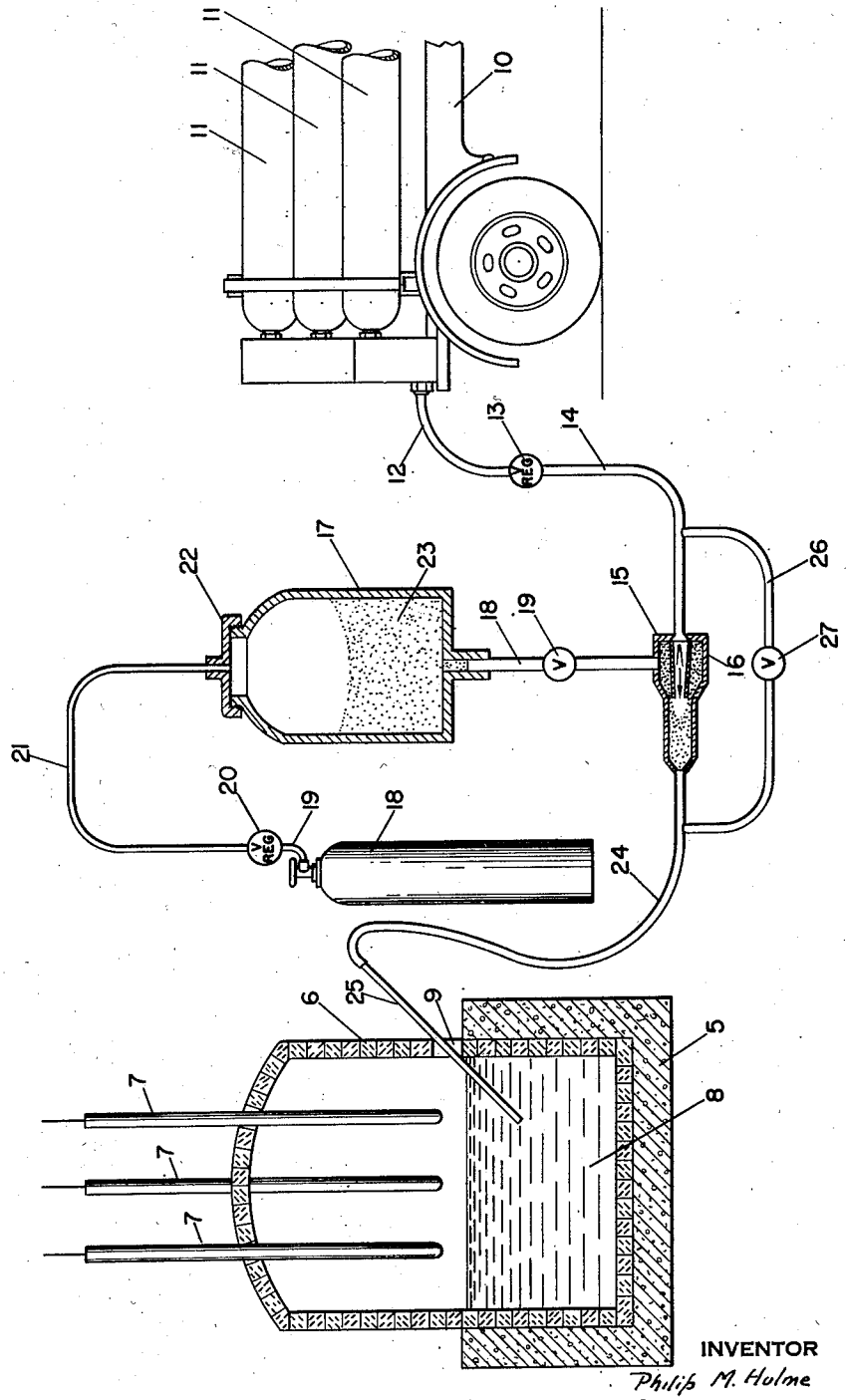
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METHOD OF ELIMINATING CARBON FROM AND CONTROLLING THE TEMPERATURE OF MOLTEN STEEL

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METHOD OF ELIMINATING CARBON FROM AND CONTROLLING THE TEMPERATURE OF MOLTEN STEEL

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4 Claims. (Cl. 75—51)

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This invention relates to decarburization of steel and particularly to an improved procedure for the oxidation of carbon in molten steel to bring the carbon content to a satisfactory low point.

In lowering the carbon content of molten steel, it has been the practice heretofore to add iron ore to the furnace for reaction with the carbon of the steel. The reaction is, however, relatively slow, and it is not readily controllable. The procedure has persisted in common practice merely because no better method has been available.

It is the object of the present invention to provide a rapid, effective and economical method of oxidizing carbon in molten steel which involves simultaneously controlling the temperature of the molten steel.

Another object of the invention is the provision of a method of reducing the carbon content of molten steel which is readily controllable and hence adapted to produce the desired effect in the minimum time and with facility heretofore impossible to attain.

Other objects and advantages of the invention will be apparent as it is better understood by reference to the following specification and accompanying drawing, which illustrates diagrammatically an apparatus suitable for the practice of the invention.

While the invention is described in connection with an electric furnace operation, it may be carried out in the open hearth or other suitable steel producing furnace. The procedure and the apparatus required are relatively inexpensive.

The invention depends upon the introduction of iron oxide, preferably in the form of finely divided crushed iron ore, in a stream of an oxidizing carrier gas containing more than 45% of oxygen beneath the surface of the molten metal and adjusting, as required, the proportions of the iron oxide and the amount of oxygen introduced by the carrier gas to either maintain a desired temperature of the molten metal or else to raise the temperature of the molten metal. The gaseous carrier may be oxygen of commercial purity, i. e., 99.5% or better, or of a lower grade, ranging from 45% to 99.5% purity. In either case, the gas should be dry to avoid introduction of hydrogen to the metal.

In carrying out the invention, the iron oxide is delivered to the stream of oxidizing carrier gas and thence conveyed to a point beneath the surface of the molten metal in which it is rapidly disseminated. Oxidation of the carbon occurs in accordance with the following reaction:

$$Fe_2O_3+3C=2Fe+3CO$$

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The formation of carbon monoxide is aided by the presence of bubbles of the carrier gas in the molten steel. Thus, the reaction is facilitated and proceeds much more rapidly and is more readily controllable than in the case of the mere addition of iron ore to the furnace. The reaction does not in fact take place effectively unless an interface such as that provided by a gas bubble is present.

The reaction between iron oxide and carbon is endothermic. Hence, the use of an oxidizing carrier gas of high oxygen content provides an effective means for maintaining the heat balance. For example, one gross ton of molten steel containing .75% carbon requires 73.4 pounds of Fe_2O_3 to oxidize the carbon. Since the ore is introduced cold, the net effect of the reaction is to reduce the bath temperature 314° F. If .75% carbon is burned with oxygen, an increase in metal temperature of 192° F. is noted. Thus, by using 5.5 to 6.6 cubic feet of oxygen per pound of Fe_2O_3, the bath temperature may be maintained substantially constant and by varying this ratio the temperature may be raised or lowered. There is a further advantage in the use of oxygen as the carrier gas, since the oxygen itself consumes some of the carbon in the steel.

Referring to the drawings, 5 indicates the foundation of an electric furnace 6 provided with the usual electrodes 7. The molten bath 8 of steel is maintained within the furnace 6, which has an opening 9 in the wall thereof.

In order to introduce iron oxide to the molten metal, I provide a source of gas under pressure such as a trailer 10 carrying cylinders 11 which are connected to a manifold 12 through which the gas is withdrawn. A pressure regulating valve 13 permits reduction of the initial pressure of the gas in the cylinders 11 to the pressure desired in the pipe 14 which is connected to a housing 15 including an injector nozzle 16.

The iron oxide to be supplied is maintained within an air-tight receptacle 17 connected by a pipe 18 having a control valve 19 to the housing 15. Gas under pressure, preferably the same gas supplied from the cylinders 11, is maintained in the cylinder 18 having an outlet 19 with a pressure regulating valve 20 which reduces the pressure to that desired in the pipe 21 connected to the removable closure 22 of the receptacle 17. Thus, suitable gas pressure may be maintained above the iron oxide 23 in the receptacle 17, serving to move it steadily to the housing 15.

As the result of the injector action, the iron oxide is picked up and carried through the pipe 24 to a metal pipe 25 which is adapted to be

thrust beneath the surface of the molten metal bath 8. A by-pass 26, controlled by a valve 27 permits the passage of additional gas to the pipe 24 without passing through the housing 15, so that the flow of gas may be regulated in the desired proportion. Thus, the iron oxide from the receptacle 17 is fed at the desired rate directly to the molten metal bath 8 for reaction with the carbon therein.

The pipe 25 may be of steel or iron. Where oxygen of commercial or higher purity is used as the carrier gas, it is desirable to maintain a velocity of flow which is sufficient to maintain the lower end of the pipe 25 at a temperature below that of ignition of the metal with oxygen. This can be accomplished readily. If desired, the pipe 25 may be coated with an insulating material such as sillimanite (a form of alumina) or other suitable refractory material, to assist in protecting the pipe from oxidation. The lower end of the pipe will gradually melt and hence the pipe must be advanced as the operation continues. However, experience has demonstrated that consumption of the pipe by melting is relatively low, and a new pipe may be substituted as required as the operation continues.

It is essential that the carrier gas be thoroughly dried to avoid the formation of hydrogen and contamination of the steel therewith.

The procedure as described materially reduces the time required for decarburizing steel, since dissemination of the iron oxide through the metal results in a relatively rapid reaction and the loss of heat and the loss of time necessary to bring the metal to the required temperature is avoided. The reaction is moreover accelerated by the provision of a multiplicity of interfaces resulting from the bubbling of the carrier gas through the molten metal.

Various changes may be made in the procedure as described and in the form of apparatus employed without departing from the invention or sacrificing the advantages thereof.

I claim:

1. The method of modifying the carbon content of molten steel and simultaneously controlling the temperature thereof which comprises introducing finely-divided iron oxide suspended in a stream of an oxidizing carrier gas containing more than 45% of oxygen beneath the surface of the molten metal, and adjusting, as required, the proportions of the iron oxide and the amount of oxygen introduced by the carrier gas to obtain a desired temperature of the molten metal.

2. The method of modifying the carbon content of molten steel as set forth in claim 1 in which the proportions of iron oxide and the amount of oxygen introduced by the carrier gas are adjusted to maintain a desired temperature of the molten metal.

3. The method of modifying the carbon content of molten steel as set forth in claim 1 in which the proportions of iron oxide and the amount of oxygen introduced by the carrier gas are adjusted to raise the temperature of the molten steel.

4. The method of modifying the carbon content of molten steel and simultaneously controlling the temperature thereof which comprises introducing finely-divided iron oxide suspended in a stream of an oxidizing carrier gas containing about 99.5% of oxygen beneath the surface of the molten metal, and adjusting, as required, the relative proportions of the iron oxide and oxygen introduced to obtain a desired temperature of the molten metal.

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