United States Patent

[11] 3,546,347

[72] Inventors Andreas Hausig; Helmfried Jeske, Henningsdorf; Karl Spiegelberg, Berlin, Germany

[21] Appl. No. 834,357
[22] Filed June 18, 1969
[45] Patented Dec. 8, 1970

[73] Assignee VEB Qualitaets-und Edelstahlkombinat, Henningsdorf, Germany

[54] METHOD AND DEVICE FOR CONTROLLING PERFORMANCE OF PLASMA ARC FURNACES

7 Claims, 1 Drawing Fig.

[52] U.S. Cl. 13/12, 219/121
[51] Int. Cl. H05b 7/18
[50] Field of Search ..... 13/1, 12, 31; 219/121(P)

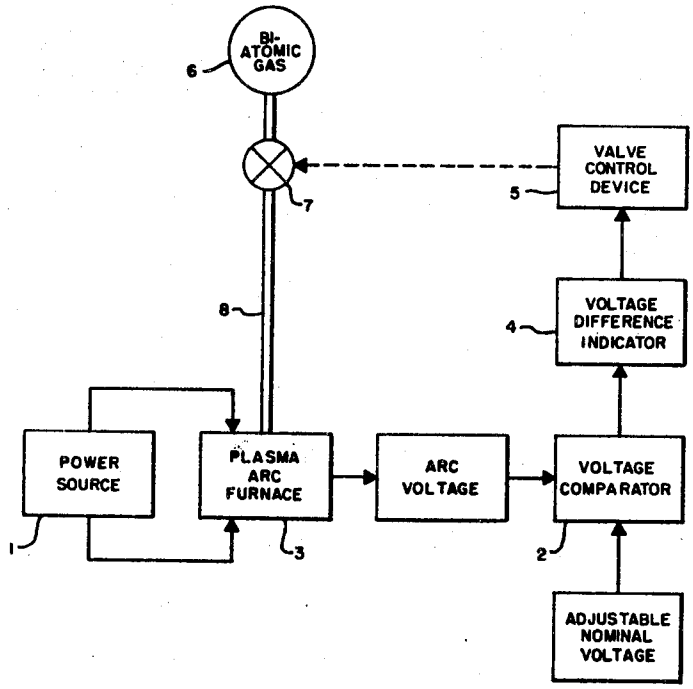
[56] References Cited

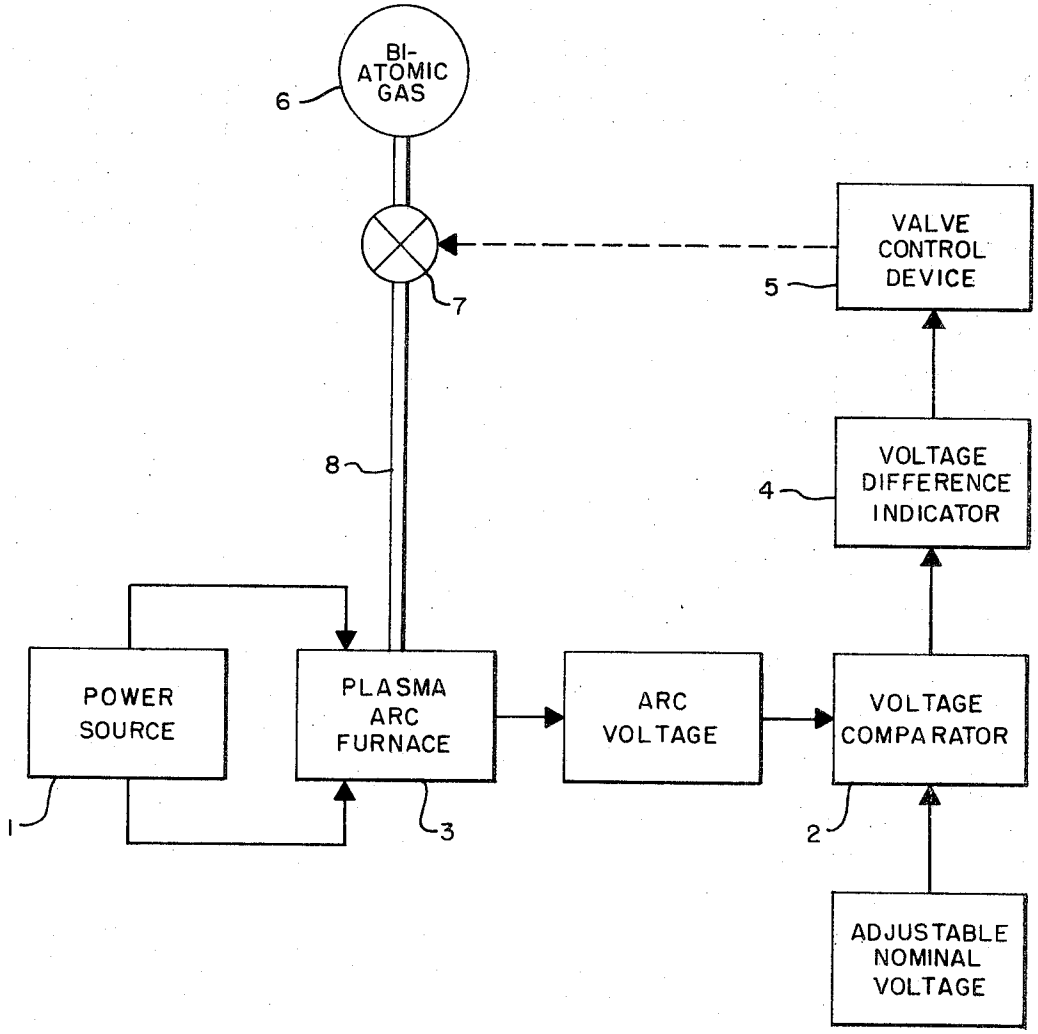
UNITED STATES PATENTS

3,250,893 5/1966 Nestor ..... 219/121(P)UX
3,404,078 10/1968 Goldberger ..... 219/121(P)UX

Primary Examiner—Bernard A. Gilheany
Assistant Examiner—Roy N. Envall, Jr.
Attorney—Nolte and Nolte

ABSTRACT: The voltage and thus the performance of the plasma arc in a plasma-arc furnace is controlled by a qualitatively regulated continuous or intermittent introduction of a biatomic gas either into a monoatomic working gas of the plasma-arc burner unit or directly into the furnace atmosphere. A valve in the gas feeding conduit is actuated by a voltage comparator in dependency on the voltage difference between the actual voltage across the arc and a predetermined nominal voltage.





INVENTORS
ANDREAS HAUSIG
HELMFRIED JESKE
KARL SPIEGELBERG

BY Nolte & Nolte
ATTORNEYS

METHOD AND DEVICE FOR CONTROLLING PERFORMANCE OF PLASMA ARC FURNACES

The present invention relates generally to electric arc furnaces and, more particularly, to a method and device in melting units controlling electric power for employing plasma arc burners as a heat source.

When employing a plasma arc burner as a heat source, the arc voltage across the arc is adjusted in dependency on the actual atmosphere within the furnace. To control the performance of a relatively short arc, a possibility has been suggested to vary the arc potential and thus the performance by varying the length of the arc.

It has been also known from literature that by introducing a biatomic gas into the neutral one-atomic working gas within the furnace, the arc voltage raises and, since the current intensity remains unchanged, the performance of the melting device is improved. In this prior art method, manually controlled magnetic valves have been proposed to serve as a measuring and feeding mechanism for the biatomic gas of the plasma arc burner.

The first mentioned method of controlling performance of plasma arc furnaces by adjusting the voltage across the arc through the adjustment of the length of the arc is effective only in a very limited range of voltages since the attainable voltage drop across the arc column is very low. If a broader range of electric power regulation is required in arc application field for plasma arc furnaces, such as, for example, in melting and alloying of metals, the prior art methods are no more applicable because by further increasing the length of the arc, only unsignificant voltage changes can be attained.

Contemporary direct current power sources are usually designed for supplying a sufficient voltage range but the cost and size of the current-supplying devices are defined substantially by the amount of the required current. To insure the maximum economy in the operation of a plasma arc melting device, it is necessary that the voltage range of the power source be utilized to its maximum. At the same time, it must be taken into consideration that in the production of metal materials by the aid of plasma arc burners in closed melting devices, an interference will occur in the atmosphere of the furnace. This interference is caused by metallurgical reactions (or by reactions in refractory material) as well as by the moisture and impurities contained in the charging material, and it brings about changes in the composition of the furnace atmosphere and, consequently, in the voltage across the arc. More specifically, the changes in the arc voltage result from different ionization voltages of various gas components of the reaction products.

The object of the present invention is to create a control system which during the melting process keeps the arc voltage on a prescribed constant value and thus stabilizes the incoming electric power for the plasma arc furnace, whereby the changes in the furnace atmosphere caused by the charging and refractory material or by metallurgical processes can be by the action of the control system continuously or intermittently compensated.

Another object of this invention is to control the composition of the furnace atmosphere in order to adjust a nominal operating voltage of a long plasma arc to a predetermined constant value.

Still further object of the invention is to compensate the voltage variations which result from additional parameters, such as variations due to the change of the arc current, for example.

The invention is based on the discovery that the arc voltage is a function of the gas mixture within the furnace.

According to the present invention, the above objects are attained by providing a dosing device that controls the feeding of the additional or auxiliary gas into the furnace in dependency on the difference between the actual arc voltage and a prescribed nominal voltage. This dosing device automatically equalizes the voltage difference in order to provide stabilization of the operating voltage and, consequently, of the performance of the entire melting device. The voltage stabilization has to be considered as essential for the performance control, since the current supply can be adjusted independently of the aforementioned interfering factors in the furnace atmosphere.

The differences between the nominal and actual voltages actuate via an amplifier the closing or opening action of a dosing mechanism, such as, for example, a magnetic valve, motor-driven control valve etc., which in turn controls the introduction of an auxiliary gas into the furnace atmosphere, either directly into the furnace space or through the burner.

The method and device of this invention makes it possible to design for a given average incoming power an optimum power source, especially with respect to its size, maximum current etc. Furthermore, by the employment of this invention the power source can be loaded to its full capacity during the melting process and thus operate more economically. By maintaining a predetermined incoming power, the control method and drive of this invention enables that the prescribed maximum current flow rate may be reduced and the arc burner will operate under lower load. Due to the automatic operation of the performance controlling mechanism, the strain on the operator in charge of the equipment is considerably reduced and a preliminary condition for a full automatization of the melting process is thus attained.

If special gas components are required for the composition of a final product, it is possible to employ these gas components for the regulation and raising of the arc voltage.

The invention will now be described by way of an example with reference to an accompanying single drawing showing schematically a block diagram of the controlling circuit of this invention. In plasma arc furnace 3 for a melting device the incoming electric power for the plasma arc is supplied from power source 1. A two-point controlling system maintains the arc voltage on a predetermined constant level. The controlling system comprises a voltage comparator 2 for comparing the actual arc voltage with an adjustable nominal voltage and a polarized relay serving as an indicator 4 of the difference between the two voltages. The indicator actuates through a valve control device 5, such as a switching transistor amplifier, a magnetic valve 7 which in turn controls the feed of auxiliary gas 6 to conduit 8 connecting a gas supply with the arc furnace. At the beginning of the melting process, first a one-atomic gas, such as argon, is introduced into the melting furnace. Without the application of a controlling process, the arc voltage may take at the beginning the melting process a value within the range of 180v.—200v. for example, subject to the amount of impurities and other gas components contained in the charging material, up to 200v. During the degasification process of the charging material in the furnace, the arc voltage may drop more or less quickly to 80—100v. By contrast, the installation of the performance control device of this invention enables that by controlling the introduction of biatomic auxiliary gases, such as H_2, or N_2, for example, the arc voltage is kept during the entire melting process on a prescribed constant value, e.g. 180v. Consequently, the power source during the period of the melting process is always loaded to its optimum working condition.

We claim:

1. A method of controlling performance of plasma arc furnaces having a given initial furnace atmosphere and controllable electric current supply means, comprising the steps of comparing the actual voltage across the arc with an adjustable nominal voltage, indicating the observed voltage difference, deriving a signal from said voltage difference, and utilizing said signal automatically to influence the composition of the furnace atmosphere simultaneously with the current supply to compensate said voltage difference.

2. The method according to claim 1 wherein said step of influencing the furnace atmosphere comprises introducing a qualitatively measured biatomic gas into the furnace atmosphere.

3. The method according to claim 2 wherein said biatomic gas is mixed with a working gas of the plasma arc burner.

4. A device for controlling performance of plasma arc furnaces having a burner system and a furnace atmosphere comprising an electric power source for energizing said arc, a voltage comparator for comparing the actual voltage across the arc with an adjustable voltage, a voltage difference indicator, conduit means for feeding a gas into the furnace atmosphere, valve means in said conduit means, and valve control means actuated by said voltage difference indicator to measure out the gas flow in said conduit means proportionally to the indicated voltage difference.

5. The device according to claim 4 wherein said valve control means controls said valve means continuously.

6. The device according to claim 4 wherein said valve control means controls said valve intermittently.

7. The device according to claim 4, wherein said burner system contains initially a working gas, and said gas from said conduit means is mixed with said working gas.