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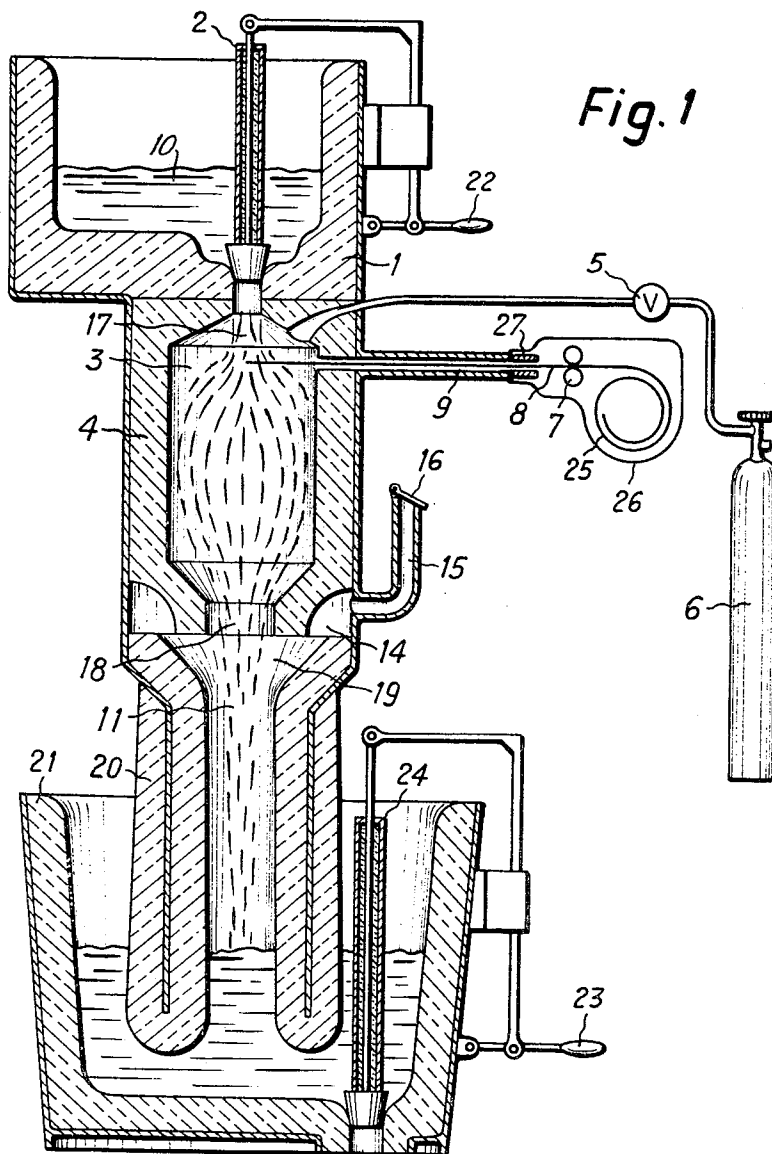
H. FEICHTINGER

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PROCESS AND APPARATUS FOR TREATING METAL MELTS

Filed June 26, 1959

2 Sheets-Sheet 1



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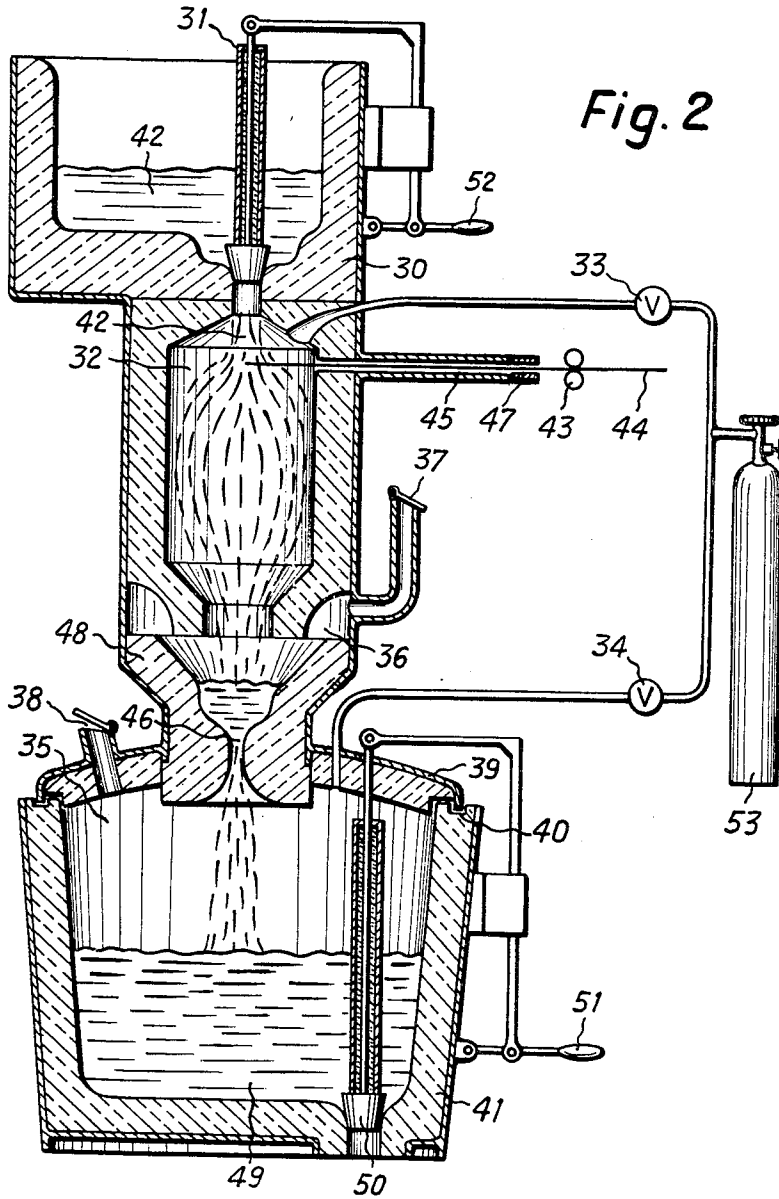
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PROCESS AND APPARATUS FOR TREATING METAL MELTS

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This invention relates to a process and apparatus for treating metal melts for the purpose of degasification or formation of certain gas-metal compounds therein which influence the primary structure.

Heretofore it has been the practice to add reducing or alloying substances to a melt that flows into a closed vessel under vacuum. The sealing of the compartments that contain a vacuum with respect to the outside atmosphere is difficult to effect in practice and requires a considerable expenditure in packings and vacuum pumps to obtain and maintain the vacuum, so that processes, where a vacuum is used, can only be applied under considerable difficulties in the rough steel mill operation, and the resulting increase in the price of the end product makes the use of these methods in many cases unprofitable.

In general, however, there is a tendency today in metallurgy to degasify metals by means of a vacuum so that a great number of processes tried out in the last years are carried out with equipment which is suitable for the production and maintenance of a vacuum, as is the case in the above described methods. I have found, however, in my investigations that practically the same and often better results can be obtained without using a vacuum for the degasification of melts.

The disadvantages resulting from the application of a vacuum are eliminated by the invention since it offers the prerequisite for a simpler and safer method where there is no necessity for vacuum pumps and vacuum-tight seals. This is achieved by carrying out the reaction of the melt with suitable substances in an atmosphere which has a slight over-pressure with regard to the outside atmosphere. The substances reacting with the melt are not added to the melt in ground or molten form, as it is the case in the known vacuum methods, but in the form of a continuous wire strip whose feed can be regulated simply and reliably.

The total arrangement thus obtained has the advantage that the apparatus in which the treatment is effected can be used with normal ladles, as they are used in steel works, using only a simple sand cup-packing between the apparatus and the ladle. Compared to other devices that require a vacuum, the apparatus and the ladle occupy only little space and have a relatively low weight, so that both can be brought directly under the casting spout of a melting unit by means of a crane and, on the other hand, can be transported directly to the casting plant after the ladle has been filled with the treated metal. The metal remains constantly under a protective gas atmosphere until it is cast, which protects it against undesired absorption of gas from the atmosphere. Methods that use a vacuum, on the other hand, must always insert the ladle to be filled with the treated melt into a closable vessel which is difficult to handle because of its vacuum-packing against the outside atmosphere; besides is heavy and has a great volume. Because of its size and its connection to the vacuum pumps, this vessel cannot be brought easily to the various molds, so that the ladles inserted in these vessels must be removed again from the vessels after they have been filled with the treated melt, and are exposed to the influence of the outside atmosphere.

These methods where the melt is introduced into a vac-

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uum chamber have not only the great disadvantage connected with the generation and maintenance of a vacuum, but the melt jet entering the chamber begins immediately to divide when entering the vacuum chamber, which renders the introduction of the reaction substances in the form of a wire or strip difficult, since the latter can only be introduced properly when it is hit directly by the flowing jet of melt.

It is, however, a principal object of this invention to introduce the substances reacting with the melt, in the form of a wire or strip which is conducted exactly into the entering melt. The melt added in controllable amounts by means of a simple feed gravitates into a confined chamber where it is combined with the metallic substance of the wire or strip without the necessity of complicated vacuum gates or dosing devices.

The process can be carried out preferably in this way that the metal wire or strip penetrating into the melt consists of partly or completely evaporating material, so that it evaporates in a sort of explosion when penetrating into the melt; the jet of the entering melt being divided so that the atmosphere prevailing in the chamber or the atmosphere formed by the metal vapor reacts over a large surface with the melt to be treated.

Since the melt can be torn into small particles within the reaction chamber without the application of a vacuum, and the method according to the invention represents a considerable progress with regard to other methods, where melts are introduced in troughs which are staggered in steps so that the melt flows like a cataract from one step to the other, and the additives are introduced in the vacuum chamber of the various steps, these methods are not suitable for an intensive treatment of melts with reaction substances, since the surface action between the reaction substance and the melt is not great enough. Efforts have therefore been made to introduce these substances, which have not been completely reacted, again in one or several successive stages into the vacuum chamber of these steps, to make the utilization of these reaction substances more economical. The thorough reaction and degasification of the melt with the reaction substances is achieved, however, in a much simpler way and in a smaller space with the method according to this invention, since the melt is introduced into a chamber that is sealed from the outside atmosphere, in which there is a highly reducing atmosphere, this reducing atmosphere being formed by means of a metal wire or strip of easily evaporating metals, which is fed penetratingly into the jet of the melt entering the sealed chamber. It is possible to add other alloying elements together with the metal wire or strip for forming the reducing atmosphere, which are to be protected against the influence of the outside atmosphere. It has been found expedient to add alloying elements mixed with magnesium and other reducing agents in the form of a wire or strip, the wire or strip cohering with mixed ground or alloyed substances within a tubular envelope which consists of magnesium, aluminum, steel or iron, sheet or other suitable metals. In those cases where the melt must be heated, the introduced wire or strip consists partly or entirely of substances, as they are used, for example, in aluminothermy, which react on contact with the jet of the liquid melt, generating heat. The composition is preferably so selected that there is also a reduction of the melt in addition to the generation of heat. According to the process of the invention it is also possible to introduce wires or strips simultaneously with the entering melt in different levels or from different directions. Thus, for example, a magnesium wire can be introduced from one side, from another direction a strip containing the alloying elements, to be added, and from a third direction a strip for increasing the temperature,

It is also possible to advance these wires and strips with a fixedly adjusted feed. Preferably a feed is selected by means of rollers which permit any desired advance motion of the wire or strip over an infinitely variable gear. It is also possible to regulate the feed over automatically controlled auxiliary devices. Thus, for example, the feed of the wire or strip for increasing the temperature of the melt can be controlled over a temperature measuring device. In this case the current of a thermocouple element, for example, which dips into the treated melt, or which is heated by the atmosphere in the reaction chamber, acts over relays on the feeding device. Instead of the thermocouple element the relays can also be actuated by a pressure element as a transmitter.

Embodiments for carrying out the process according to the invention are represented in the attached drawing, in which:

FIG. 1 is an embodiment of the invention in which the treated melt enters into an open ladle; and

FIG. 2 shows a modified form of my invention in which the treated reaction device proper is attached on a lid closing the ladle.

The process is principally suitable for treating different metal melts. The method and the apparatus shown in FIG. 1 consists of a composite iron and steel melt. The steel melt to be tapped from a melting unit, for example, an arc furnace, is discharged slowly into the upper ladle 1, so that the ladle 1 remains filled with an approximately constant level of liquid steel 10 during the entire process. At the same time, or a little earlier, the cock 5, leading from an inert gas supply, is opened so that an inert gas atmosphere flows into the chambers 3 and 11, as the gas flows from the steel cylinder 6 into the chamber 3. This flow of inert gas displaces the non-inert gases found in the chambers 3 and 11. The over-pressure thus generated escapes over the annular receiver 14, over the line 15, and over the relief valve 16 to the outside atmosphere. As soon as an inert gas atmosphere has been formed in the chambers 3 and 11, the stopper 2 is opened so that the melt 10 can flow into the reaction chamber 3, which is formed by the walls 4. At the same time a conveyor drive 7 is started so that the metal wire or strip 8 moves through the guide 9, in the reaction chamber 3, against the entering jet 17, penetrating into the latter. The metal wire or strip 8 melts during the penetration and mixes with the entering metal at 17. This metal wire or strip 8 consists of partly or completely evaporating substances, for example, magnesium, and the jet of the entering melt is torn by the spontaneous formation of vapor into small particles which can enter into interaction with the gaseous and vaporous atmosphere because of their large surface. The gas source contained in steel cylinder 6 is argon or any other inert gas. It is also possible to replace this source by a protective gas generator. This treated melt passes through a constricted annular chamber 18, and discharges into a funnel-shaped extension 19, and flows finally into the channel 11 which is formed by the walls 20, and terminates in the ladle 21. The stopper 2 is controlled by operating handle 22 while the stopper 24 is controlled by the operating handle 23. The metal strip 8 consists of thin wires or strip, for example, magnesium wire, and it is preferably rolled up as a roll 25, and inserted in a housing 26 coupled in the tubular member 9 at 27, so that it is protected against steel splashes, for example, which might ignite it. This housing 26 starts at 27, close to the tubular member 9. The delivery rate of the feed means or rollers 7 can be adjusted in a suitable manner by an infinitely variable gear (not shown) to any desired speed. It is thus possible to treat the steel, which has first been analyzed for its gas content, with an accurately adjusted amount of reacting additives, for example, magnesium. It is also possible to use the apparatus without the stopper 2. In this case the cock 5 and the metal strip 8 are actuated as hereinbefore described. Moreover, it is also

possible to carry out the process completely without any additional supply of an inert gas atmosphere or an inert and reducing gas atmosphere, respectively, being formed automatically in the chamber 3, by the entering melt on the one hand and by the introduced metal strip on the other hand.

In the embodiment of the device for carrying out the process according to the invention represented in FIG. 2, an upper ladle 30 is again used which can be closed with a stopper 31. Before the metal melt is introduced into the chamber 32, the valves 33 and 34 are opened so that both the ladle chamber 35 and the reaction chamber 32 are filled with inert gases or with gases which are not harmful for the reaction process. The over-pressure generated in this case escapes either through the annular chamber 36, or through the relief valve 38, inserted in the lid 39. The lid can be sealed with a sand cup-packing 40, against the ladle 41. As soon as an inert gas, or any other desired gas atmosphere has been formed in the chambers 32 and 35, the stopper 31 is opened so that the metal melt 42 flows into the chamber 32. At the same time, the conveyor 43 is put in motion, so that the metal strip 44 is moved through the tubular member 45. At 47 a packing is preferably provided so that the over-pressure generated in the chamber 32 cannot escape through the tubular member 45, thus overheating the conveyor or feed means 43 as well as the metal wire or strip 44. After the melt has passed the reaction chamber 32 it arrives in the collecting funnel 48, and over a constriction in the ladle 41. The ladle 41 is provided with stopper 50 and an operating handle 51 controls the opening and closing thereof. The stopper 31 is provided with operating handle 52. Reference character 53 designates the gas source for inert gas. As soon as the ladle is filled with the treated melt it is possible to transport it, together with the entire equipment, entirely to the casting mold by means of a crane. The lid 39 can remain closed so that the treated melt 49 is protected against undesired gasification during the transport. During the casting it is also possible to fill the mold first with an inert gas. Besides, a protective tube filled with inert gas can be arranged between the casting mold and the ladle 41 so that it is possible to cast the treated melt, which has an optimum of gas content and gas metal compound, without uncontrolled gasification. Particularly, because of these properties and characteristics, the process according to this invention has great advantages over the known processes where the treated melt cannot be protected during the transport against gasification, and it is particularly suitable for alloying those elements which are to be protected against the influence of an uncontrolled atmosphere.

In the operation of the method and apparatus of my invention, the chamber 3 is sealed from the outside atmosphere and an over-pressure is maintained in the inner atmosphere of the chamber allowing the inner atmosphere to escape to the outer atmosphere without the latter penetrating into the chamber. The metallic substance, which may be magnesium, or an alloy consisting of aluminum, magnesium or manganese, is fed through the tubular member 9 or 45 which may be formed from sheet metal such as steel, iron, aluminum, or magnesium, adapted to readily combine with the metallic melt which gravitates downwardly from the upper ladle 1 into the chamber 3 where the metallic substance combines with the metallic melt and evaporates and greatly divides the melt and degasifies the same. The feed means 7 are located within the housing 26 for advancing the wire or strip 8 from a coil 25 through the tubular member 9. The composite melt with the metallic substance combined therein is collected in the ladle 21 or 41 for discharge under control of stopper 24 or 50.

While I have described my invention in certain of its preferred embodiments I realize that modifications may be made and I desire that it be understood that no limi-

tations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A process for treating metal melts which comprises: introducing a metal melt in the form of a jet of molten metal into a treatment chamber substantially closed from the outside atmosphere, introducing into said treating chamber a stream of inert gas, whereby there is established in said treating chamber, an inner atmosphere of said inert gas, simultaneously allowing said inner atmosphere of inert gas to escape into the outer atmosphere, without permitting the latter to penetrate into said inner chamber, whereby there is maintained in said treating chamber a slight overpressure of said inert gas, feeding at a controllable, continuously variable rate of speed, a strand of metallic composition, directly into said jet of molten metal, whereby said jet is split and disrupted without the necessity of requiring a vacuum.

2. A process for treating metal melts as set forth in claim 1 in which said strand of metallic composition which is fed into the melt is partially evaporated therein.

3. A process for treating metal melts as set forth in claim 1 in which said strand of metallic composition which is fed into the melt is spontaneously evaporated at approximately the position the melt enters the chamber for dividing melt.

4. A process for treating metal melts as set forth in claim 1 in which said strand of metallic composition which is fed into the melt is composed of magnesium.

5. A process for treating metal melts as set forth in claim 1 in which said strand of metallic composition which is fed into the melt consists of an alloy of aluminum, magnesium, and manganese, operating to degasify the melt.

6. Apparatus for treating metal melts which comprises: a treatment chamber substantially closed to the outside atmosphere, conduit means for introducing into said treating chamber a stream of inert gas, means for allowing escape of gas from said chamber into the outer atmosphere and for substantially preventing penetration of outer atmosphere into said chamber, means for introducing molten metal into said treatment chamber, and means for feeding at a controllable, continuously variable speed, a continuous strand of metallic composition through said conduit means directly into said molten metal as it is introduced into said chamber, said metallic composition reacting with the melt.

7. Apparatus for treating metal melts as set forth in claim 6 in which said conduit means is formed from sheet metal and provides a substantially air-tight seal at its outer end for the introduction of the strand of metallic composition while excluding the outer atmosphere therefrom.

8. Apparatus for treating metal melts as set forth in claim 6 in which said conduit means is formed from steel and provides a substantially air-tight seal at its outer end for the introduction of the strand of metallic composition while excluding the outer atmosphere therefrom.

9. Apparatus for treating metal melts as set forth in claim 6 in which said conduit means is formed from iron and provides a substantially air-tight seal at its outer end for the introduction of the strand of metallic composition while excluding the outer atmosphere therefrom.

10. Apparatus for treating metal melts as set forth in claim 6 in which said conduit means is formed from aluminum and provides a substantially air-tight seal at its outer end for the introduction of the strand of metallic composition while excluding the outer atmosphere therefrom.

11. Apparatus for treating metal melts as set forth in claim 6 in which said conduit means is formed from magnesium and provides a substantially air-tight seal at its outer end for the introduction of the strand of metallic composition while excluding the outer atmosphere therefrom.

12. Apparatus for treating metal melts as set forth in claim 6 in which the metallic composition constitutes introduced through said conduit means contains reducing elements for combination with the metal melt.

13. Apparatus for treating metal melts as set forth in claim 6 in which the strand of metallic composition introduced through said conduit means also constitutes means which effects the heating of the melt.

14. Apparatus for treating metal melts as set forth in claim 6 in which the metallic composition constitutes a strip and wherein there is a housing attached to the exterior end of said conduit means containing a reel on which said strip is coiled and in which said means for feeding said metallic composition is located within said housing and engages said strip for feeding the strip through the conduit means.

15. Apparatus for treating metal melts as set forth in claim 6 in which the metallic composition constitutes a wire and wherein there is a housing attached to the exterior end of said conduit means containing a reel on which said wire is coiled and in which said means for feeding said metallic composition is located within said housing and engages said wire for feeding the wire through the conduit means.

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