

United States Patent [19]**Camacho**[11] **3,749,802**[45] **July 31, 1973**[54] **VESSEL PREHEATING METHOD AND APPARATUS**

3,383,163	5/1968	Menashi	219/121 P X
3,524,006	8/1970	Ebeling et al.	13/1 X
3,600,544	8/1971	Smith	219/61

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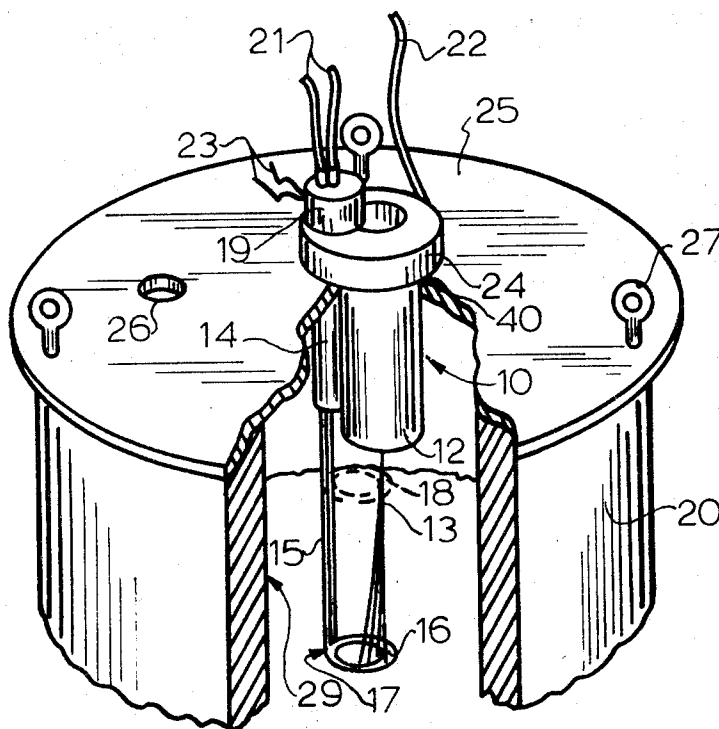
[22] Filed: **Aug. 24, 1972**[21] Appl. No.: **283,514**[52] U.S. Cl. **13/1, 13/9, 219/121 P**[51] Int. Cl. **H05b 7/00**[58] Field of Search **13/1, 2, 9, 31, 34;**
219/121 P, 137, 61[56] **References Cited****UNITED STATES PATENTS**

2,957,977 10/1960 Sullivan 219/137 X

[57]

ABSTRACT

A vessel preheating method and apparatus are directed to a long arc column forming plasma generator utilizing an external movable electrode to generate a long transferred arc column. Means are provided for positioning the arc column within a vessel whereby to radiatively and convectively preheat the vessel to a desired temperature.

5 Claims, 3 Drawing Figures

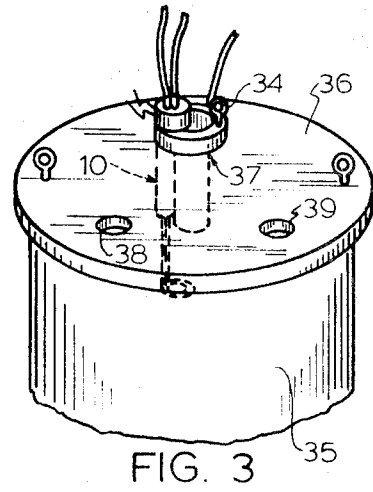
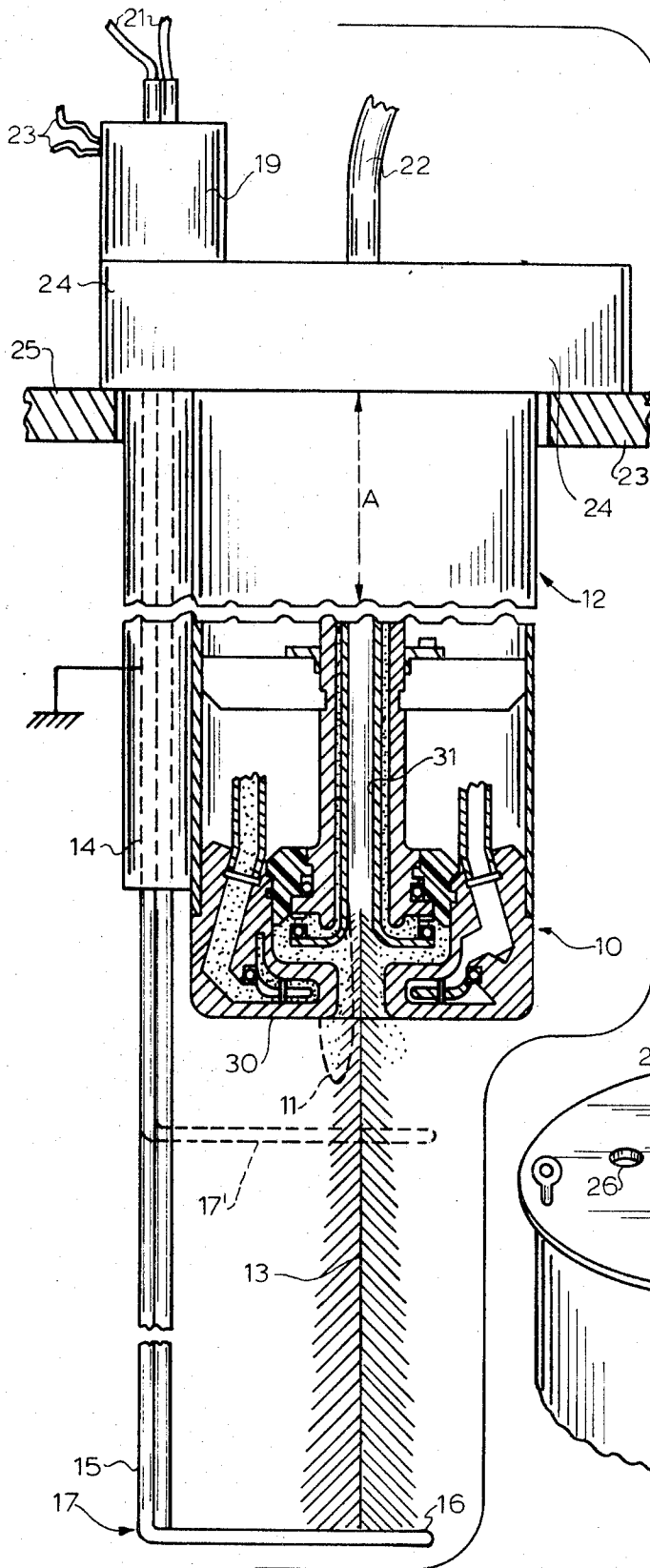


FIG. 1

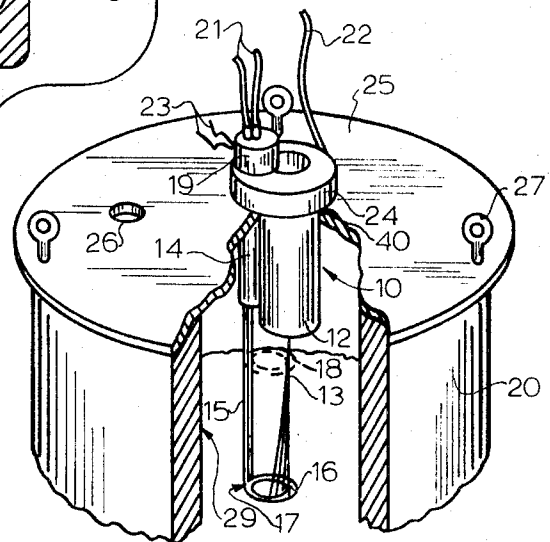


FIG. 2

VESSEL PREHEATING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to methods and apparatus for preheating vessels such as furnaces, ladles, and the like, as are commonly used in steelmaking and particularly such methods and apparatus utilizing long arc column forming plasma torches.

2. Description of the Prior Art

Vessel preheating is employed in the steelmaking industry to promote greater furnace efficiency, prevent deterioration of firebrick and refractory due to sudden temperature changes and to decrease heat loss during the transfer of molten steel and the like. Methods and apparatus for preheating the various types of vessels employed have largely depended upon utilization of a methane burner to project an intense open flame into the vessel. Due to the large amount of gases entering a vessel from such burners adequate venting precludes the use of any cover or seal configuration and as a result much heat and efficiency is lost. Vessel preheating as practiced with such methane burners has been characterized as being a costly and time consuming operation. Air in the general range of 0.75 to 3.00 pounds of air per 1,000 B.T.U.'s of heat is required by the burner.

U.S. Pat. No. 24,006 teaches moving a plasma arc electrode. However, in what is perhaps the closest known prior art, U.S. Pat. No. 3,673,375, entitled "Long Arc Column Plasma Generator and Method," issued to the same inventor, teaches the utilization of an external, fixedly positioned, ring-shaped electrode in combination with a long arc column forming plasma torch to generate a long arc plasma column therebetween to melt non-electrically conductive materials located forward of the external electrode. Such teachings do not, however, suggest the utilization of an external electrode remotely positionable with respect to the torch. Nor do the teachings suggest a method for preheating a vessel based on utilizing a remotely positionable external electrode, initially positioning the external electrode in close proximity to the torch for purposes of transferring a pilot arc formed in the torch to a short arc formed between the torch and external electrode, then positioning the external electrode forwardly to form a long transferred plasma arc column and using the radiated heat of this long arc column to preheat the vessel as well as using convected heat.

SUMMARY OF THE INVENTION

As a primary object, this invention seeks to greatly improve vessel preheating efficiencies by substantially cutting costs while decreasing the amount of preheating time required. The instant invention utilizes a long arc column forming plasma generator or "torch," as often referred to in the art, in combination with a movable, external, nonconsumable electrode mounted on said torch parallel to the torch axis and which includes a ring shaped tip portion bent perpendicular to the torch axis, so as to reside forward of and in axial alignment with the torch, whereby a long transferred plasma arc column may be struck between the torch and the movable electrode tip portion. According to the method of the invention, remotely controllable electrode positioning means are provided enabling the tip portion to be positioned near the torch for purposes of

transferring a "pilot arc" formed in the torch to the movable electrode tip portion or away from the torch for purposes of drawing the short transferred arc column thus formed outward into a long transferred arc column. The torch and movable electrode may be mounted in an appropriate lid structure having only a small vent due to the small amount of gas utilized in generating the arc column. A torch and movable electrode mounted in such a lid provide a highly efficient means for vessel preheating. Air consumption is substantially reduced.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cutaway side elevation in partial cross section of a long arc column forming plasma torch and a movable electrode operatively arranged according to the invention.

FIG. 2 is a perspective view of an apparatus according to the invention employed in a lid structure for open vessel preheating.

FIG. 3 is a perspective view of an apparatus according to the invention employed in a conventional furnace for closed vessel preheating.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 in a preferred embodiment, the apparatus of the present invention generally designated 10 utilizes a long arc column forming plasma generator 12 in combination with an externally positionable electrode 17 to initiate and sustain a long transferred plasma arc column 13 between generator 12 and electrode 17. A long arc column forming plasma generator which can be modified for the needs of the instant invention has been previously disclosed in U.S. Pat. No. 3,673,375, issued to the same inventor. The generator generally comprises a cylindrical shaped electrode 31, a gas directing nozzle 30 axially aligned with forwardly spaced and insulated from electrode 31, and appropriate gas 22, water 21 and electrical supply means 23. As previously disclosed in U.S. Pat. No. 3,673,375, a "pilot arc" indicated by dashed lines 11 may be struck between electrode 31 and nozzle 30 by introducing a potential therebetween while simultaneously applying a vortical flow of gas directed outward through said nozzle 30. This invention recognizes that such a "pilot arc" may be transferred to movable electrode 17 when electrode 17 is moved to the position 17' proximate pilot arc 11. Thus, according to the invention, the externally mounted movable electrode 17 causes transfer of pilot arc 11 when electrode 17 is at position 17' and causes a main long transferred arc column 13 to be formed when the electrode is at its normal position, designated at 17.

Electrode 17 includes an elongated portion 15 which is adapted to extend through a guide member 14 which mounts on the plasma generator and slidably guides the portion 15 for linear movement parallel with the generator longitudinal axis A. Electrode 17 also includes an annular shaped tip portion 16 which is bent at a right angle to elongated portion 15 so as to reside forward of and in axial alignment with plasma generator 12 in a plane perpendicular to the generator axis A. Said electrode tip portion 16 may be positioned at various distances from nozzle 30 by operating appropriate motorized or hydraulic electrode positioning means 19 also secured to said generator 12. In accordance with the

present invention, the external electrode 17 employed is preferably of a nonconsumable nature. A water cooled copper tube, for example, bent over upon itself and formed into the described configuration is found to be highly suited to this invention. In addition, appropriate gas 22, water 21, and electrical supply means 23 are provided to energize the apparatus.

During normal operation, later described in greater detail, the invention apparatus is adapted to be lowered through an appropriate aperture 40 in the lid 25 of the vessel to be preheated. The apparatus is retained in such aperture due to abutment with a rearwardly located cylindrical flange 24 integrally formed in said generator 12. Such an aperture may be the normal roof mounted electrode apertures in a conventional carbon arc type electric furnace or, if no lid is present as in the case of an open vessel, e.g., ladle for pouring molten steel, the invention contemplates providing an auxiliary lid structure 25 to prevent substantial heat losses. Next, the external electrode 17 is positioned such that tip 16 is within 1-2 inches of nozzle 30, as represented by dashed lines 17'. The previously mentioned "pilot arc" is now struck between internal electrode 31 and nozzle 30, and instantaneously thereafter a short transferred arc (not shown) is formed between internal electrode 31 and said proximate tip 16. In accordance with the invention method, external electrode 17 is now moved to an outward position thereby forming the long arc plasma column 13 and radiating a substantial amount of heat into the vessel as well as convecting heat.

Referring now to FIG. 2, which shows a typical application of the invention apparatus adapted for use in preheating vessels of the aforementioned open type such as ladles, an auxiliary lid structure 25 is provided and is adapted to reside over the mouth of said open vessel 20 to minimize heat losses during the preheating operation. As previously mentioned, lid 25 includes an aperture 40 through which extends the apparatus 10 of the invention. A flange 24 integrally formed in plasma generator 12 comes into abutting relationship with said lid 25 and seals said generator 12 in aperture 40. In preferred form aperture 40 is adapted to cause apparatus 10 to centrally locate the arc column formed for all exposed interior wall portions 29. An appropriate vent hole 26 is adapted to vent the small amount of incoming gases during formation of the long transferred arc column 13 inside vessel 20.

As previously mentioned, a long plasma arc column 13 is adapted to be initiated and sustained by positioning electrode tip 16 in a position (17') proximate plasma generator 12 whereby to transfer a "pilot arc" formed within said generator, to said tip, and then moving said tip 16 to an outward position whereby to draw said arc into a long column 13. Also provided in such an "open" vessel preheating embodiment are attachments 27 for appropriate lifting apparatus (not shown) whereby to transfer the combined invention apparatus and lid assembly to the next vessel to be preheated or to temporary storage.

Referring next to FIG. 3, in a second embodiment for pre-heating vessels of the "closed" type, or those having an integral lid 36, such as a conventional electric furnace 35, and having apertures 37, 38, 39 normally adapted to receive arc forming graphite electrodes, the invention apparatus is readily adapted for vessel preheating by being extended through one (37) of said apertures, the other two, 38, 39, serving to vent the in-

coming small amount of gas. Even heating of such a furnace is obtained by periodically transferring apparatus 10 to alternate apertures 38, 39. Attachments 34 are therefore provided on the apparatus 10 itself for appropriate lifting apparatus (not shown). As an added advantage, it is apparent that the invention apparatus is capable of being fully remotely operated, thereby lending itself to modern automated steelmaking techniques.

While the preceding description has been directed at two main embodiments of the instant invention for use in open vessel preheating as in the case of ladles and the like not having an integral lid, and for use in closed vessel preheating as in the case of conventional electric furnaces, such description should not be viewed as limiting the true scope of the invention apparatus which can be adapted for use in an extremely wide range of vessels, for purposes of preheating same.

Based on the above, it is apparent that the instant invention provides a highly efficient means with which to effect preheating of a wide range of vessels. Due to the ability of this invention to generate a substantial amount of heat while introducing only a small amount of gas into a vessel, it is now possible to almost totally enclose the vessel during preheating thereby keeping heat losses at an absolute minimum. Vessel preheating now proceeds quicker and more efficiently in an apparatus which lends itself to fully automated remote operation. The employment of a long arc column torch having the described remotely adjustable external electrode furthermore provides a unique starting procedure for preheating and simplifies the starting apparatus. In the description and the claims it should, of course, be understood that the invention apparatus and method are based upon use of a "long arc" plasma column generator and which is intended to mean plasma arc columns having a length when being used for preheating of at least 10 inches and which are normally in the range of 10-40 inches. It is such a heat source, when used in the manner disclosed, that provides the many unique advantages described. Of special significance to the art of steelmaking, it should be recognized that whereas conventional ladle preheating with burners requires a supply of air in the range of 0.75 to 3 pounds of air per 1,000 B.T.U.'s of heat, the present invention may require only 1/300th of the amount normally required.

To summarize the method steps previously set forth, such steps comprise the following with respect to the heated space:

- a. removably securing within the space a liquid cooled, gas fed and electrically energized long arc column generator having an external electrode mounted for adjustable positioning in the path of the column and mounted so as to have the long arc column generated by the generator surrounded by the space to be heated;
- b. establishing a pilot arc with said generator;
- c. moving the generator external electrode to a position adjacent the nozzle of the generator to effect transfer of the pilot arc to the said external electrode;
- d. moving the said external electrode to a position forward and remote from the generator nozzle to create a long arc column; and
- e. heating said space with the heat from said column.

What is claimed is:

1. A space heating apparatus comprising, in combination:

a. a long arc column forming plasma generator having an internal electrode and a gas directing nozzle located forward of and insulated from said internal electrode and having appropriate gas, cooling liquid and electrical supply means, said generator being adapted to form an internal pilot arc and with an appropriate forwardly spaced external electrode in circuit therewith being adapted to transfer the pilot arc and form a long transferred plasma arc column extending from said nozzle to said external electrode;

b. an external movable electrode mounted proximate said generator and adapted for rectilinear bidirectional movement along an axis parallel to the longitudinal axis of said generator, said external electrode having a tip portion oriented perpendicular to and residing in a plane through which passes said generator axis;

c. means adapted to linearly and selectively position said external electrode with respect to the nozzle of said generator whereby upon creation of said pilot arc said external electrode may be positioned adjacent said nozzle and have said pilot arc transferred thereto and then positioned to a more remote position forward of said nozzle to create a said long column arc; and

d. means adapted to temporarily secure said generator with respect to the space to be heated whereby said long column arc may effect said heating while

said external electrode remains fixed in said forward remote position.

2. The apparatus of claim 1 including a vessel to be preheated having a lid and wherein said means to secure said generator comprises means to secure said generator to said lid during preheating of said vessel.

3. The apparatus of claim 2 wherein said vessel lid includes apertures normally reserved for insertion of electric arc apparatus and said generator is adapted to be removably secured in a selected said aperture.

4. The apparatus of claim 1 including means adapted to remotely position said external electrode.

5. The method of heating a vessel space, comprising the steps:

a. removably securing within the space a liquid cooled, gas fed and electrically energized long arc column generator having an external electrode mounted for adjustable positioning in the path of the column and mounted so as to have the long arc column generated by the generator surrounded by the space to be heated;

b. establishing a pilot arc with said generator;

c. moving the generator external electrode to a position adjacent the nozzle of the generator to effect transfer of the pilot arc to the said external electrode;

d. moving the said external electrode to a position forward and remote from the generator nozzle to create a long arc column; and

e. heating said space with the heat from said column.

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