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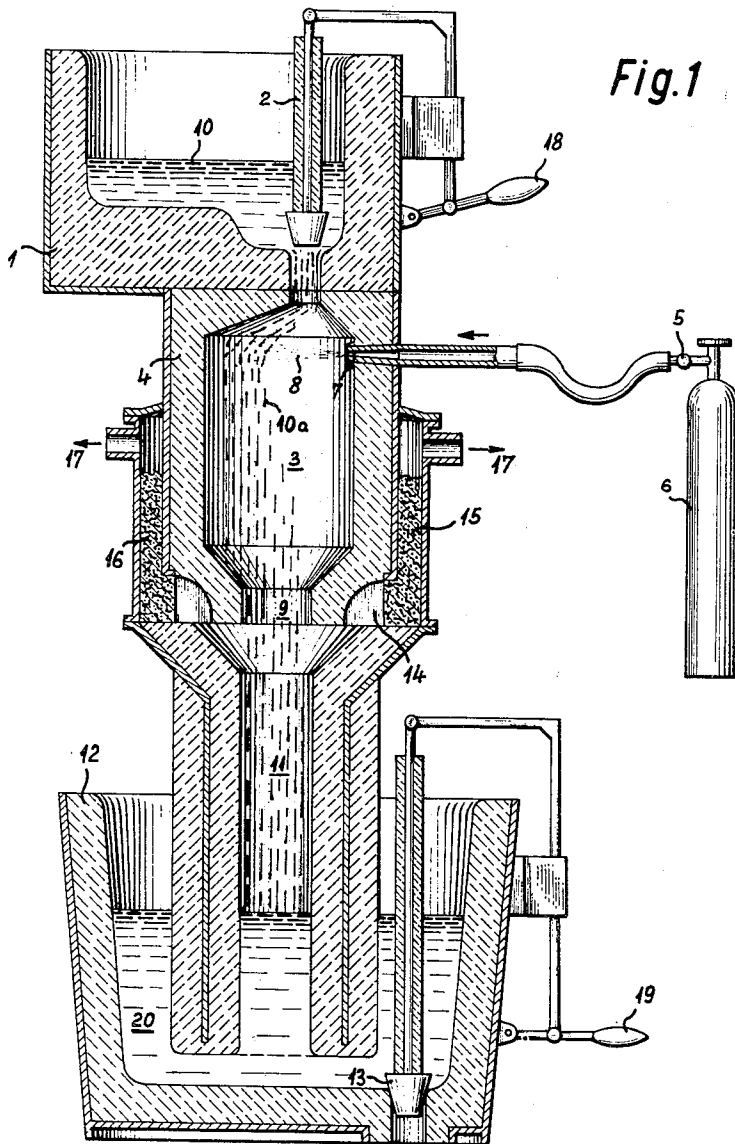
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METHOD OF TREATING MOLTEN METAL

Filed March 19, 1959

2 Sheets-Sheet 1



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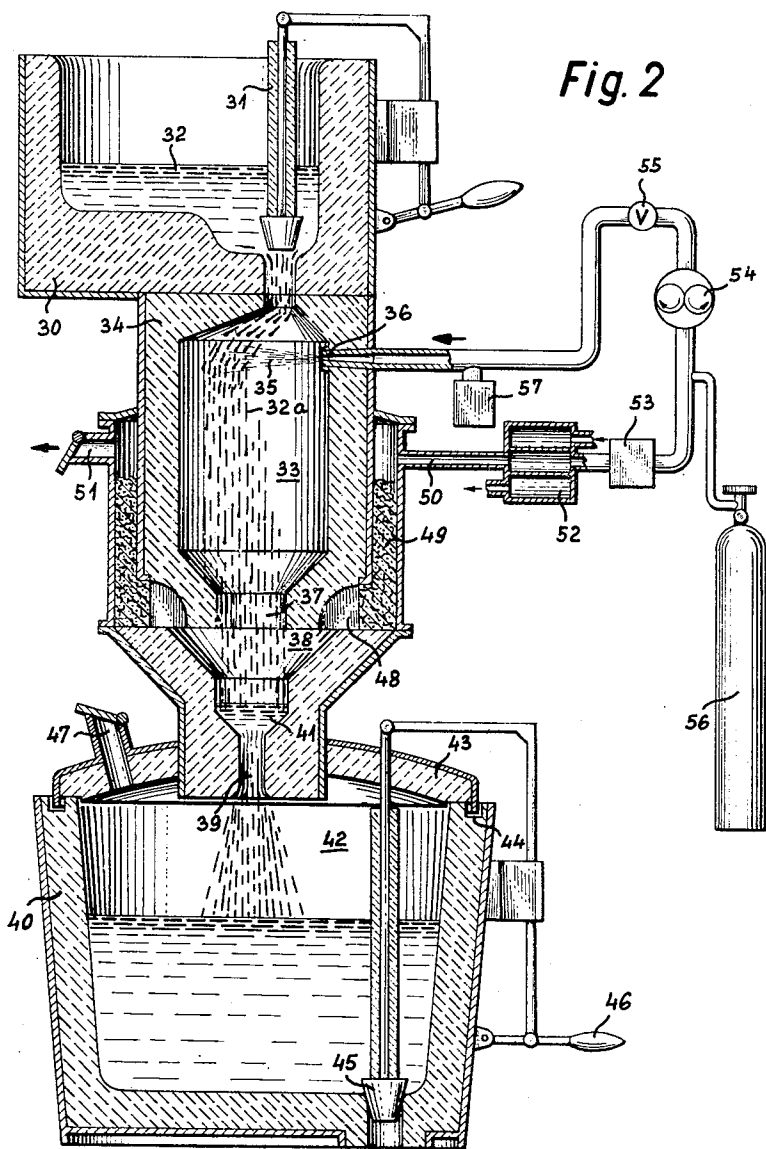
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METHOD OF TREATING MOLTEN METAL

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My invention relates to a process for treating molten metal for gasification or degasification and more particularly to a method of treating metal melts by introducing the melt into a chamber sealed off from the outside atmosphere and subjecting the melt to a gaseous or vaporous jet while penetrating into the chamber.

Heretofore steel melts have been degasified by introducing them into evacuated chambers.

It is also known to introduce steel melts into an evacuated chamber for degasification and division into small droplets and to introduce into this chamber by means of inert gases solid substances, which are to be reacted with the melt.

All the foregoing methods use as a fundamental characteristic, that is, a vacuum or reduced pressure for division or degasification. This has the result that the chambers into which the melt is introduced must be sealed off, vacuum-tight from the outside atmosphere, and on the other hand must be evacuated and maintained under vacuum with an expensive and voluminous vacuum pump system. The absolutely necessary division of the melt is effected during the entrance into the evacuated chambers in such a way that the gases dissolved in the melt expand by the sudden reduction of the outside pressure, thus breaking the melt up into drops. Devices which work by using a vacuum are expensive and susceptible to many operating difficulties and require considerable physical space for installation and operation.

These inconveniences are eliminated by the hereinafter described process according to my invention by subjecting the melt while flowing in a stream to the action of a gas jet, approximately at the level of the chamber into which the metal melt is released, and at such a high velocity that its kinetics are sufficient to divide the melt, while the over-pressure produced in the sealed off chamber can escape by the application of suitable means which prevent the outside atmosphere from penetrating into the chamber.

In the process of my invention the melt is thus divided in contrast to previous methods, not by a vacuum but by the opposite effect, that is, a pressurized gas jet, or other jet that is compatible with the characteristics of the flowing metal melt which is directed at a high velocity against the melt entering the reaction chamber. The melt enters the reaction chamber in a flowing stream and is blasted, so-to-speak, by a gas pressure jet into small droplets and particles. The effect of this gas jet is increased by adding solid substances in the form of powdered or granulated material which evaporate in a sort of explosion when penetrating into the descending stream-like melt so that the dividing effect is increased. Suitable for this purpose are, for example, magnesium, calcium, and similar metals, which react under considerable evolution of vapor on contact, for example, with a steel melt. The degasification of such a melt, divided into small parts, is very effective and rapid, since the gases dissolved therein are given off to the surrounding atmosphere by diffusion. This atmosphere is formed and renewed by the dividing gas jet.

My invention will be more fully understood from the specification hereinafter following by reference to the accompanying drawings which show two embodiments for

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carrying out the process according to the invention, in which:

FIG. 1 shows an embodiment where the melt enters an open ladle; and

FIG. 2 shows an embodiment where the treating part proper is connected to the cover closing a ladle which receives the melt.

The process is principally suitable for treating various metal melts. FIG. 1 shows the apparatus employed and method of operation of the apparatus on a molten iron and steel melt. The steel melt, tapped from a smelting unit, for example, an arc furnace, is introduced into the upper ladle 1. As soon as a certain amount of liquid steel 10 has accumulated in the ladle 1, the plug 2, which normally closes a drain opening in the bottom of ladle 1 controlled by lever 18, is opened so that the molten steel can flow in a stream into the reaction chamber 3 formed by the walls 4. At the same time the cock 5 of an argon-filled bottle 6 is opened so that a gas jet 8 is injected through the nozzle 7 onto the descending stream-like melt 10a. The gas jet 8 penetrates partly into the descending stream-like melt 10a, so that the latter is divided over a large surface and torn apart. Due to the larger surface of the melt 10a the gas jet 8 produces an argon atmosphere which surrounds the descending melt 10a in its dynamic state and has a degasifying effect, i.e. so to speak washes out the gases dissolved in the melt 10a. The melt 10a thus treated flows through the orifice 9 of reduced section into the channel 11, and arrives thus in the lower ladle 12, where the treated melt 20 accumulates. In this way a seal is formed at the lower end of the channel 11. The over-pressure or increased pressure, which is formed in the reaction chamber 3, escapes through the radial slots 14 into the annular chamber 15 which is filled with filters 16. The filters 16 consist for example of coke or ceramic, or similar materials. Finally, the gas having a pressure above atmospheric pressure escapes, through radially disposed orifices 17, into the outside atmosphere. A drain opening is provided in the bottom of lower ladle 20 which is closed or opened by a plug 13 operated by a lever 19. The operating lever 18 for the plug 2 and the operating lever 19 for the plug 13 may be coordinated for simultaneous operation.

In the embodiment of the device for carrying out the process according to the invention represented in FIG. 2, an upper ladle 30 corresponds to the ladle 1 of FIG. 1 and is closed by a plug 31. With the plug 31 open, the melt 32 flows into the reaction chamber 33, formed by the walls 34 as shown at 32a. The division or split-up of the melt is effected by means of a gas jet 35 which is guided by the nozzle 36 to the descending melt at 32a. The treated melt flows through the orifice 37 of reduced section into the funnel 38 and through the orifice 39 of further reduced section into the lower ladle 40 where it accumulates. At 41 a certain backwash level of the melt accumulates so that the reaction chamber 33 is sealed off from the chamber 42 in the interior of the lower ladle 40. The lower ladle 43 is provided with a cover which bears, when necessary, on a sand packing 44. The lower ladle 40 is also provided with a plug 45 which is actuated by the lever 46. The over pressure formed in the chamber 42 can escape through the pressure release seal 47. The over-pressure gases produced in the reaction chamber 33 escape through radial slots 48 into the annular chamber 49 from which the gases are released, either through the pipe connection 50 to a circulation system, or through the flapclosed pressure release orifice 51, leading to the outside atmosphere. The gases in the reaction chamber 33 are conducted from the chamber and subsequently over cooling and purifying devices after which a compressor forces the gases again under

pressure into the chamber; the gas losses in this circulation system being replaced by a gas source.

The circulation system consists of a cooler 52, a purifier 53, a compressor 54, and a shut-off element 55. The gas losses of this circulation system are replaced by a gas source 56 which, in the present example, is a steel bottle containing compressed gas. A steam generator 57 may be connected to the circulation system. This generator can produce a vapor in cases where a gas-vapor mixture is used, by heating metals, or water which is added to the gas jet and which increases its effect. The cooler 52 is preferably so constructed that it removes at the same time the dust from the exhaust gases. The purifier 53 acts also as a filter, and the gases are liberated during their passage through the purifier from those gases and vapors which must be removed from the circulation, for example, hydrogen can be burnt to water by oxidation, the water being absorbed in the purifier itself, if necessary, or condensed behind the compressor. A Root's blower or similar pump is used as a compressor 54. The gas jet issuing from the nozzle 36 may be adjusted by the shut-off element 55.

The pressure can also employ a vapor jet directed against the entering melt 10a or 32a, instead of a gas jet, so that it divides the latter, gasifying or degasifying it at the same time. Water vapor or metal vapor can be used for this purpose. It is also possible to subject the entering melt to the action of a gas-vapor mixture.

The dividing effect of the gas jet can be further increased by substances, which are added to the gas jet in ground form and which form vapor when penetrating into the melt. These substances, are, for example, calcium, magnesium, or alloys of both with aluminum, titanium, or other metals.

The great advantage of the new process, compared to those processes which use a vacuum, can be seen in the fact that the devices used for the new process are much simpler in their construction than those used in the processes working with a vacuum. First of all, there is no vacuum-tight seal required, since there is a certain over-pressure in the device, compared to the outside atmosphere, so that the outside atmosphere cannot penetrate into the reaction chamber. As far as vapors, for example, metal vapors, are to react with the melt charge, the reaction is more rapid and economical since these vapors have a higher pressure. Where only degasification is to be achieved, it is possible to use noble gases or gases which do not enter into any reaction with the metal to be treated. Where a reaction or carburization by means of gases is to be obtained, hydrogen, methane, nitrogen and inert gases can be used, and where the treatment is to yield an oxidation of a nitrogenation of the melt by means of gases, oxygen, nitrogen, air, steam, CO₂ or mixtures or dilutions thereof with inert gases can be used. If a process is to be obtained with this method which degasifies the melt, it is advisable to add evaporating agents to the gas jet which have a high chemical affinity to the gases to be removed.

While I have described my invention in certain preferred embodiments I realize that modifications may be made, and I desire that it be understood that no limitations 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 method of treating molten metal which comprises: reducing metal to a molten state, passing the molten metal in a condition of free-fall from the top to the bottom of a vertically extending confined space, introducing a jet of gaseous material into the confined space near the point of entry therein of the molten metal

and directing said jet laterally of the confined space so that the path thereof intersects the path of movement of the molten metal, delivering said gaseous material at sufficient pressure to break up the flowing stream of molten metal into a plurality of smaller streams thereby to expose a greater surface area of the molten metal and to intermingle the molten metal with the gaseous material, collecting the molten metal in the region of the bottom of said confined space, removing gases from said confined space near the bottom thereof, and restricting the movement of the gases from the confined space to maintain a pressure in the confined space greater than atmospheric pressure but permitting degassing of said molten metal into said confined space.

2. A method of treating molten metal according to claim 1 in which substances are added to and carried by the gaseous material which form vapors at the temperature of the melt thereby augmenting the breaking up of the stream of molten metal falling through said confined space.

3. A method of treating molten metal according to claim 1 in which the said gaseous material after being withdrawn from said confined space is cooled and compressed and again introduced into the incoming stream of said gaseous material.

4. A method of treating molten metal which comprises: reducing the metal to a molten state, passing the molten metal in a stream vertically through a confined space in a condition of free fall, sealing the upper end of said confined space with the molten metal to be passed through the space, collecting the molten metal after it has passed through the space in the region of the bottom of said space and sealing the bottom of said space with the collected molten metal, introducing gaseous material in the form of a high velocity jet laterally into said space near the upper end thereof in the region where the molten metal commences its free fall through the said space so the path of the jet of gaseous material will intersect the path of the freely falling molten metal, introducing said gaseous material with such pressure and velocity as to cause breaking up of the stream of molten metal and intermingling of the gaseous material in the molten metal, removing the gaseous material from the region of the bottom of said confined space and restricting the movement of the gaseous material during the said removal thereof to maintain a pressure in said confined space greater than atmospheric pressure but permitting degassing of said molten metal into said confined space greater than atmospheric pressure.

5. A method of treating molten metal according to claim 4 in which substances are entrained in the said gaseous material and delivered thereby into intimate admixture with the broken-up stream of molten metal, which substances are retained by the molten metal to become an essential ingredient of the melt and which is collected at the bottom of said confined space.

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