July 2, 1957 G. KÖPKE ET AL 2,797,994

METHOD AND APPARATUS FOR TREATMENT OF IRON MATERIALS IN A LIQUID STATE

Filed Feb. 10, 1953 3 Sheets-Sheet 1

Fig. 1.

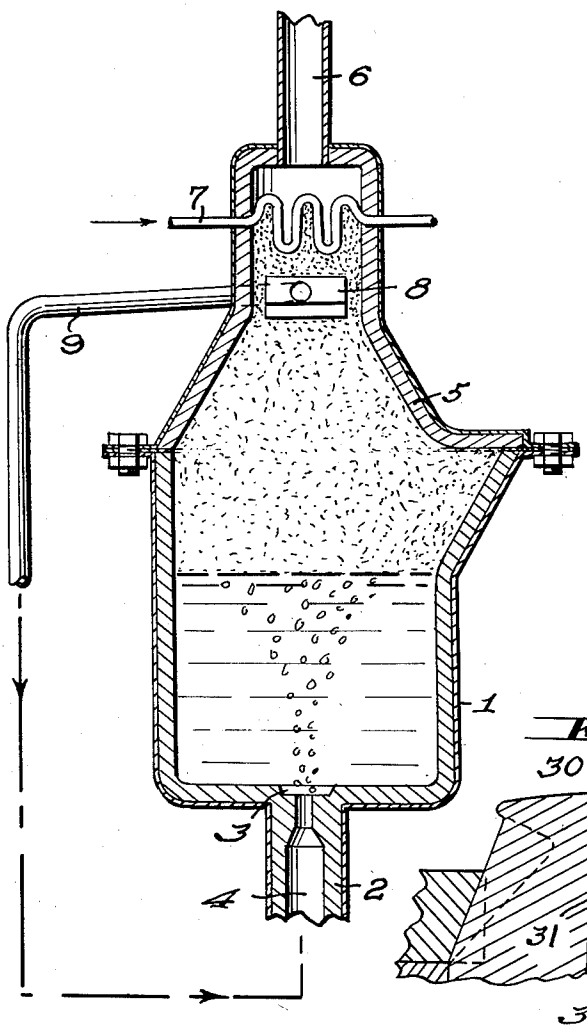
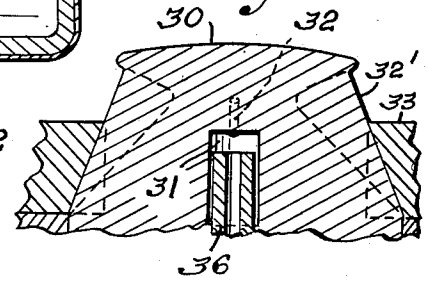


Fig. 8.



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METHOD AND APPARATUS FOR TREATMENT OF IRON MATERIALS IN A LIQUID STATE

Filed Feb. 10, 1953 3 Sheets-Sheet 2

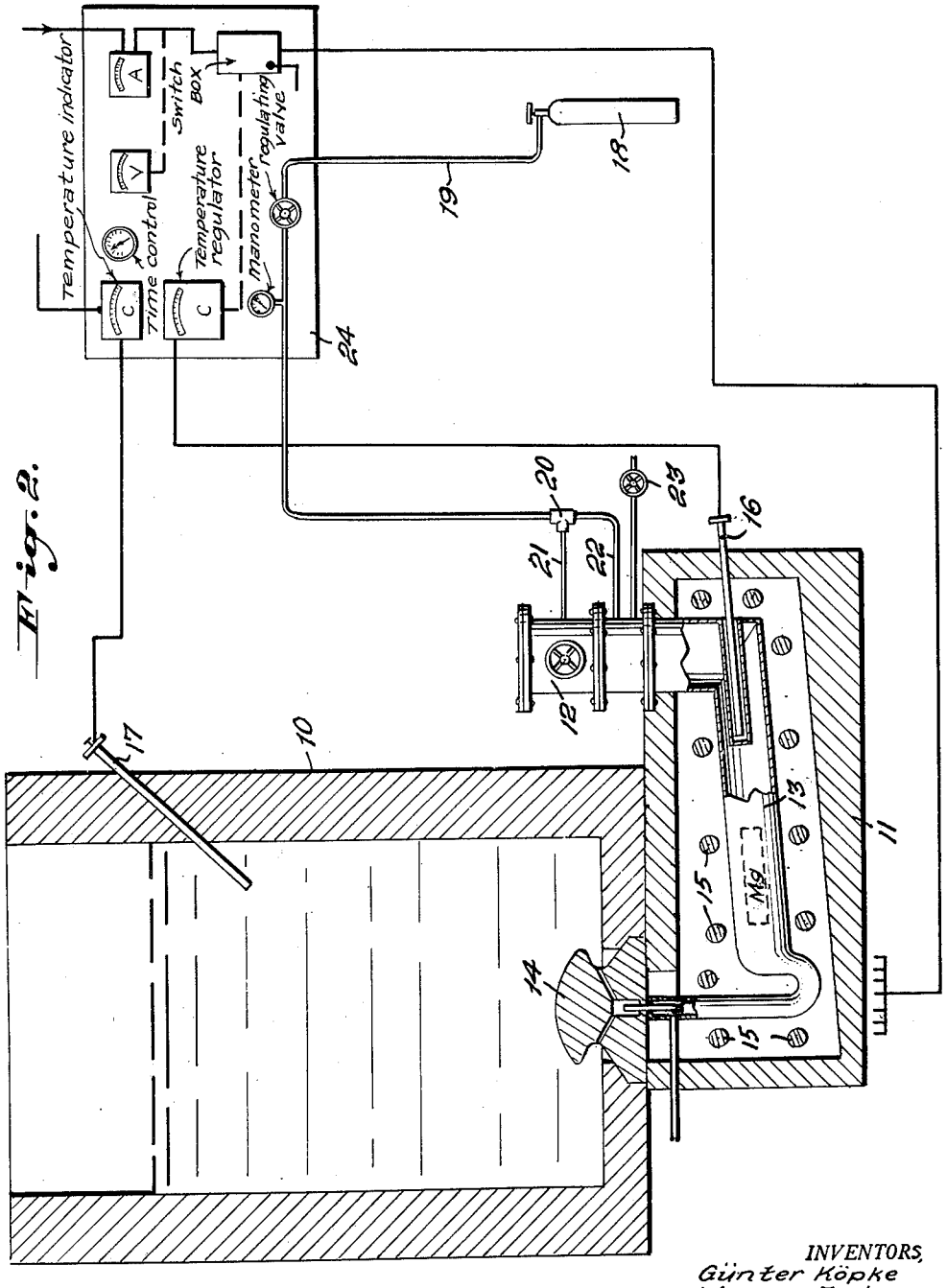


Fig. 2.

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METHOD AND APPARATUS FOR TREATMENT OF IRON MATERIALS IN A LIQUID STATE

Filed Feb. 10, 1953 3 Sheets-Sheet 3

Fig. 5.

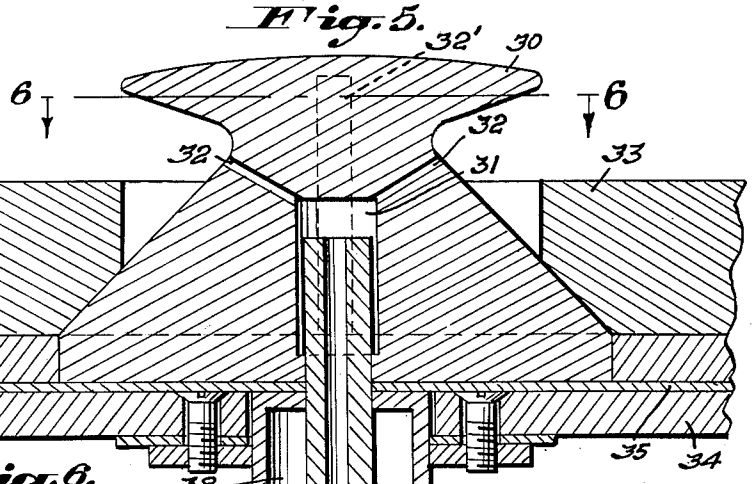


Fig. 6.

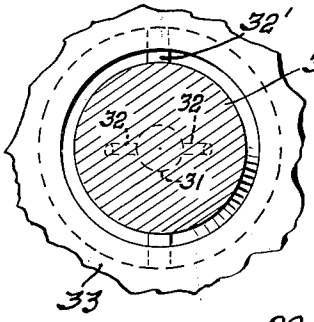


Fig. 7.

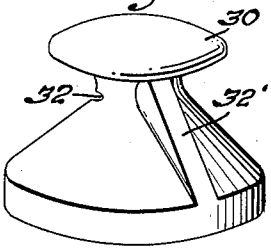


Fig. 3.

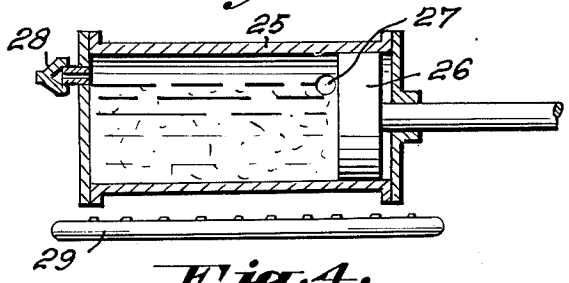
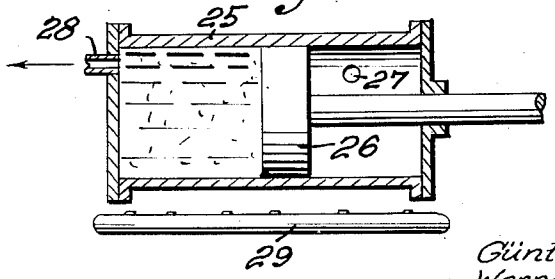


Fig. 4.



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United States Patent Office

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METHOD AND APPARATUS FOR TREATMENT OF IRON MATERIALS IN A LIQUID STATE

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Application February 10, 1953, Serial No. 336,164

Claims priority, application Germany April 28, 1952

13 Claims. (Cl. 75—130)

The present invention relates to a method and apparatus for treatment of iron materials in a liquid state, particularly cast iron.

Specifically the invention relates to treatment of cast iron to produce what is known as spherulitic cast iron, that is, cast iron having spherical graphite formation.

It is known that magnesium, cerium or other alkaline-earth elements or alloys of such substances or elements have been added to cast iron. Present technological developments indicate that the treatment of cast iron with magnesium provides the greatest advantages. In such treatment the content of the magnesium that remains in the cast iron amounts to a percentage between 0.015 and 0.5%.

The addition or introduction of magnesium into liquid cast iron is a difficult procedure since the boiling point of magnesium which is at 2030° F., lies below the melting point and substantially below the flow temperature of the cast iron. It thus follows that a very rapid and even explosion-like evaporation of magnesium occurs. Due to its low specific weight, 14.52 pounds per gallon, the magnesium floats on the surface of a bath of cast iron and when introduced on to the surface of the bath in solid form is hurled upwardly from the bath while evolving flame and light. In such instances high magnesium loss occurs, the control of the proper additive quantities of magnesium to the cast iron cannot be regulated, and furthermore personnel are endangered due to the violent reaction.

In view of this fact, prealloys are used. Such so-called prealloys particularly comprise an alloy of magnesium with nickel and to which have been added in relatively small quantities other components such as copper, silicon, manganese, calcium, aluminum and the balance iron, with the magnesium content not exceeding 40%. In this connection when using such alloys of relatively high magnesium content, it is necessary that the temperatures of the iron melt or bath must lie as close as possible to and above the liquidity line. Even using these prealloys, very strong reactions with brilliant light phenomena occur. The output does not amount to more than 30 to 50% in effectiveness so that even considering the relatively high cost of prealloys the total manufacturing cost of a cast iron with spherical graphite are rather high. Therefore the desired utilization and obtaining of spherulitic cast iron with its recognized qualities as regards rigidity and comparatively high elongation value is substantially restricted or prevented by the fact that the economic factors, proper technological manufacturing processes and the safety factors of present manufacturing processes, in spite of numerous proposals made in the past few years, have not been developed in a manner to perfectly satisfy all requirements.

The present invention therefore proceeds from the basic consideration of eliminating the present and aforementioned difficulties connected with the production of spherulitic cast iron and consists in avoiding the simultaneous addition or introduction into the ladle or the like

of the entire quantity of reaction medium that is to be added to the cast iron content. This consideration applies to additions introduced on the surface of the melt as well as below the surface of the melt. Due to the aforementioned physical relation between magnesium and iron, when the former is added to liquid molten iron, it immediately changes from a solid or liquid state and in addition to a substantial change in volume tends to rise to the surface of the melt. Upon the introduction of magnesium or to a lesser degree, this alloy mixed with other reaction materials at an area just below the surface of the iron melt there results a vigorous surging and foaming of the bath or melt. Thus it has already been proposed to introduce magnesium into the melt in successive portions rather than in a single charge, such as by progressive feeding of a wire of the metal, the flowing in of powder or vapor by means of an inert carrier gas or by means of pressure generated in a steam operated diving bell type device and also by introduction of liquid magnesium from a melting chamber arranged directly within the ladle or other vessel containing the iron bath.

As far as these proposals, which incidentally in part need not yet be considered as the state of the art, have been practically tested, they have been confined to relatively small quantities and apparatus of small dimensions. Additionally as far as is known, there has been no practical use of pure magnesium or of an alloy of a magnesium content exceeding conventional quantities. Despite any theoretical considerations of this process, a practical solution to the difficulty has not been obtained. This is readily understandable because on the one hand, while there has been discussed the possible addition of pure magnesium while maintaining a very definite temperature condition in the bath and then the diversion from this theory to the recommended use of a prealloy with a maximum magnesium content of 40%, further literature references still reveal the expressed warning against the "dangerous use of smelter magnesium." In this connection literature further reveals that the methods of addition of magnesium to cast iron are still in the developmental stage and with most methods the accuracy or quantitative control leaves much to be desired.

In contrast to the foregoing and in view of the major economic importance of this entire problem, the present invention has for a primary object the solving of this problem in such a manner as to make possible a safe and properly controllable addition to an iron melt of magnesium as a reaction material either entirely without or with only a substantially lower quantity of alloying components, than in the known prealloys, which components in this instance merely serve as carriers.

In accomplishing the primary object, the present invention has as a further object the addition of the reaction material in such a manner as to control the tendency of metallic magnesium to explode and oxidize.

Thus the invention has for an object the utilization of a high percentage magnesium alloy, preferably a reaction material containing magnesium between its perfectly pure form and a prealloyed form with a minimum content of 40% and in a liquid condition.

Specifically it is an object to provide a method and apparatus for controllably adding the reaction material and introducing it to an area of the bath lying as deep as possible within the bath and introducing the addition in minute quantities according to the desired conditions to be obtained in the cast iron with the total content of addition being controllably introduced over a definite time cycle which can be adjusted in accordance with conditions.

It is a further object to provide a method and apparatus in which the magnesium additive material is introduced to the melt under pressure generated either pneu-

matically or mechanically. In the former case a gaseous medium is utilized which is not blown into the melt together with the gaseous material, but is merely used for injection. Thus the medium comes into contact with the reaction material only over a surface corresponding to the cross-section of the injection conduit. If necessary, the medium can be separated from the reaction material by an intermediate layer consisting of salts. Therefore the temperature of the pressure gas or medium cannot effect the iron melt or the reaction material that is to be liquified before injection into the melt to cause any undesired cooling. In generating the introducing pressure by mechanical means a piston can be utilized.

In accomplishing these objects the installation for carrying out the process generally consists of a unit connected to the exterior of the treating vessel into which unit the reaction material is brought into the proper state required for injection into the melt to be treated.

Accordingly it is a still more specific object of the present invention to provide a unit for association with a ladle or other liquid iron containing vessel and which unit embodies an adjustably heatable smelting means for the reaction material and is so connected to an adjustable and entirely closeable pressure gas conduit that the pressure may be exerted on the reaction material in the unit in order to introduce the material into the melt. It follows therefore that to accomplish this object an additional specific object includes the provision with the unit of a gate or lock controlling the introduction of the reaction material and which is alternatively operable as an inlet and outlet that is in sealing relation with the unit so that the reaction material can be replenished without interrupting the operation of the unit.

It is a further and specific object to provide at least one nozzle through which the material is introduced into the vessel, the nozzle preferably being a spherical body that is interchangeably and/or removably mounted in the vessel.

It is a still more specific object of the present invention to provide a nozzle body through which is introduced the reaction material which includes a central inlet bore and plural outlet bores extending in different directions and which nozzle body is made of a highly resistant, preferably sintered and pressed material, particularly magnesium oxide, which material is chemically insensitive and physically resistant to the conditions existing in the process.

Further and more specific objects will be apparent from the following description taken in connection with the accompanying drawings illustrating the invention, and in which:

Figure 1 is a diagrammatic view illustrating the application of the invention to a ladle containing an iron melt, including means for recovering or recirculating superfluous magnesium,

Figure 2 is a cross-sectional view illustrating a reaction material treating unit mounted on the exterior of an iron containing vessel and diagrammatically illustrating the means for subjecting the reaction material to gaseous pressure,

Figures 3 and 4 illustrate in two different positions of operation and partly in cross-section and partly in elevation an embodiment for mechanically generating the pressure required to introduce the reaction material into a vessel,

Figure 5 is a partial cross-sectional view and on an enlarged scale of a reaction material introducing nozzle and its connection with the base of a liquid iron containing vessel,

Figure 6 is a cross-sectional view taken on line 6—6 of Figure 5 and on a reduced scale,

Figure 7 is a perspective view of the nozzle body also on a reduced scale, and

Figure 8 is a cross-sectional view on a smaller scale taken at right angles to Figure 5 and through the center of the nozzle body.

Figure 1 illustrates diagrammatically an apparatus for carrying out the process of injecting or adding the magnesium reactive material to the cast iron melt in such a fashion as to eliminate the violent reaction generally accompanying the addition of magnesium or one of its compounds to iron melts and in which apparatus a practical constructional arrangement is utilized. In the drawings, 1 denotes a ladle in which is received the liquid cast iron. The ladle as indicated includes a cylindrical extension 2, extending downwardly from the bottom. At the bottom of the actual iron receiving chamber is a small depression 3 to the base of which communicates an inlet conduit 4. The inlet conduit has a neck that is narrowed similar to a bottle neck and it is through this conduit that the magnesium reactive material is introduced into the liquid iron at an area at the bottom of the ladle 1. The ladle 1 is furthermore provided with a pouring lip as shown.

In sealed relation on the ladle 1 is applied a closure cap 5 of somewhat dome-shaped configuration and to the top of the dome there is attached an outlet tube 6. The dome tapers from its juncture with the top or upper rim of the ladle toward the outlet pipe and in the narrowed portion immediately subjacent the outlet pipe is provided a tube coil 7 serving as a condenser and through which flows a cooling medium either liquid or air. Beneath this tube coil there is a shallow receptacle or tub 8 which is supported within the narrowed portion of the dome in spaced relation to the walls thereof so as to create an annular passage between the receptacle 8 and the walls of the dome. A downwardly inclined conduit 9 is connected to this receptacle for reasons hereinafter set forth.

If liquid magnesium or if magnesium in a liquid state, which is preferably utilized as a reaction material, is introduced into the iron melt in small quantities corresponding to the small outlet diameter of the conduit 4 at its juncture with the depression 3, a vehement reaction between the magnesium and the oxygen contained in the iron, sulphur and the other substances in the iron melt with which magnesium combines occur. Additionally the magnesium evaporates immediately upon entering the bath of iron since the temperature of the bath is considerably above the boiling point of the magnesium. Simultaneously the entire bath or melt commences to surge or in effect effervesce or bubble. If it is desired, the boiling point of the reaction material can be raised by utilization of an alloy, that is, a mixture of magnesium and cerium or nickel in order to retard evaporation.

In every instance the reaction material due to its low specific weight divides into very small bubbles or particles and thereby forms as large a surface area as possible in its effervescence or bubbling path from the base of the ladle up to the surface of the bath and the greatest portion of the introduced magnesium together with substances expelled from the iron is discharged into the space above the surface of the bath. Depending on the manner in which the method is practiced, one can immediately either lead away the vapors rising from the surface of the bath or permit them to react on the bath surface. This is effected by a suitable control, not shown, of the discharge through outlet pipe 6.

The tube coil or condenser 7 liquifies or condences some of the magnesium vapors so that they are caught in the receptacle 8 and pass away through the downwardly inclined conduit 9 for either disposal, or as indicated, reuse by circulation back through the inlet conduit 4. The non-condensed gases pass off through the pipe 6.

In the particular arrangement illustrated in Figure 1, after the method has proceeded to the extent of treating a particular quantity of liquid iron that is contained in the ladle 1, the cap 5 is removed, since as shown it is bolted to a flange on the upper rim of the ladle. Thus after the first batch treatment, the iron is poured out

through the lip of the ladle, a new charge of iron is admitted to the ladle and the cap is remounted thereon so that the process can proceed with the treatment of another batch. It is possible to so arrange the structure that the molten iron that has been treated can be discharged and fresh iron added in a continuous manner so that the addition of the magnesium can be accomplished in a continuous manner.

A particular advantage of the present process consists in the fact that the respective iron melts, in addition to the other change, such as the formation of a spherulitic structure, due to the low potential pressure are to a great extent simultaneously and/or completely degasified.

Figure 2 illustrates a practical embodiment of the invention in which to the underside of a cast iron containing ladle or vessel **10** is mounted a reaction material melting and injecting unit **11**. In this form the magnesium in a solid state is introduced through a controllable gas-tight lock or rotary seal **12**. The unit **11** includes a hollow body or chamber portion **13** that is inclined downwardly from its inlet or right hand side as viewed in the drawing to a siphon-like discharge tube formation including a vertically extending portion communicating with a discharge nozzle body **14** that is replaceably mounted in the base of the ladle or vessel **10**. The hollow body **13** is constructed of a material that is insensitive to liquid magnesium, that is, unalloyed steel, low in carbon content and on the heated side of this body there is provided a non-scaling coating, that is a layer of non-corrosive steel, which is surrounded by controllable and adjustable heating elements **15**. The temperatures of the reaction materials, that is the magnesium or its alloy within the hollow body **13**, and of the iron bath to be treated are controlled by thermostatic elements respectively denoted at **16** and **17**. Additionally the outer wall of the unit **11** can be heated by electrical means mounted as diagrammatically indicated, subjacent the siphon-formed end of the hollow unit **13**.

In order to inject the reaction material into the iron bath, that is into the ladle at the bottom thereof, against the ferro-static pressure of the bath and so as to prevent a penetration of cast iron into the nozzle **14**, a conduit **19** which is connected to a pressure gas reservoir **18** containing argon or some other gas under pressure, communicates with branch conduits **21**, **22** which through suitable valves are alternately connectable and disconnectable through a corresponding T section conduit **20** with either and/ or the rotary seal or feeding lock gate **12** and the inlet end of the hollow body **13** of the magnesium smelting device at a point subjacent or in effect behind the inlet or feeding gate. A safety valve **23** is mounted to a conduit communicating with the inlet channel subjacent the lock or gate **12** so that the injection pressure of the reaction material cannot exceed a certain adjustable maximum value. The various control, indicating and switching elements for observing and controlling the temperatures of the reaction material in the smelting device and the bath in the ladle and for regulating the heat applied in the smelting device and for controlling the injection pressure and thereby the quantities of reaction material injected in a given unit of time into the melt are grouped on a single control panel **24**.

It is thus clear that with the introduction of the magnesium through the gate **12** and the heating of the tubular smelting chamber **13**, the magnesium is brought to the desired liquid state and under suitable control the gas under pressure is introduced into the hollow body **13** to drive the liquid magnesium vertically up the discharge portion of the smelting chamber **13** through the nozzle **14** and thence into the bath. Obviously the molten magnesium will form a level on opposite sides of the bight or bend of the siphon portion of the smelting chamber so that the pressure of the gas will drive the magnesium upwardly through the nozzle **14** and the gas under pressure will, for the most part, not flow into the bath with the

magnesium. Thus the present invention utilizes gas under pressure primarily as a driving force and not as a carrier.

In lieu of the aforedescribed manner of constructing the smelting device, it is possible that the smelting unit can be mounted separately and the magnesium or reaction material after having been liquefied can be led into the portion of the unit that is connected with the ladle or vessel containing the iron and thence subjected to the injection pressure.

Such an arrangement is diagrammatically illustrated in Figure 3 in which a cylinder **25**, within which is movable a piston **26**, shown in its retracted position, is directly connected with the ladle or another vessel containing the iron bath. Within the cylinder wall and slightly in advance of the front or pressure applying piston **26**, an inlet orifice **27** through which flows the liquid reaction material. The left hand end wall of the cylinder has an orifice therein communicating with a nozzle **28** which is mounted in a suitable aperture in the base or lower side wall of the iron receiving vessel or ladle and through which nozzle the reaction material passes. The ladle has not been illustrated in this figure. In order to maintain the reaction material within the cylinder **25** in its liquid condition and also if necessary to effect melting of a reaction material, a suitable heating means is provided. Diagrammatically illustrated in this figure is a gas burner **29** which is provided with a plurality of jet openings distributed throughout the length of the cylinder. Obviously the cylinder **25** can be heated by other means such as an electric coil or other type electric heating unit placed subjacent the same.

In Figure 4 is illustrated another position of the structure of Figure 3 with the nozzle **28** removed. In this figure the piston **26** is in its pressure stroke and during the initial movement thereof the side walls of the piston of course close off the inlet orifice **27**. The supply through this orifice previously having been shut off after the desired quantity of the reaction material had been placed within the cylinder **25**. By means of indicating marks, not shown on the drawings, the rod of piston **26** bearing these marks denotes from the exterior of the cylinder **25** the extent of movement of the piston and thus the quantity of reaction material that has been injected into the bath. Additionally by means of the speed of stroke of the piston, the amount of reaction material injected in a given time unit may be ascertained and, if necessary, the amount can be controlled by accelerating or decelerating the speed of movement of piston **26**.

In Figure 5 there is illustrated on a larger scale the nozzle **14** that is utilized in the embodiment illustrated in Figure 2. The nozzle body **30** is designed symmetrically with respect to the axis of the vertical entrance bore **31**. From the inner terminal end of this entrance bore a plurality of outlet bores **32** are arranged which extend in different directions at an upwardly inclined angle. The number of these bores **32** will of course depend on the particular requirements, it being obvious that they are spaced around the circumference of the nozzle body. Additionally the respective nozzle bores **32** are separated from one another by protecting webs **32'** extending downwardly from the outwardly flared top of the nozzle body **30** to its sloping side wall or conical base portion. As indicated, the conical formation of the body permits the insertion of the same from beneath into a suitably formed aperture in the bottom **33** of the ladle or the like. Between the lower side or face of the nozzle body and the bottom of the pouring ladle **33** and the upper wall **34** of the reaction material smelting unit there is provided a plate-like member **35** functioning as an additional seal and as a heat guard. Into the entrance or inlet bore **31** of the nozzle body extends the upper end **36** of the reaction material inlet pipe. The lower end of this pipe is widened or enlarged at **37** and a coolant medium receiving chamber **38** is formed above this enlarged lower end and around the reduced upper end **36**. If it is desired,

heating medium can be circulated through this chamber **38**.

As shown in the drawings, the upper portion or top surface of the nozzle body **30** projects laterally above the discharge orifices or bores **32** and functions to guide the jets issuing from these orifices and which jets of course are of a material of lighter specific weight than the material of the bath, somewhat further away from the central axis of the ladle before the jets start to rise upwardly through the bath. Additionally this protecting portion or overhanging lip of the nozzle body **31** functions as a shield so that the outlet ends of the orifices or bores **32** will not become clogged. Additionally this structure will minimize any damage that could occur as the result of impact from articles or objects which might fall into an empty ladle.

As illustrated in Figure 6, the nozzle body includes two diametrically opposed outlet bores **32** which extend from and communicate with the upper terminal end of the central inlet bore **31**. Between the bores, that is 90° from each bore, are two vertical webs or partitions **32'**, which as shown in Figures 5 and 7 extend between the upper overhanging portion of the nozzle body **30** and the conical portion of the body. Opposed guide grooves or recesses are provided in the edges of the aperture in the bottom **33** of the ladle.

In carrying out the process with particular reference to a ladle containing, for example, 5,000 pounds of a cast iron of a composition consisting of 3.5% carbon, 2.5% silicium, 0.5% manganese, 0.11% sulphur, 0.1% phosphorus, and balance consisting substantially of iron, there is introduced through the nozzle and in liquid condition about 0.2% by weight of a reaction material consisting of pure magnesium. If the reaction material consists of a prealloy having a composition 40% magnesium (minimum) and 60% other components (maximum), there is introduced about 0.5% by weight of such a prealloy relative to the weight of the cast iron.

The convenient quantity of the reaction material depends chiefly on the sulphur content of the cast iron. For example, if the sulphur content amounts to 0.08%, then the reaction material consisting of pure magnesium is introduced in an amount of about 0.15% by weight.

What we claim is:

1. A method of producing cast iron containing graphite in spherulitic form comprising introducing a reaction material having at least 40% magnesium content into a melt of cast iron from the bottom thereof in small quantities controlled in accordance with the desired characteristics of the iron to be produced while preventing a reaction of explosive violence upon introducing the reaction material by driving the reaction material into the melt under pressure and in a liquid condition with a gaseous medium and interposing a protective body between the medium and the material.

2. Apparatus for introducing liquefied reaction material into a vessel containing a melt of liquid iron comprising means for placing liquefied reaction material under pressure, means constituting an outlet channel for said material, a nozzle in communication with said last mentioned means and adapted to be removably mounted in the vessel containing liquid iron at an area thereof at least closely adjacent the lowest level of said vessel, said nozzle comprising a body disposable in the bottom of the vessel in an upright condition, said body having a central inlet bore communicating with the outlet channel and plural exit bores extending upwardly and outwardly therefrom in plural directions so as to facilitate a uniform distribution of reaction material within the melt adjacent the bottom thereof.

3. Apparatus as defined in and by claim 2 in which the nozzle body is composed of material of high heat resistance consisting of pressed and sintered magnesium oxide which is chemically insensitive and physically resistant to the conditions existing when the magnesium reaction material is introduced into a liquid iron melt.

4. Apparatus for injecting a magnesium reaction material into a liquid iron melt comprising a vessel for receiving a quantity of liquid iron, said vessel having a bottom, a unit arranged subjacent the bottom of said vessel comprising a chamber, a tube including a vertically disposed portion extending from said chamber to and communicating with the bottom of said vessel, a nozzle at the end of said tube and interiorly of the bottom of said vessel including plural radially spaced exit bores, and said nozzle further including a shielding portion spaced above and overlying said bores, said shielding portion deflecting material passing out of said bores outwardly of the nozzle within the melt of liquid iron, said unit further including an inlet for reaction material, means for liquifying the reaction material within the chamber, and means for controllably introducing gas under pressure into said chamber so that when the magnesium reaction material is liquified the introduction of gas under pressure drives said liquefied reaction material through said vertically disposed portion of the tube and into and out of said nozzle and into the melt.

5. In the production of a cast iron having its graphite in spherulitic form, the improvement comprising inoculating a cast iron bath with a reaction material of at least 40% magnesium content by injecting small quantities of liquid reaction material into the bottom of the bath in the form of at least one upwardly flowing and outwardly divided fine stream while controlling the quantity injected in accordance with the desired characteristics of the iron to be produced whereby a reaction of explosive violence upon contact of magnesium with iron is prevented.

6. The method defined in and by claim 5 including introducing about 0.2% by weight of a reaction material consisting of pure magnesium into an iron melt containing about 3.5% carbon, about 2.5% silicon, about 0.5% manganese, about 0.11% sulphur, 0.1% phosphorus and the balance substantially iron.

7. The method as defined in and by claim 5 including introducing about 0.5% by weight of a reaction material consisting of a prealloy having a composition of at least 40% magnesium and a maximum of 60% other components into an iron melt containing about 3.5% carbon, about 2.5% silicium, about 0.5% manganese, 0.11% sulphur, 0.1% phosphorus and the balance substantially iron.

8. The method as defined in and by claim 5 in which the relative weight of the reaction material introduced into the iron melt is chiefly dependent on the sulphur content of the cast iron and amounts to about 0.15% by weight of a reaction material consisting of pure magnesium, if the sulphur content of the cast iron amounts to about 0.08% only.

9. In the production of cast iron having its graphite in spherulitic form, the improvement comprising inoculating a cast iron bath with a reaction material of at least 40% magnesium content by injecting small quantities of liquid reaction material into the bottom of the bath in the form of at least one stream upwardly flowing at first and then finely divided in several smaller streams directed outwardly in different directions from the bottom of the bath to uniformly distribute the reaction material within the bath at the lowest possible level therein so as to prevent the occurrence of a reaction of explosive violence when the liquid reaction material is introduced into the iron.

10. An improvement as claimed in claim 9, in which the quantity of reaction material is between about 0.15% and 0.5% by weight of the cast iron.

11. Apparatus for injecting a magnesium reaction material into a liquid iron melt comprising a unit adapted to be arranged subjacent the bottom of a vessel adapted to receive a quantity of liquid iron, said unit comprising a chamber having a bottom that is downwardly inclined with respect to the vertical axis of the vessel, a

siphon shaped tube including a vertically disposed portion extending from said chamber to and adapted for communication with the bottom of said vessel, a nozzle at the end of said tube adapted to be removably disposed interiorly of the bottom of said vessel, said unit further including an inlet for reaction material, means for liquifying the reaction material within the chamber, and means for controllably introducing gas under pressure into said chamber so that when the magnesium reaction material is liquified the introduction of gas under pressure drives said material through said siphon portion and into and out of said nozzle and into the melt.

12. Apparatus for inoculating a liquid iron melt with a reaction material having at least 40% magnesium content and thus normally explosive upon contact with liquid iron, including a unit having wall means defining a reaction material receiving chamber, means for adjustably heating the chamber for liquefying the reaction material therein, a source of inert gas under pressure, outlet means operably associated with the chamber and adapted for communication with the bottom of a vessel containing a liquid iron melt, a controllable conduit means connected between said source and said chamber, control means for said conduit means whereby gas under pressure can enter said chamber and controllably force reaction material liquefied in the chamber through the outlet and into the melt and said chamber including a sealable inlet through which reaction material is fed to the chamber, said inlet including means for feeding additional reaction material to the chamber while continuing the forcing of previously liquefied reaction material into the melt.

13. The method as claimed in claim 1 in which the protective body comprises a quantity of liquefied reaction material.

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