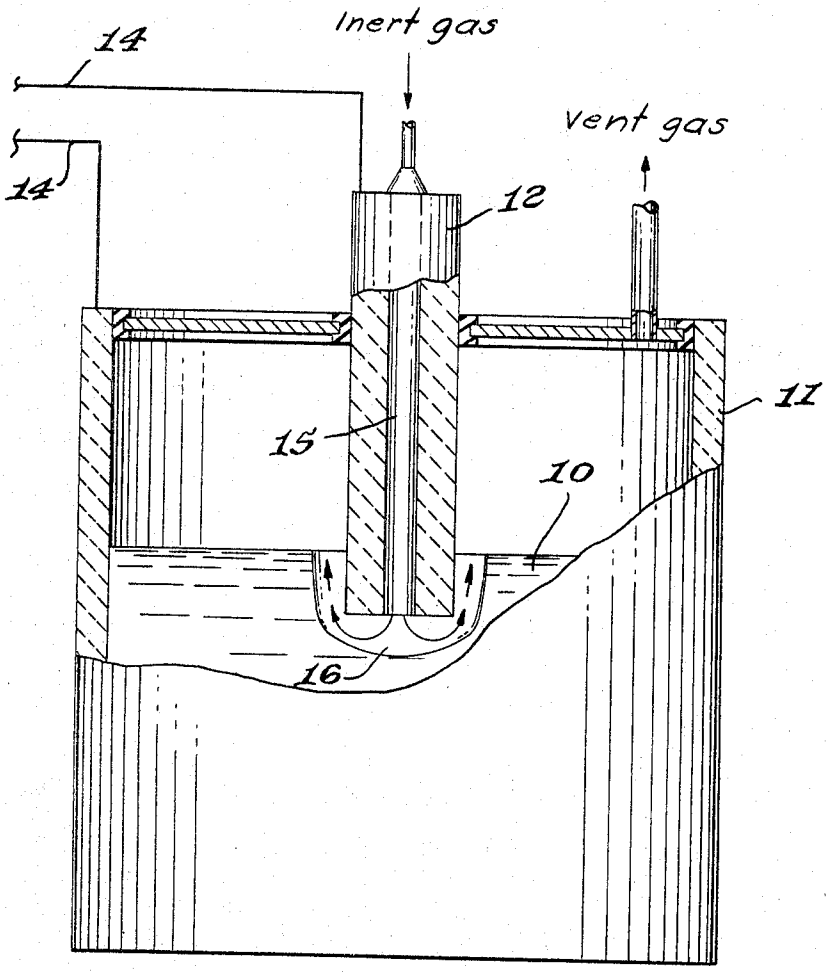
March 12, 1968 W. H. BOECKLER ET AL 3,373,240

METHOD OF OPERATING AN ELECTRIC ARC FURNACE

Filed June 1, 1964



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United States Patent Office 3,373,240
Patented Mar. 12, 1968

3,373,240

METHOD OF OPERATING AN ELECTRIC ARC FURNACE

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Filed June 1, 1964, Ser. No. 371,547
2 Claims. (Cl. 13—34)

ABSTRACT OF THE DISCLOSURE

An improved method of operating an electric arc furnace by immersing a hollow electrode below the surface of the melt and passing an inert gas through the hollow electrode to form an envelope of inert gas between the electrode and the melt. By varying the flow rate of the inert gas and consequently varying the size of the gas envelope, the electrical resistance between the electrode and the bath is controlled thereby controlling the power to the electric arc furnace.

This invention relates to an improved method of operating an electric arc furnace of the type wherein an arc is drawn between the charge or bath in the furnace and at least one electrode, and particularly to such a method employing an inert gas to provide a high resistance envelope around at least one electrode of said arc furnace.

A preferred embodiment of the present invention is schematically shown in the drawing which illustrates an elevation, partially in section, of an electric arc furnace.

Operation of electric arc furnaces generally may be separated into two distinct phases. The first or "start up" phase, generally consists of passing electric current through the charge in the furnace, thereby to heat the charge by means of electrical resistance. No electric arc is usually employed during this phase of operation. After a portion of the charge in the furnace has been heated sufficiently to form a molten bath, the second phase of operation begins. In the second phase, an electric arc is drawn between an electrode and the molten bath. It is to this second phase that the present invention is directed.

An electric arc furnace of the type herein contemplated may be thought of as a series circuit containing a plurality of resistances. Power, then is the product of the square of the current (I^2) and the overall resistance of the circuit (R). Overall resistance under ordinary operation is the sum of lead resistance (R_L) and bath resistance (R_B) when electrode and hearth resistances are neglected. Thus, Power$=I^2(R_L+R_B)$.

When an electric arc furnace is operated in the conventional manner, an arc is drawn between the electrode and the molten bath. As the bath heats up, its electrical resistance R_B becomes lower. In order to maintain a constant power input to the furnace, then, the electrical current must be increased. Increase of current input to the furnace causes heating of the leads and increases their electrical resistance R_L. Power is then lost to the leads and more must be supplied in order to continue heating the bath. As more power is supplied to the system and the bath continues to heat up, the cycle repeats itself, thereby requiring increasing amounts of electrical current to maintain heating operation of the arc furnace and increasing the possibility of damage to the electrical leads.

It is an object of the present invention to provide a method of operating an electric arc furnace whereby power input to the furnace may be maintained substantially constant without substantial increase in current input.

Other objects and advantages of the present invention will become apparent in the course of the following specification.

The Figure of the drawing presents an embodiment of an arc furnace for carrying out the present novel process. In the embodiment illustrated, a molten bath **10** is positioned in a suitable crucible or hearth **11** made of an electrically conducting material. An electrode **12** is positioned so that at least a portion thereof is within the crucible or hearth **11** and immersed in the molten bath **10**. Lead wires **14** provide external communication between hearth **11** and electrode **12** through a source of electrical power. The electrode **12** is further characterized by a bore **15** connected to a source of inert gas.

In accordance with the present invention, an inert gas is passed through the bore **15** of the electrode **12** during second phase operation of the furnace. An envelope **16** of inert gas is thus formed around the exterior of the electrode **12**, especially the portion of electrode **12** in close proximity to the molten bath **10**. By this means, an additional resistance (R_G) is placed in series with the furnace electrical circuit, which resistance may be controlled so as to maintain current and power substantially constant. An increased flow of inert gas through the bore **15** of electrode **12** increases resistance R_G and, conversely, a decrease in the flow of inert gas decreases resistance R_G.

As the bath resistance R_B decreases with increasing bath temperature, R_G may be increased to make up for the loss in bath resistance. In this manner, the power input $[I^2(R_L+R_B+R_G)]$ may be held substantially constant without increasing the current flow in the system or altering the position of the electrode **12** relative to the bath **10**.

Suitable inert gases for use in the present invention are wholly or partially ionizable gases which do not react with the electrode **12**, the hearth **11**, or the bath **10** to any significant extent at the temperatures employed. Preferred inert gases for use in the present method are helium, neon, argon, krypton, xenon, radon, nitrogen and mixtures thereof.

A better understanding of the present method may be obtained in light of the following examples which are set forth to illustrate, and are not to be construed to limit, the present invention.

Example 1

A four-inch diameter impervious graphite hearth was charged with 1.5 kilograms of bauxite, pyrites and coke. The desired reaction temperature of these materials is about 1850 degrees centigrade. Electrical resistance of the furnace circuit, including the charge (bath) resistance (R_B), at start up was about 0.065 ohm.

A cylindrical graphite electrode having a diameter of one inch and a 1/32 inch diameter axial bore was positioned substantially vertically with its lower end immersed in the charge (bath). Electrical connection was made between the graphite hearth and the electrode through an electrical power source. A source of argon gas was connected to the axial bore of the electrode. The electric power was turned on to begin the heating process.

After heating for about 1½ hours employing no gas, the bath was molten and had attained a temperature of about 1850 degrees centigrade. Electrical resistance of the circuit had decreased to about 0.035 ohm. Argon gas was then fed through the bore of the electrode under about 5 pounds per square inch pressure. Electrical resistance of the furnace circuit was increased to about 0.3 ohm thereby, with a correspondent reduction in the amperage required to maintain the bath at the desired (1850° C.) temperature.

It was also found that electrode wear, as compared

to a solid graphite electrode of the same dimensions, was reduced by a factor of about four when the gas envelope of the present method was employed.

Example 2

The method described in Example 1 may be carried out in substantially the same manner substituting helium, neon, krypton, xenon, radon, nitrogen, or mixtures thereof for the argon employed therein with substantially the same beneficial results.

Various modifications may be made in the present invention without departing from the spirit or scope thereof, and it is to be understood that we limit ourselves only as defined in the appended claims.

We claim:

1. In a method of operating an electric arc furnace having a hearth and an electrode, said hearth and electrode communicating electrically with an external electric power source through an electrically conductive charge, the improvement comprising providing said electrode with an internal longitudinal bore, immersing said electrode below the surface of the charge, and passing an inert gas through said bore during operation of said electric arc furnace to produce an envelope of inert gas between the electrode and the charge, thereby to increase the arc resistance and to thereby control the electrical power input to said arc furnace.

2. The method of claim 1 wherein the inert gas is a member selected from the group consisting of helium, neon, argon, krypton, xenon, radon, nitrogen and mixtures thereof.

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