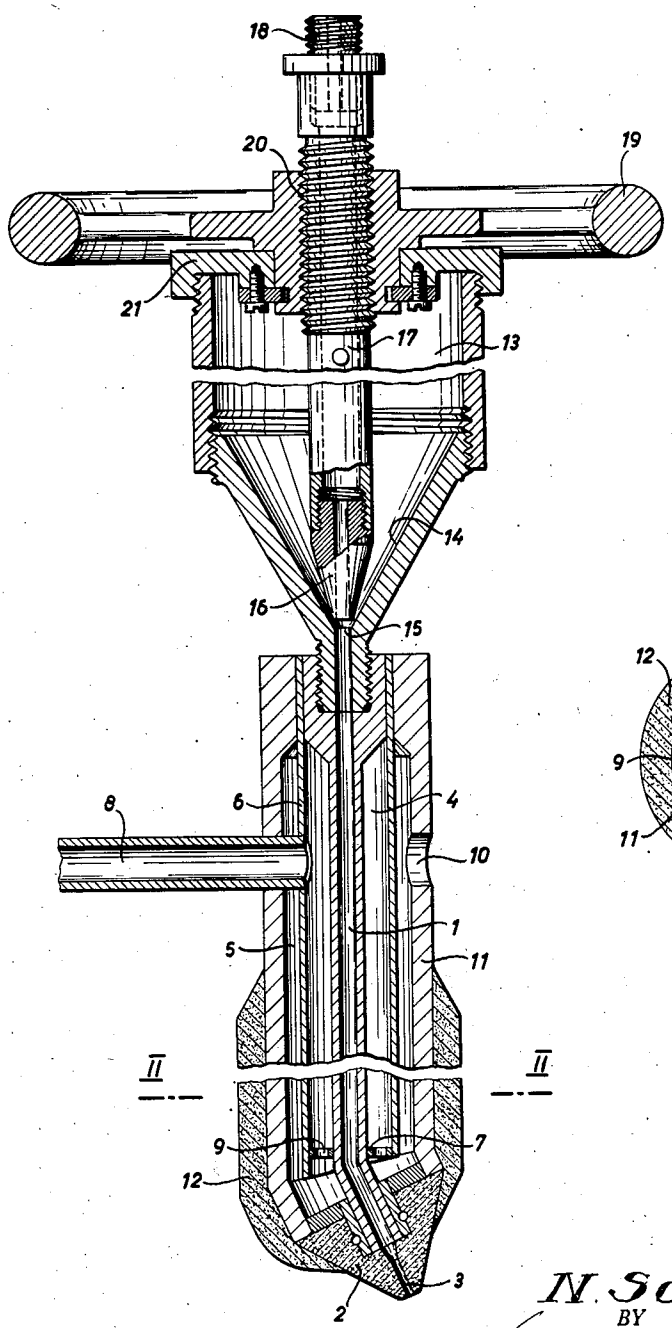
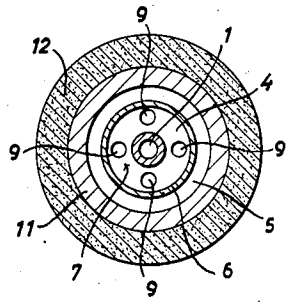


Fig. 2



INVENTOR.

N. Schreiber

BY

Glascock Downing & Seibold

ATTYS.

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PROCESS AND APPARATUS FOR INTRODUCING FINE-GRAINED ADDITIONS BELOW THE SURFACE OF METAL MELTS

Norbert Schreiber, Innsbruck, Austria, assignor to Tiroler Röhren- und Metallwerke Aktiengesellschaft, Solbad Hall, Austria

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12 Claims. (Cl. 75—53)

The invention relates to the introduction of fine-grained solid additives, particularly of a readily reacting type, below the surface of metal melts. In that connection the invention essentially resides in the fact that the solids are introduced directly into the melt, suitably deeply below the surface thereof, with the aid of a carrier gas serving as a vehicle for the solid, and that the violence of the reaction of the additions with the melt is checked by metering quantities introduced per unit time. To be able to serve as a vehicle for the solids and to convey them in an unchanged state into the metal bath, the carrier gas must be under a pressure sufficient to overcome the counter-pressure prevailing in the metal bath at the point of introduction. When readily reacting solid additions, such as aluminium, magnesium, or ferrotitanium, are introduced, the metering according to the invention enables the introduction of these additions in a pure form into the melt, without involving the danger that the reaction between the additions and the metal melt may be too violent or may even cause explosions at the point of introduction when an excessive amount is introduced. By this metering of the quantity introduced per unit time and also by the step of introducing the solids deeply below the surface of the melt, any loss of additions is reduced to a minimum. By the gradual introduction of the additions into the melt, their absorption by the melt adjacent to the point of introduction is afforded. A further absorption of these additions in the melt takes place as they rise therein. Thus the proportion emerging from the melt in solid, liquid or gaseous form is relatively small.

For instance, when magnesium is introduced in the manner according to the invention into a cast-iron melt, the temperature of the iron bath will always lie above the vaporization temperature of magnesium, which is 1102 deg. C. However, the vaporization of 1 kg. of magnesium produces 5650 liters of vapor which indicates that there is and explosion risk. Moreover, the major part of the magnesium will escape from the melt as vapor unless magnesium is supplied to the melt at a controlled rate, according to the invention. For this reason magnesium has been introduced into an iron melt always in the form of an alloy, to retard the absorption of the magnesium by the melt. The cost of such alloy, however, is a multiple of the cost of magnesium as such.

Since such metered supply of the solids involves the necessity of prolonging the time of introduction to at least some minutes, the action of the melt causes an undesired heating of the feeding device and of the mixture of solid and gas while supplied. For this reason the feeding device and the mixture of solid and gas in its passage almost to the point of contact with the melt are cooled according to the invention, to allow the practical prolongation of the time of introduction without undue wear of the feeding device. When a carrier gas is used which is effective as a protective gas only at relatively low temperatures, the mixture of solid and gas is cooled according to the invention to below the temperatures at

which a reaction of the carrier gas with the solids takes place. In this manner gases may be used for the carrier gas which are much less expensive than inert gases such as argon, that remain effective as protective gases even at high temperatures. For instance, nitrogen can be used to advantage as a carrier gas, whereas at elevated temperatures it would violently react with magnesium, aluminium or titanium to form nitrides. The cooling is to keep the temperature of the mixture of solid and gas on its way into the melt at least so low as to retard the reaction between the solid and gas and to prevent any appreciable reaction between solid and gas.

Thus the process according to the invention enables solid additions which readily react with the melt to be introduced deeply below the level thereof, in a simple, economical way. For instance, magnesium can be introduced into cast-iron melts for the production of cast-iron with globular graphite, or in melts of pig iron, cast-iron, or steel, for deoxidation or desulfurization. In accordance with the requirements, such as the temperatures, the sulfur and oxygen contents of the melt, the magnesium may be introduced into the melt at a rate which lies between the empirical approximate limits of 0.5 gram to 10 grams per second and per 100 kg. of metal melt, so that the process takes place as quietly as possible and with a far-reaching utilization of the amounts of magnesium introduced. The rate at which magnesium is introduced may be determined suitably in accordance with the absorption capacity of the melt adjacent to the point of introduction so that the magnesium can be absorbed by the melt with the smallest loss possible. Particularly in the case of relatively large melts, or of relatively large quantities of iron in the ladle, it appears suitable to introduce the magnesium into the melt at several points at the same time, to effect a better and more rapid distribution of the magnesium in the bath.

It is also possible, however, to introduce any readily oxidizable alloying metals into different types of metal melts in the manner according to the invention. For instance finely divided solids can be introduced in this way into cast-iron or steel melts to effect seeding.

The apparatus for carrying out the process according to the invention is essentially characterized by a feed pipe for the mixture of solid and gas, which pipe is surrounded by a cooling jacket and opens into a nozzle. The cooling medium may be a gaseous medium, such as compressed air, or a cooling liquid.

In the drawing the invention is illustrated diagrammatically with reference to an example.

Fig. 1 shows a feeding device in a longitudinal sectional view, whereas Fig. 2 is a cross-sectional view taken on line II—II of Fig. 1.

1 is the feed pipe for the mixture of solid and gas. That feed pipe opens at its lower end into a nozzle 2 having a relatively small orifice 3, and is surrounded by a double cooling jacket 4, 5. The annular cooling jacket spaces 4 and 5 are separated by a pipe 6, which is centered at its lower end relative to the feed pipe 1 by a disk 7. The cooling medium, which for example may be compressed air, is supplied into the inner annular space 4 through a pipe connection 8 and flows at the lower end of pipe 6 through holes 9 in disk 7 to the outer cooling jacket 5, from which it escapes through an opening 10. The outer cooling jacket 5 is confined by a pipe 11 immersed in the melt and protected against the melt by a protective coating 12 of refractory material such as graphite or fireclay. Having no cooling, the nozzle 2 is as short as possible and replaceably attached to pipe 11. The material of that nozzle 2 may consist of known ceramic compositions or, where the device is used for iron melts, of graphite.

The feed pipe 1 or the pipe 11 has attached to its upper end a container 13 containing the solid. That container ends in a funnel 14, whose opening 15 can be closed by the tapered tip 16 of a hollow stem 17. That stem 17 conducts the carrier gas, supplied to its through a connection 18, and is vertically adjustably fitted so that between the opening 15 of the funnel 14 and the hollow tip 16 an annular gap can be adjusted, through which the fine-grained solid from the container 16 is entrained by the injector effect of the gas flowing through the hollow rod 17. By a vertical adjustment of the stem 17 the injector effect of the carrier gas can be varied for metering the solid to be fed to the bath. To this end the stem 17 is guided in the female thread 20 to a handwheel 19, which is rotatably carried in the cover 21 of the container 13, so that the annular gap at the stem tip 16 can be adjusted by turning the handwheel 19 relative to the stem 17, which is held against rotation. That device enables an accurate metering of the fine-grained addition in conjunction with a minimum consumption of carrier gas. Such metering is essential in cases in which a violent reaction takes place between the additives and the metal melt because then a supply at an excessive rate may lead even to explosions at the point of introduction.

As shown in the drawing, the nozzle is attached to the pipe 11 in an angular position. That corresponds to the fact that for design reasons the pipe 11 generally must be inclined whereas it is of advantage to blow the mixture of solid and gas vertically into the melt so as to form around the nozzle 2 a gas cushion protecting the same to a certain extent against the action of the melt.

What I claim is:

1. A process for introducing readily reacting, fine-grained solid additives below the surface of a metal melt, comprising suspending the solids in a carrier gas, cooling the gaseous suspension substantially to the point of contact with the melt and passing the cooled suspension directly into the melt deeply below the surface thereof at a timed rate sufficiently slow to limit the violence of the reaction of the solids with the melt.

2. A process for introducing fine-grained magnesium below the surface of an iron melt comprising introducing the said fine-grained magnesium from above directly into the said melt deeply below the surface thereof, with the aid of a carrier gas serving as a vehicle for the magnesium and cooling the mixture of the said magnesium and the said carrier gas on its way almost until it contacts the iron melt.

3. A process according to claim 2, in which the carrier gas is nitrogen.

4. A process for introducing fine-grained magnesium below the surface of an iron melt, comprising introducing the said fine-grained magnesium from above directly into the said melt deeply below the surface thereof, suspended in a carrier gas reactive with the magnesium at high temperatures serving as a vehicle for the magnesium and cooling the suspension of the magnesium and the carrier gas on its way substantially to the point of contact with the iron melt, and limiting the violence of the reaction of the magnesium with the iron melt by controlling the quantities of magnesium introduced per unit time.

5. A process according to claim 4, in which the carrier gas is nitrogen.

6. A process for introducing readily reacting, fine-grained solid additives below the surface of a metal melt comprising introducing the said fine-grained solids from above directly into the melt deeply below the surface thereof, with the aid of a carrier gas serving as a vehicle for the solids, the said carrier gas being effective as a protective gas only at relatively low temperatures, and cooling the mixture of the said solids and the said carrier gas on its way almost to the point of contact with the metal melt, thereby keeping the temperature of said mixture below the temperature at which the reaction of the said carrier gas with the said solids takes place.

7. A process for introducing fine-grained magnesium below the surface of an iron melt, comprising introducing the said fine-grained magnesium from above directly into the said melt deeply below the surface thereof, with the aid of nitrogen serving as a vehicle for the magnesium and cooling the mixture of the said magnesium and the said nitrogen on its way almost until it enters the iron melt, thereby keeping the temperature of said mixture below the temperature at which the reaction of the said nitrogen with the said magnesium takes place.

8. A process according to claim 6, in which the fine-grained solids are entrained at an adjustable rate by the injector effect of the carrier gas.

9. A process for introducing fine particles of solid substantially pure magnesium into an iron melt, comprising suspending the finely divided magnesium in a gaseous carrier comprising nitrogen, and injecting the gaseous suspension into the molten iron at a substantial distance below the surface of the melt while maintaining the temperature of the suspension substantially below the temperature of reaction of the magnesium with its gaseous suspending agent until it has substantially reached the point of contact with the molten iron, and adjusting the rate of feed to supply the magnesium to the iron melt in quantity of 0.5 to 10 grams of magnesium per hundred kgs. of iron melt per second.

10. A process for introducing fine-grained aluminum below the surface of a metal melt comprising introducing the said fine-grained aluminum from above directly into the melt deeply below the surface thereof, with the aid of a carrier gas serving as a vehicle for the fine-grained aluminum, the said carrier gas being effective as a protective gas only at relatively low temperatures, and cooling the mixture of the said fine-grained aluminum and the said carrier gas on its way almost to the point of contact with the metal melt, thereby keeping the temperature of said mixture below the temperature at which the reaction of the said carrier gas with the fine-grained aluminum takes place.

11. A process for introducing fine-grained ferro-titanium below the surface of a metal melt comprising introducing the said fine-grained ferro-titanium from above directly into the melt deeply below the surface thereof, with the aid of a carrier gas serving as a vehicle for the fine-grained ferro-titanium, the said carrier gas being effective as a protective gas only at relatively low temperatures, and cooling the mixture of the said fine-grained ferro-titanium and the said carrier gas on its way almost to the point of contact with the metal melt, thereby keeping the temperature of said mixture below the temperature at which the reaction of the said carrier gas with the fine-grained ferro-titanium takes place.

12. A process according to claim 7, in which the fine-grained solids are entrained at an adjustable rate by the injector effect of the carrier gas.

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