

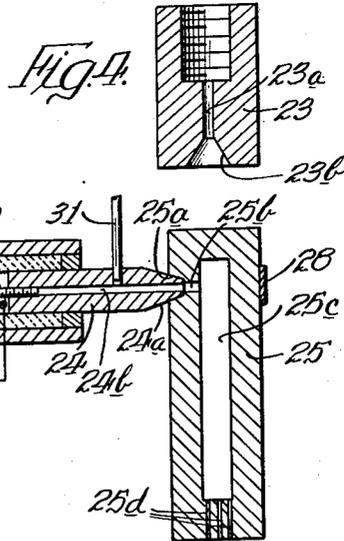
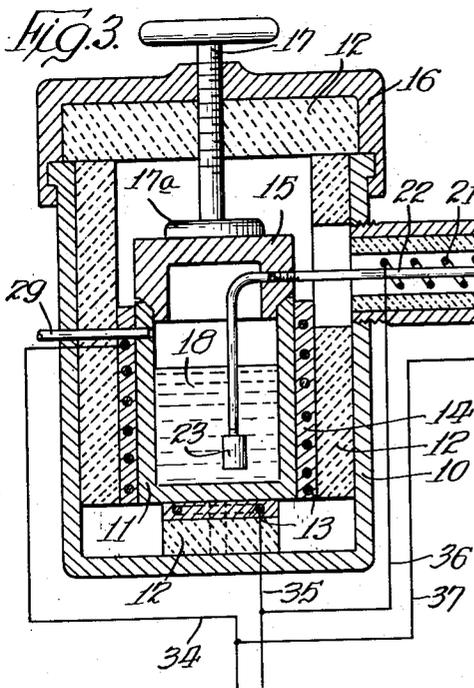
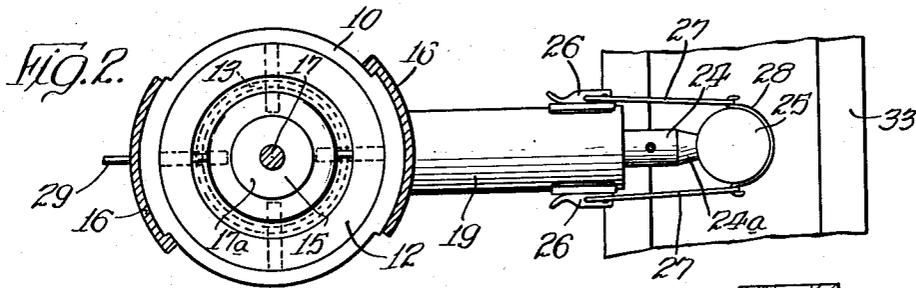
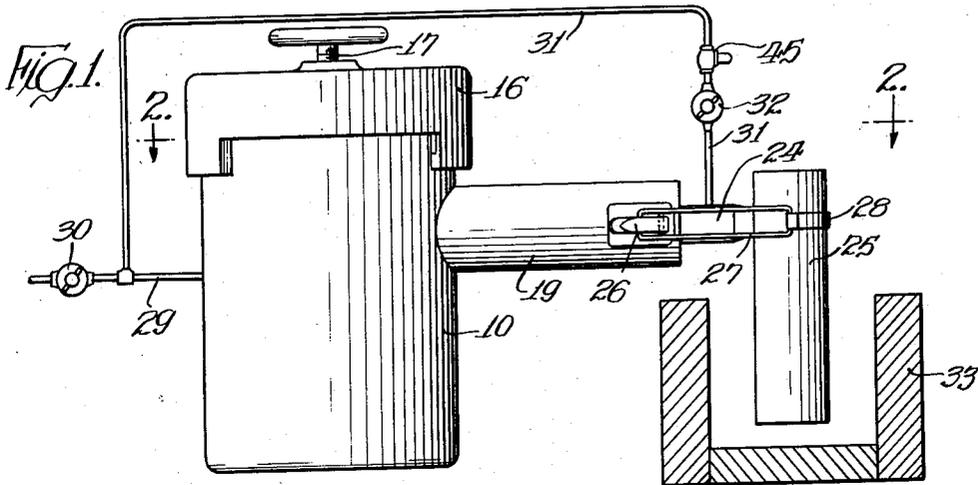
May 11, 1954

L. R. ZIFFERER

2,678,266

INTRODUCTION OF MAGNESIUM INTO MOLTEN IRON

Filed Nov. 8, 1951



INVENTOR.
L. Robert Zifferer

BY
Wm. & Wm. C. Co.

UNITED STATES PATENT OFFICE

2,678,266

INTRODUCTION OF MAGNESIUM INTO MOLTEN IRON

Lothar Robert Zifferer, York, Pa.

Application November 8, 1951, Serial No. 255,430

4 Claims. (Cl. 75-130)

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This invention relates to a device for introducing a first metal to a molten mass of a second metal and to a method for thus introducing the first metal.

In preparing various types of metal alloys, introducing purifying ingredients in metals and on similar occasions, it is customary to add a small amount of a first metal to the larger mass of the second metal. An example of this is the addition of magnesium to cast iron to produce gray iron with the graphite in nodular or spherulitic form and to purify the iron by desulfurizing and deoxidizing.

Although magnesium need be introduced in only small amounts to the cast iron to achieve the above described beneficial results, the introduction of the magnesium brings about many problems so that more is involved than merely adding the magnesium to the molten iron. For example, magnesium boils at about 2030° F. and thus is gaseous at molten iron temperatures. Furthermore, magnesium burns explosively in air so that there is considerable danger connected with its use. Because of the great advantage of magnesium in preparing cast iron however, many attempts have been made to develop safe and accurate methods and apparatus for introducing a predetermined amount of magnesium to iron.

Among the methods proposed in the past for solving the problems involved in adding magnesium to iron has been to use magnesium alloys of which nickel-magnesium and copper-magnesium have been found to be most suitable. Although magnesium can be introduced in this manner, this method has not been too successful as the amount of magnesium must be kept rather small. For example, the magnesium in each of these two alloys should not be more than about 20%. Thus the amount of nickel or copper in the iron can build up to undesirable proportions where iron containing scrap is inoculated repeatedly with the alloys.

One of the objects of the present invention is to provide a device for introducing a first metal such as magnesium to a molten mass of a second metal such as iron wherein the apparatus comprises a hollow nozzle immersible in the molten mass, a means for supplying the first metal in liquid form to this hollow nozzle, and means for supplying additional heat to the nozzle to vaporize the first metal prior to its introduction into the molten mass. Another object is to provide a method for introducing this first metal which comprises melting this metal, conveying the melted first metal to a point adjacent a

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molten mass of second metal, vaporizing the first metal by application of additional heat obtained at least in part from this molten mass, and introducing the vapors under pressure beneath the surface of the molten mass. Other objects, features and advantages of the invention will be apparent from the following description of one embodiment of the invention in connection with the accompanying drawings.

Of the drawings:

Fig. 1 is a semi-diagrammatic side elevation partially in section of one embodiment of the device of this invention.

Fig. 2 is a sectional view taken substantially along line 2-2 of Fig. 1.

Fig. 3 is a vertical sectional view taken substantially through the center of a portion of the apparatus of Figs. 1 and 2.

Fig. 4 is an enlarged detailed sectional view of the inlet tip of the device.

In the embodiment shown in the accompanying drawings, the apparatus includes an outer container 10, an inner container 11 positioned therein, insulation 12 such as firebrick between the inner and outer containers and electric resistance heating wires 13 surrounding the inner container 11 and held in any suitable heat conducting material 14. The inner container 11 is provided with a removable cover 15 which may rest on top of the container 11 and have an inwardly sloped fit therewith as shown in Fig. 3. The outer container 10 also has a removable cover 16 held in place on the outer container by any means desired such as the screw type locking arrangement shown. The outer cover 16 is provided with a vertical compression screw 17 extending therethrough and having a base portion 17a on the inner end bearing against the top of the inner cover 15. As is best shown in Fig. 3 the screw 17, when tightened, bears downwardly against the top of inner cover 15 and holds it in sealing relationship with the top of the inner container 11. The inner container is intended to hold a supply of a first metal 18 such as magnesium. The heating coils 13 around and beneath the inner container serve to maintain this metal in melted condition.

Extending outwardly from one side of the outer container 10 there is provided a tubular member 19 also containing insulation 20 around the inner surface thereof and housing an auxiliary resistance heating coil 21. This tubular member 19 and its associated insulation 20 and heating coil 21 contains a pipe 22 serving as a passageway for the melted first metal 18. This

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passageway extends upwardly from beneath the surface of the metal 18 and is turned outwardly through the inner cover 15 to extend through the tubular member 19 where it is surrounded by the insulated heating coil 21. The inner end of this pipe is connected to a removable inlet tip 23. The outer end of the pipe 22 forming the metal passageway is attached to a plug 24 of substantially cylindrical shape but with a conical tapered outer end 24a. This plug 24 has an axial passageway 24b communicating with the end of the pipe 22 as shown in Fig. 3 so as to provide an extension of this pipe.

The outer end 24a of the plug 24 is positioned beyond the outer end of the tubular member 19 and is removably held in a similarly shaped opening in a hollow nozzle 25. As is shown most clearly in Fig. 3, this outer end 24a is held at opening 25a so that the axial passageway 24b is in communication with a second opening 25b through the wall of the nozzle and into the relatively large inner chamber 25c of the nozzle. As can be seen in Fig. 3 the combination of the pipe 22, the axial passageway 24b and the second opening 25b provides a continuous passageway from beneath the surface of the metal 18 within the container 11 to the inner chamber 25c of the nozzle 25.

The nozzle 25 is removably held in position against the outer end of the plug 24 by any means desired. In the embodiment shown in the drawings, this locking means includes a pair of toggle latches 26 on opposite sides of the tubular member adjacent the outer end thereof with each connected through link members 27 to a strap 28 that extends around the nozzle 25. This arrangement holds the parts of the device in close contact but permits ready removal of the nozzle 25 whenever this is desired.

The inner end of the pipe 22, which is separable at the cover 15, is provided with the inlet member 23 in order to provide easy regulation of the amount of melted metal flowing through the device. As shown in Fig. 4 this inlet member is provided with a relatively small orifice 23a with a flared outer end 23b and the member is adapted to be screwed on or otherwise attached to the threaded lower end of the pipe 22.

In order to prevent air contacting the melted metal 18 within the container 11, to provide for moving the melted metal through the passageway formed by the pipe 22 and to prevent entry of the molten second metal into the interior of the nozzle 25, there is provided a source of inert gas such as helium under pressure. This pressurized gas, whose pressure may be controlled by the ordinary pressure regulator (not shown) communicates through pipes 29 and valve 30 to the interior of the inner container 11 above the surface of the melted metal 18 contained therein. Another pipe 31 for this gas is provided extending from the pipe 29 around the container through an ordinary pressure regulator 45 and a second valve 32 to communicate with the axial passageway 24b in the plug 24 and thus with the inner chamber 25c of the nozzle 25.

In order to provide communication between the lower end of the nozzle 25 and the inner chamber 25c there is provided a plurality of exit passages 25d, each of small diameter.

With the structure described herein, a first metal 18 may be easily introduced into a second metal flowing through a spout 33. In order to accomplish this, the first metal 18 such as magnesium is maintained in melted condition and

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forced through the passageway formed by the pipe 22, axial passageway 24b, and opening 25b into the inner chamber 25c of the nozzle 25 by the pressure of an inert gas flowing through pipe 29 to the space within the inner container 11 above the surface of the metal therein. As soon as this metal has reached the inner chamber 25c it is vaporized by additional heat such as that obtained from the molten second metal within the spout 33 and these vapors immediately flow through the small exit passages 25d into the flow of metal within the spout 33. The valve 32 in the by-pass pipe 31 is used to aid in flushing the apparatus free of air before melting the magnesium and to maintain pressure within the nozzle 25 and prevent the entry of the molten second metal through the passages 25d prior to the time the melted first metal reaches the nozzle.

The temperatures within the inner container 11 and the tubular member 19 are controlled by temperature controllers of any desired type. Thus, these controllers which are not shown may include a thermocouple in each of these parts of the apparatus which regulates the amount of current flowing to the resistance heaters 13 and 21. As shown diagrammatically in Fig. 3 the heater 13 is supplied with electricity from wires 34 and 35 while the resistance heater 21 is supplied from similar wires 36 and 37.

The device illustrated herein and described above is particularly useful for introducing magnesium into molten iron. It is obvious however that other metals can be used. For convenience, however, the operation of the device will be described in conjunction with magnesium as the first metal and iron as a second metal.

The inert gas as used in the system may be of any desired kind including helium, argon, krypton, xenon and the like. Helium and argon are preferred for economical reasons with helium being the most readily available.

The amount of flow of the magnesium from the device can be readily controlled by selecting the proper inlet member 23 having the desired orifice 23a, regulating the gas pressure on the top of the molten bath of magnesium and by controlling the temperature of the magnesium as the higher the temperature, the less viscosity of the melted metal. In one example, upon inoculating about .010% magnesium into an iron stream flowing at the rate of about 100 pounds per minute, the temperature within the container 11 was maintained at about 1500° F., the gas pressure was maintained at 30-35 pounds per square inch and the inlet member 23 had an orifice 23a of about .030 inch. In general, the range of the pressure required will be between about 25 and 50 pounds per square inch and by varying this pressure, the injection rate can easily be varied.

The magnesium is maintained in a molten state by the auxiliary heating coil 21 within the tubular member 19. The melted magnesium flows through the apparatus into the inner chamber 25c of the nozzle 25. As the boiling point of the magnesium is below the temperature of the molten iron within the spout 33, the magnesium is vaporized within the chamber 25c from heat received from the melted iron. As these vapors build cumulatively to a release pressure, they are immediately forced through the exit passages 25d into the stream of iron flowing through the spout 33, which may be a cupola spout of the usual type communicating with the tap hole of an iron cupola. In this member 19, the magnesium is

heated to as near the vaporizing temperature as possible so that all will be vaporized in the nozzle 25. If not all the magnesium is vaporized in the nozzle, there is some danger that an evolved mixture of liquid and gaseous magnesium will damage the nozzle.

Although when magnesium is introduced to iron the additional heat required in the nozzle 25 to vaporize the magnesium is secured from the iron, other heating means may be used if desired especially where metals with higher vaporizing temperatures are employed. The present apparatus is particularly useful with magnesium, however, as the relatively large amount of heat needed to convert molten magnesium to gaseous magnesium is obtained from the heat content of the molten iron and thus, in effect, uses what would otherwise be waste heat.

The magnesium on first contacting the molten iron reacts with the sulphur in the iron. The magnesium then has a tendency to leave the iron as a vapor. Because of the close controls of the rate of magnesium input obtainable with the apparatus of this invention, the input of magnesium is so regulated that very little waste is encountered.

In the preliminary flushing of the system to remove air, the pressure of the inert gas such as helium is ordinarily only 2 to 4 pounds per square inch. Prior to the operation of the device when the valve 32 is opened so as to create gas pressure within the chamber 25c and prevent the entry of molten iron, the pressure is maintained just sufficient to prevent this entry. When the valve 30 is opened to force gas into the container 11 and start the flow of melted magnesium, valve 32 is kept open until magnesium is flowing from the device. This valve is then closed so that there will be no gas within the passageway 24b to interfere with the flow of molten magnesium.

The various parts of the device are constructed so that they can withstand the temperatures encountered. Thus, the nozzle 25 which is immersed in molten iron is preferably made of carbon, graphite, silicon carbide or the like. Similarly, the strap 28 used in holding the nozzle in place may be steel covered with asbestos.

The apparatus described herein permits introducing a metal such as magnesium to another metal such as iron in accurate, carefully controlled amounts and without danger of explosion such as occurs when heated magnesium is in contact with air. Furthermore, the apparatus requires no moving parts, is compact, and conserves the inert gas which is used only as a source of pressure to move the melted magnesium, to flush the device free of air and keep molten iron from entering the device at the beginning of the operation. Furthermore, the device permits a higher rate of feed of the magnesium or the metal with very little cooling of the molten iron as the magnesium is preheated to a vaporizing temperature. Furthermore, by heating the passages for the melted metal, the dangers of clogging of the system and subsequent feed stoppage are practically eliminated.

Having described my invention as related to the embodiments shown in the drawings, it is my intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

I claim:

1. In a device for introducing a first metal to a molten mass of a second metal, apparatus comprising: a hollow nozzle having a relatively large internal chamber and immersible in said molten mass, the nozzle having an exit passage therein; means for supplying said first metal in liquid form to said hollow nozzle comprising a container for the first metal, means for supplying heat thereto to melt said first metal, a passageway from the container to the nozzle and separate means for supplying heat to the passageway to maintain the melted condition of the first metal; and a source of an inert gas under pressure communicating with the interior of said nozzle to prevent entry of the second metal thereto prior to the introduction of the liquid first metal.

2. The apparatus of claim 1 wherein said separate means is arranged to maintain the metal in said passageway at a temperature slightly below its vaporizing temperature.

3. In a device for introducing a first metal to a molten mass of a second metal, apparatus comprising: a container for the first metal; means for supplying heat thereto to melt said first metal; a source of an inert gas under pressure to the container; a passageway from beneath the surface of said molten metal; separate means to supply heat to said passageway to maintain the melted condition of the first metal; a hollow nozzle having a relatively large internal chamber and immersible in said molten mass of second metal, the chamber communicating with said passageway and the nozzle containing a plurality of exit openings of small diameter; means for supplying heat to said nozzle to vaporize the first metal in the nozzle prior to the introduction of the first metal into said molten mass; and a source of an inert gas under pressure communicating with the interior of said nozzle to prevent entry of the second metal thereto prior to the introduction of the liquid first metal, the amount of first metal flowing being controlled by the temperature thereof, the size of the entrance to said passageway and the pressure of the inert gas.

4. The method of introducing a first metal to a molten mass of a second metal, comprising: melting said first metal at a point remote from said mass; conveying the melted first metal in a conduit to a point adjacent said molten mass of second metal; continuously applying heat to said first metal in said conduit to maintain said melted condition vaporizing said first metal by application of additional heat obtained at least in part from said molten mass of second metal; and introducing said vapors under pressure beneath the surface of said molten mass.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
754,566	Hulin -----	Mar. 15, 1904
1,298,229	Levy -----	Mar. 25, 1919
1,750,390	Conner -----	Mar. 11, 1930
1,931,144	Gilbert -----	Oct. 17, 1933
1,938,716	Norris -----	Dec. 12, 1933
2,158,517	McParlin -----	May 16, 1939
2,259,342	Harder -----	Oct. 14, 1941
2,266,750	Gilbert -----	Dec. 23, 1941
2,283,299	Tisdale -----	May 19, 1942
2,527,498	Jordan -----	Oct. 24, 1950
2,577,837	Zifferer -----	Dec. 11, 1951