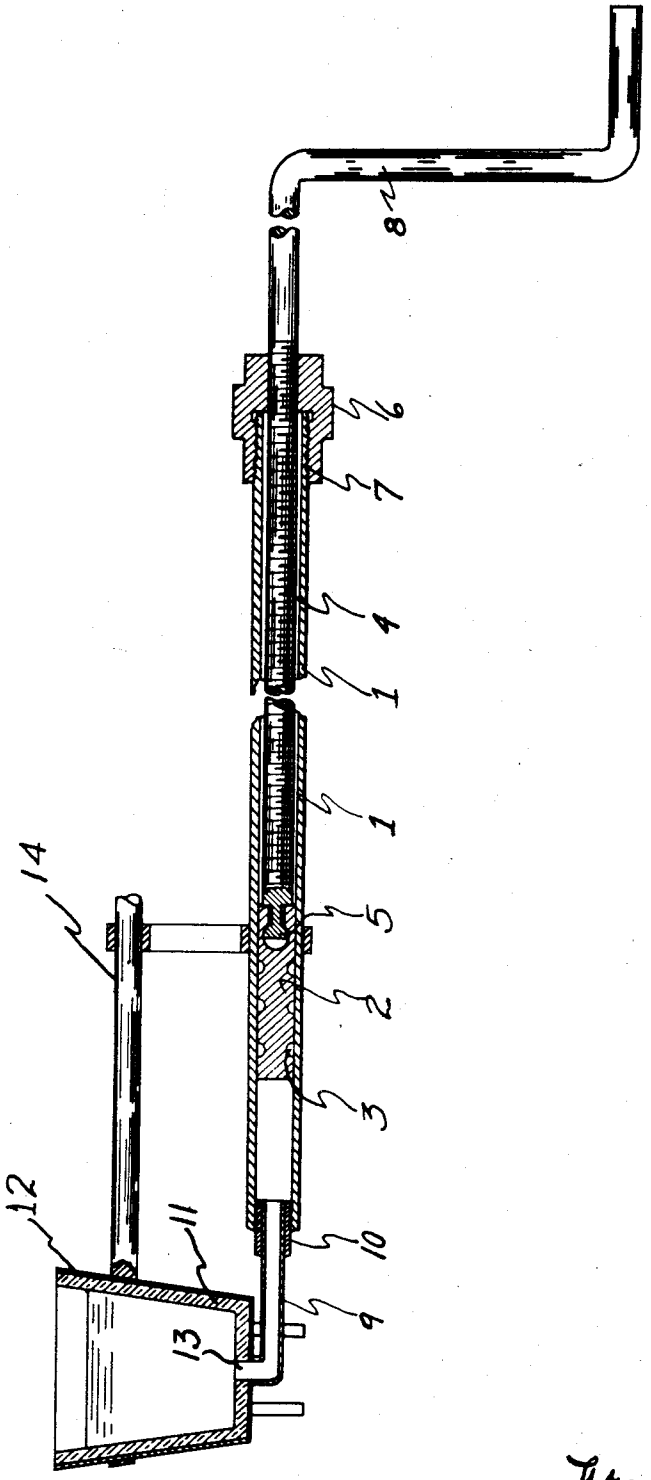
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METHOD OF DEOXIDIZING IRON AND STEEL

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METHOD OF DEOXIDIZING IRON AND STEEL

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My invention is addressed to the deoxidation of metals by the use of extremely active deoxidizers. Heretofore deoxidation of iron and steel has been carried on when the metal was in a molten condition by treatment with so-called deoxidizers, of which compounds of manganese, silicon and aluminum are of the greatest commercial importance. Considerations which are important with reference to the use of substance for this purpose are, among others, whether the deoxidizer alloys with the metal to be treated, or contains substances which can alloy, whether the action of the deoxidizer is to produce inclusions in the metal of one character or another, whether the deoxidation is completely effective upon the metal being treated, its cost, and the ease of handling it.

In order for deoxidation to be completely effective, the oxide of the deoxidizing element should be stable and undissociated in the presence of iron at 1600 degrees C. Also, the deoxidation product, or oxide of the deoxidizing element, should be negligibly soluble in molten iron. If the deoxidizing element does not combine chemically with the iron or other molten metal being treated, and is insoluble therein, there will be no alloying.

An equally important condition to prevent contamination by the deoxidizer is that its vapor pressure at the temperature of the molten metal being treated shall be greater than one atmosphere.

The deoxidizing elements with vapor pressures above one atmosphere at steel making temperatures may be classified in two groups on the basis of the vapor pressure of their oxides. In the first group are elements such as potassium, whose oxides have a high vapor pressure. In the case of these elements, there is a tendency for both the element and the oxide formed to be boiled or vaporized from the iron or steel. This tendency promotes the production of a very pure and completely deoxidized metal.

In the second group or classification are elements such as barium, whose oxides have a low vapor pressure at steel making temperatures. When using these elements, the uncombined metal will vaporize from the steel, but the oxide formed will not be removed in this manner.

Efforts looking toward the use of extremely active deoxidizing agents which could remove the last traces of oxygen in the metal, even to the point of entirely killing it, which had no alloying properties, and which did not produce substances difficult to remove, or likely to form inclusions, have been made from time to time. In attempts to use metallic sodium as a deoxidizing agent, it was found that when lumps of this metal were added to iron in a ladle an explosion occurred. It has been suggested that the metallic sodium might be combined with a metal having greater specific gravity than the iron, such as lead in the form of a capsule, or other form which could be dropped into the molten metal and would sink therein. The reason why the use of metallic sodium, as such, has been found dangerous in the past, is that its boiling point is around 880 degrees C., whereas the temperature of steel or iron in a ladle will preferably be in the neighborhood of 1600 degrees C. The other materials to be mixed with sodium, if they do not alloy with the iron, may form a stratum of foreign material which must be taken care of in the tapping of the metal. Thus lead will produce a molten layer on the bottom of the ladle which must be tapped off first. Furthermore, dropping materials into the molten metal does not always result in so effective a treatment of the mass as does the procedure I shall hereinafter describe.

My invention has for its primary object a process of using extremely active substances with high vapor pressure, for the treatment of molten metals, and more particularly deoxidizing substances. I shall describe my invention in connection with the use of metallic sodium, but it will be understood that this use is exemplary only, and is not limiting upon the broader aspects of my invention.

These and other objects of my invention which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, I accomplish in that process and by that apparatus of which I shall now describe an exemplary embodiment.

I have found that I can use extremely active substances in the treatment of molten metals, and particularly substances the boiling point of which, with reference to the temperature of the metal being treated, is relatively very low, by adding these substances to the molten metal by small increments or continuously in a stream, or the like, preferably through the bottom of the ladle or other container in which the molten metal is held during the time of treatment. Reference is now made to the drawing, in which the single figure shows a form of apparatus which may be used in the practice of my process. I have shown at 1 a piece of tubing which forms

the cylinder of my apparatus, fitted with a plunger 2, which may have packing rings 3, or the like. The plunger may be actuated by a threaded rod 4, having a projection 5 which is rotatably fitted within the plunger. The threaded rod operates in a threaded boss 6, which has the collar portion 7 adapted to be attached to the cylinder 1 in any way desired, as by being screwed thereon, the sleeve 7 and the end of the cylinder being threaded for that purpose. The end of my rod 4 which projects from the cylinder may be fitted with a handle 8, or other device, whereby it may be turned so as to move the plunger in the bore of the cylinder, and to the other end of the cylinder will be attached a tube 9, as by means of a threaded bushing 10. This tube is a delivery tube that passes through the shell of a ladle 12, or other device in which the molten metal is to be treated, and will communicate with a passageway 13 through the refractory lining 11 thereof.

A quantity of metallic sodium may be placed in the hollow interior of the cylinder, and the plunger 2 inserted. When the boss 6 is screwed into place, a rotation of the handle 8 in a clockwise direction will force the plunger toward the other end of the tube. The metallic sodium is soft enough to be extruded by the pressure of the plunger and forced through the said tube 9 in the form, initially, of a ribbon, rod, or pencil, and subsequently into the molten metal.

It will be understood that the said tube 9 and the bushing 10 may be formed as a part of the permanent equipment of the ladle, and the remaining mechanism, comprising the cylinder, may be taken away after a treatment for refilling in preparation for the next treatment, or, if desired, the cylinder 1 may be attached to the ladle by a suitable brace or clamp 14 and may be filled in situ. Due to the difficulties in handling metallic sodium, it is preferable to make my pump construction in the form of a detachable unit. It will be understood also that instead of the handle 8 other means may be taken for rotating the rod 4 if it is to be forced down by screw pressure, or the plunger 2 may otherwise be forced along the length of the cylinder 1, as by fluid pressure or the like.

It will be understood that the sodium is not solid throughout the entire length of the tube 9 and/or any communicating passageway into the molten metal. Since there is a temperature gradient from the temperature of the molten metal in the bottom of the ladle to the temperature in the cylinder 1, there will be three states of sodium (vapor, liquid and solid) as determined by the temperature. It is advantageous to keep the cylinder 1 below the melting point of the sodium (97.5 degrees C.) or other treating material, since otherwise the liquid material may tend to flow past the plunger 2 when force is applied. This is particularly true of sodium which is very thinly liquid above its melting point. My process as described, applied to the treatment of iron or steel with sodium, essentially results in subjecting the molten metal to the action of sodium vapor.

In the simplest arrangement the heat required to vaporize the sodium prior to its introduction into the ladle is supplied by the molten iron or steel. A modification may comprise heating the tube 9 so as independently to cause the vaporization of the sodium.

If I am treating a large quantity of metal, by modifying the apparatus of the figure, or equivalents of it, I might introduce the sodium into the molten metal at a number of different points in the bottom of the ladle, or other container, and thus secure a very complete distribution thereof throughout the molten mass. In practice, no visual results in the molten metal are apparent for a little time after the initial introduction of the sodium, then the metal begins to boil with a degree of activity which may be controlled by the speed of introduction of the deoxidizer. The initial apparent inactivity is thought to be due to a combination of the sodium and oxides, or oxygen, in the metal to produce sodium oxide Na_2O. During the boiling, dense, white fumes may be evolved. These are thought to be a sodium oxide smoke. It is not known whether the sodium burns to Na_2O at the surface of the metal, thus producing the smoke or fumes, or whether the Na_2O is formed by the action with the oxides in the metal and is later eliminated at the metal surface as the smoke or fumes. Probably both actions occur to some extent. By reason of the fact, however, that I maintain at all times exact control of the quantity of deoxidizer being introduced, I can control conditions in my ladle to the end of producing a complete deoxidation without using an excess of the deoxidizer.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A process of deoxidizing iron or steel which comprises bringing the metal into molten condition and injecting metallic sodium beneath the surface of said metal in small increments through the bottom of a container holding said molten metal, said metallic sodium being vaporized by the heat of the metal.

2. That process of deoxidizing iron or steel which comprises holding the metal in a suitable container and injecting through a wall of said container and beneath the surface of said molten metal metallic sodium in regulated quantities over a period of time, said metallic sodium being vaporized by the heat of the metal.

3. In combination with a container for holding molten metal, a tubular connection to and through the bottom thereof, and means for forcing an initially solid substance of deoxidizing characteristics under pressure through said tubular connection and into and beneath the surface of a body of molten metal in said container whereby said substance may first be liquefied and then gasified by the heat of said metal.

4. In combination with the ladle, a tubular connection to and through the bottom thereof, a cylinder connected with said connection, said cylinder adapted to contain a filling of deoxidizing substance, a plunger in said cylinder, and means for moving said plunger under pressure to empty said cylinder by forcing said deoxidizing substance into said ladle through said tubular connection.

5. In combination, a container for molten metal, a tubular connection to and through a wall thereof beneath the normal upper level of a body of molten metal in said container, a cylinder adapted to contain metallic sodium connected to said tubular connection, a plunger in said cylinder, and means for moving said plunger under pressure to empty said cylinder.

FRANK G. NORRIS.