April 23, 1968 W. B. PARKER 3,379,815

ELECTRIC ARC FURNACE HAVING TWO HEARTHS AND INTERCHANGEABLE ROOFS THEREFOR

Filed Sept. 3, 1965 2 Sheets-Sheet 1

Fig. 3

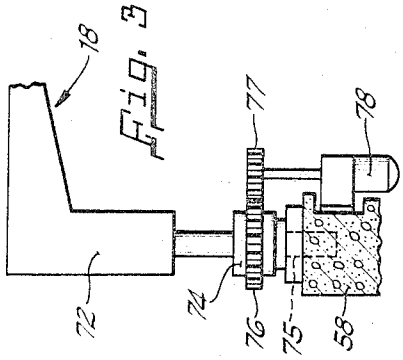


Fig. 1

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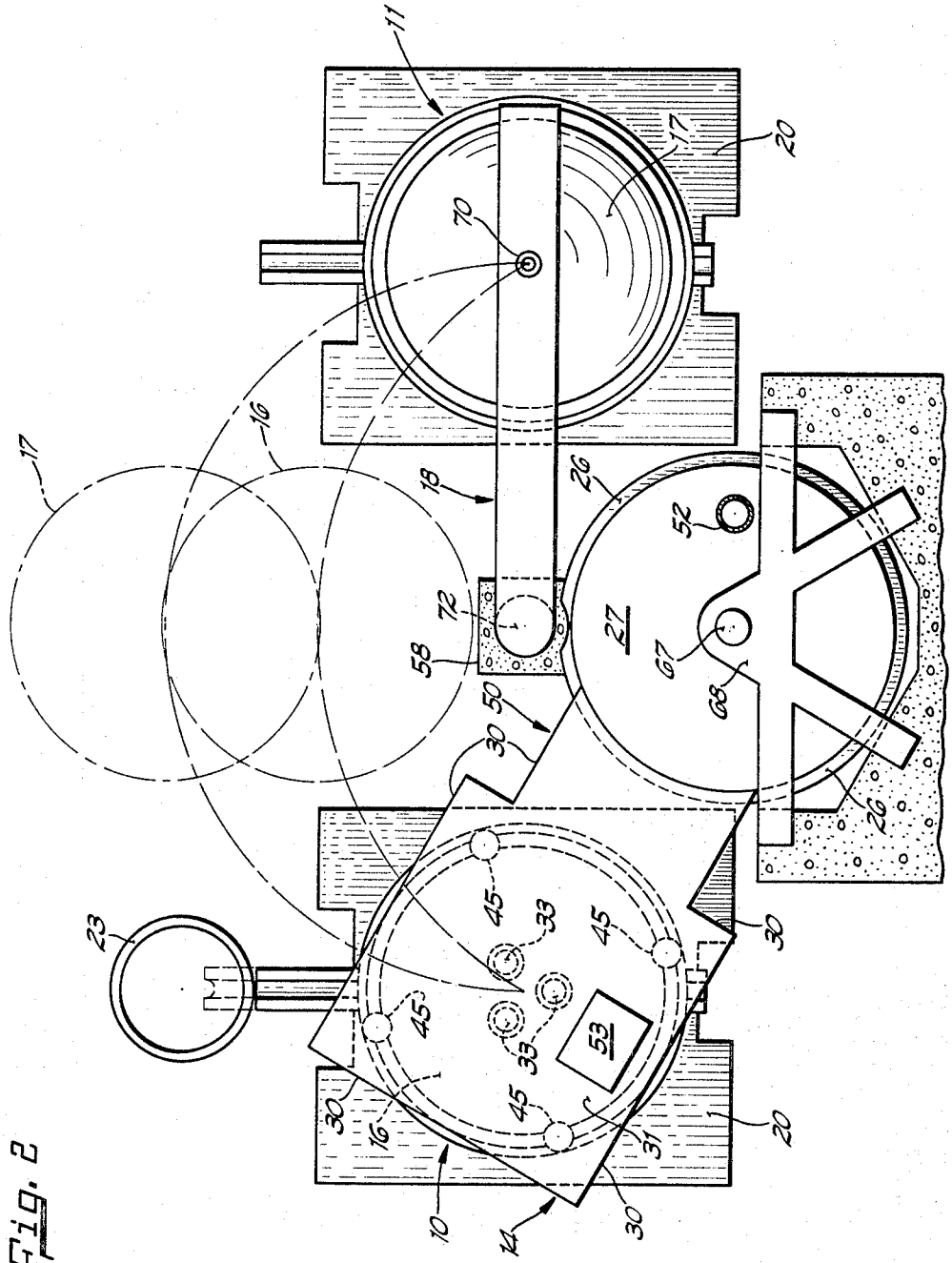


Fig. 2

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ELECTRIC ARC FURNACE HAVING TWO HEARTHS AND INTERCHANGEABLE ROOFS THEREFOR

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This invention relates to electric arc furnaces and, more particularly, to a dual shell continuous availability electric arc furnace.

In the normal operating cycle of an electric arc furnace, a cold charge is first placed within the furnace chamber, the furnace electrodes are then lowered toward the furnace charge, and the cold charge is then heated until it fluidizes and further until the desired furnace operation has been performed. The molten charge is then removed from the furnace as by tipping the furnace chamber so that the charge may be poured into a suitably positioned ladle. It may be necessary after the charge has been removed to patch the bottom and sidewall furnace refractories before the furnace is again charged in preparation for a subsequent melting operation. It can be seen that the time required to patch the furnace refractories and then to place a cold charge within the furnace and to initially heat the cold charge, substantially lengthens the time between actual furnace melting operations wherein relative expensive equipment such as the electrode clamps and supporting structure and the energizing transformer and power conductors remain idle.

It is, therefore, an object of the invention to provide an electric arc furnace assembly having a pair of furnace bodies and a first movable furnace roof and electrode assembly for performing a melting operation in one furnace body and a second movable furnace roof having heating means for preheating a furance charge in the other furnace body wherein substantially continuous operation is possible.

The supporting structure for the electrodes of electric arc furnaces generally include electrode clamps which also support the electrical connection to the electrode. In order to limit the resistance presented by the electrode to the energizing current, the electrode clamps are connected at a relatively low position on the electrode. However, as the electrode becomes worn or otherwise consumed in the melting process, the electrode clamp must be periodically raised in order to prevent engagement between its associated support structure and the furnace roof structure. While the electrodes are suspended above the electric furance during a melting operation, their upper surfaces become coated with highly resistive ferrous oxide dust. If this dust is not removed prior to the electrode clamp raising operation, the clamp contact surfaces become coated with this resistive material which can cause poor conductivity of power into the electrode and result in clamp overheating.

It is, therefore, a further object of the invention to provide an electric arc furnace assembly wherein an enclosed conditioned atmosphere is provided around the electrode supporting assembly to prevent the deposit of electrically resistive material on the upper portions of the electrodes.

In certain electric arc furnace applications, it is desirable to employ self-baking electrodes because of substantially reduced cost relative to preformed electrodes. Self-baking electrodes, for example, may consist of an elongate cylindrical steel shell into which electrode material in the form of a paste is added and which bakes as it approaches the melt. As the electrode is consumed, it is necessary to add shell sections and paste at the upper

end. This limited the use of self-baking electrodes to applications where there was a substantial amount of room above the furnace so that the personnel performing the shell and paste adding operations were not exposed to the furnace heat.

It is, therefore, another object of the invention to provide an electric arc furnace assembly wherein an enclosed conditioned atmosphere is provided around the electrode supporting assembly to allow the use of self-baking electrodes without the need for substantial headroom above the furnace.

These and other objects and advantages of the instant invention will become more apparent from the detailed description thereof taken with the accompanying drawings wherein:

FIG. 1 is a side elevational view, with parts broken away, schematically illustrating an electric arc furnace according to the instant invention;

FIG. 2 is a top plan view of the arc furnace assembly illustrated in FIG. 1; and

FIG. 3 is a fragmentary view of the furnace assembly shown in FIGS. 1 and 2.

In general terms, the invention comprises an electric arc furance assembly having first and second furnace bodies, an electrode energizing and suspension assembly, enclosure means surrounding the electrode energizing and suspension assembly, a first furnace roof suspended from the enclosure assembly, mean for swinging said enclosure assembly from a position above one furnace body to a position above the other furnace body, a second furnace roof provided with pre-heater means, and means for swinging the second roof means from a position above the second furance body to a position above the first furnace body and in avoidance of said enclosure means. In addition, the invention may include means for conditioning the atmosphere within the enclosure.

Referring now more specifically to FIG. 1, the furnace assembly is shown to include a first furnace body **10**, a second furnace body **11**, an electrode suspension assembly **12** for each electrode **33** (only of which is shown in FIG. 1), an enclosure **14** for the electrode suspension assembly and means **15** for rotating the enclosure **14** from a position above the furnace body **10** to a position above the furnace body **11**. In addition, a first furnace cover **16** is adjustably suspended from the enclosure **14** and a second furnace cover **17** is mounted on arm means **18** so that it may be alternately positioned above the furnace bodies **10** and **11**.

Each of the furnace bodies includes a generally rectangular support platform **20** for supporting the metallic furnace shell **21** which has generally cylindrical sidewalls and a dished bottom. The shells **21** are lined with suitable refractory material **22** and are provided with an access door **24** for removing slag from the molten furnace charge when the occasion for the operation arises. As those skilled in the art will appreciate, the platform **20** is mounted upon a rocking mechanism **25** so that the furnace shell **21** may be tipped and the molten content thereof discharged into a ladle **23** (see FIG. 2) through suitable doors (not shown).

A third platform **26** is disposed equidistantly from each of the platforms **20** and is generally circular and located so that lines joining its vertical axis with the axes of each of the platforms **20** has an interior angle of approximately 120°. The enclosure **14** is mounted atop the platform **26** and includes a generally cylindrical, sealed first enclosure portion **27** which supports the furnace energizing transformer **28** adjacent its upper end. As those skilled in the art will appreciate such equipment as a circuit breaker, metering transformers and control panels (none of which are shown) will normally be disposed in the lower end of the enclosure portion **27**. Sus-

pended from one side of the enclosure portion 27 and generally opposite the transformer 28 is a second enclosure portion 30 which is sealed to the portion 27. The enclosure portion 30 is generally cubicular and includes suitably joined and supported metallic sidewall members 30, a roof member 31 and a floor member 32.

The electrode suspension assemblies 12 (only one of which is shown in FIG. 1) are each disposed within the enclosure portion 30 and each includes a positioning motor 34 and a cable and pulley assembly 35 connected at one end of its respective motor 34 and at its other end to the electrode clamp 37. As those skilled in the art will appreciate, each of the motors 34 will be connected to control apparatus, which is not shown but which is well known in the art, for individually moving each of the electrodes 33 relative to the furnace charge in accordance with the electrical conditions in the arc. Each of the electrode suspension assemblies also includes a plurality of guide rollers 38 which are mounted on the clamps 37 and which engage tracks 39 extending between the roof 31 and the floor 32 of the enclosure 14. The guide rollers 38 and tracks 39 prevent the upper end of the electrode 13 from whipping due to electromagnetic coupling between the electrodes as a result of the relatively large polyphase currents which are supplied to the electrodes from the transformer 28 through bus bars 40 and flexible conductors 42 connected to each electrode holder 37.

The lower ends of the electrodes 33 pass through sealing bushings 44 in the floor 32 of the enclosure 14 so that the interior of the enclosure may be sealed. In addition, a hydraulic cylinder 45 is disposed adjacent each of the four corners of the floor 32 and each has a piston stem 46 extending downwardly therefrom for releasably engaging the first furnace cover 16 so that said cover may be selectively raised and lowered into engagement with the upper end of the furnace shells 10 or 11.

As seen particularly in FIGS. 1 and 2, the cylindrical enclosure portion 27 is connected to the generally cubicular enclosure portion 30 by a hollow connecting portion 50 through which the power conducting bus bars 40 pass. Access to the interior of the cylindrical enclosure 27 and the cubicle 14 may be had through a suitable door 29. In addition, a door 53 in the roof 31 of enclosure portion 30 allows new electrode sections to be added when needed.

The interior of each of the interconnected enclosure portions 27 and 30 are connected to a source 51 of pressurized and conditioned atmosphere by a conduit 52 opening into the roof of the cylindrical enclosure 27 so that maintenance work may be performed during furnace operation. In addition, the pressurized and conditioned atmosphere surrounds the upper ends of the electrodes 33 above the holders 37 so that as the lower end of the electrodes are worn away and otherwise consumed during the furnace melting operation necessitating the elevating of the electrode holders 37 on the electrodes 33, the surfaces of said electrodes will not be coated with highly resistive oxide dust. Further, if the electrodes 33 are of the self-baking type, the additional electrode shell portions and paste material can be added within the enclosure portion 30 which eliminates the necessity for a large area above the furnace as required in prior art apparatus wherein these shell portions and paste could only be added a substantial distance above the furnace as a result of the high furnace temperature.

As seen in FIG. 1, the platform 26 is affixed to an enlarged ring 54 having a central hub 55 which is affixed to a vertical bearing post 57 rotatably mounted in the foundation structure 58. Also affixed to the hub 55 of the ring 54 is a ring gear 60 which engages a pinion 62 carried on the output shaft of a motor 63. The ring 54 rests atop a plurality of rollers 65 disposed in circular array on an annular portion 66 of the foundation. It can thus be seen that when the mottor 63 is energized the platform 26 along with the enclosure portions 27 and 30 and the furnace roof 16 may be swung so that the roof 16 and the electrodes 33 are moved from a position above the furnace shell 10 to a position above the funace shell 11. In order to prevent undue stress on the enclosure 27 as a result of the weight of the cubicle 14 and the electrode suspension assembly 12 disposed therein, a bearing pin 67 is affixed to the roof of the cubicle 27 in alignment with the bearing post 57 for pivotally engaging a frame assembly 68 which extends upwardly from the floor 26 and the foundation 58 and over the upper end of the enclosure 27.

The arm 18, from which the second furnace roof 17 is suspended, includes a burner 70 which extends through the roof 17 into the interior of the furnace shell 11. The burner 70 is connected through the arm 17 to a suitable source of fuel such as, a mixture of oxygen and natural gas, so that the charge in the furnace 11 may be preheated. In addition, the roof 17 is slightly deeper than the cover 16 to permit expansion of the combustible gases.

As seen in FIGS. 2 and 3, the arm 18 is affixed to a hydraulic cylinder 72 so that the furnace roof 70 may be raised and lowered into and out of engagement with the furnace shells 10 and 11. In addition, the hydraulic cylinder 72 rests upon a base 74 carried by a vertical bearing post 75 which is suitably mounted for rotation in the foundation 58. In addition, the base 74 has a ring gear 76 suitably affixed thereto and which is engaged by the pinion 77 of a reversible motor 78.

While the charge in the first furnace shell 10 is being melted, the roof 17 will be positioned away from the second furnace shell 11. When the roof 17 is in this position, the lining 22 of the second furnace shell 11 will be inspected and repaired where necessary. A full molten capacity furnace cold scrap charge will then be placed in the second shell 11 whereupon the motor 78 is operated so as to swing the roof 17 to position over the shell 11. The hydraulic cylinders 72 are then operated to lower the roof 17 into its position shown in FIG. 1. The gas burner 70 is then fired to preheat the charge within the furnace 11 to the desired preheat temperature, which may be, for example, 1,650° F.

When the final electric furnace melting and refining operation within the first furnace shell 10 is completed, the electrodes 33 are raised by their respective motors 34 so that they clear the furnace roof and shell 10. The tilting mechanism 25 may then be operated to pour the contents of the shell 10 into the ladle 23. The hydraulic cylinders 45 are then actuated to raise the furnace cover 16 to a position clear of the shell 10 and the motor 64 is then operated in a direction which swings the cubicle 14 and the furnace cover 16 horizontally away from the furnace shell 10.

Upon completion of the tapping of the molten heat from the first furnace shell 10, the burner 70 is turned off and the hydraulic cylinder 72 is actuated to raise the cover 17 away from the furnace shell 11. The motor 78 is then operated to swing the arm 18 horizontally away from the furnace shell 11 so that the hydraulic cylinder 72 may then be actuated to lower the arm 18 whereby it may pass beneath the cover 16 suspended below the enclosure portion 30. The cover 17 is then swung to a position adjacent the furnace shell 10 while the enclosure portion 30 and the cover 16 are swung to a position above furnace shell 11. The cover 16 is then lowered into position atop the shell 11 whereupon the electrodes 33 are lowered and melting of the preheated furnace charge within the cubicle 11 may then begin. After inspection of and repair of the lining 22 of the furnace shell 10, the charging and preheating thereof will be repeated.

It can be seen from the foregoing description that the electric furnace assembly according to the instant invention allows substantially continuous utilization of the transformer 28 and the electrode suspension assembly 12.

In addition, more rapid and efficient operation is possible because the furnace charge is preheated in the same furnace shell that it is finally fluidized and refined. Also, the enclosure **14** allows maintenance to proceed while the furnace is in operation. Further, the enclosure **14** prevents the collection of resistive oxides on the electrodes **33** above the clamps **37** and allows the use of self-baking electrodes in a relatively confined space.

While only a single embodiment of the invention has been shown and described, it is not intended to be limited thereby, but only by the scope of the appended claims.

I claim:

1. In an electric arc furnace the combination of first and second spaced apart furnace bodies, a sealed enclosure mounted for rotation about a first vertical axis disposed equidistantly from each of said furnace bodies, a plurality of electrodes extending downwardly through said enclosure, electrode positioning means disposed within said enclosure and including an electrode clamp engageable with each of said electrodes and means for raising and lowering said electrode clamps relative to said enclosure, transformer means disposed within said enclosure and being electrically connected to said electrodes for providing energizing current thereto, a first furnace cover, means for suspending said first furnace cover below said enclosure and for moving said first cover vertically, said electrodes extending through said first furnace cover, a second furnace cover, heater means disposed in said second furnace cover, and means for moving said second furnace cover vertically and for swinging said second furnace cover horizontally about a second vertical axis equally spaced from each of said furnace bodies and spaced from said first vertical axis so that each of said first and second furnace covers may be alternately swung from positions above one of said furnace bodies to a position above the other of said furnace bodies and subsequently lowered into position on said furnace bodies.

2. The combination set forth in claim **1** wherein said electrodes are of the self-baking type and including means for pressurizing and conditioning the atmosphere within said enclosure.

3. In an electric arc furnace the combination of first and second spaced apart furnace bodies, a sealed enclosure mounted for rotation about a first vertical axis disposed equidistantly from each of said furnace bodies, a plurality of electrodes extending through the lower end of said enclosure, electrode positioning means including an electrode clamp disposed within said enclosure for raising and lowering said electrodes relative to said enclosure, polyphase electrical energizing means disposed within said enclosure and being connected to said electrodes for providing energizing current thereto, a first furnace cover having a plurality of electrode receiving apertures formed therein, means mounted on said enclosure for moving said first furnace cover vertically relative to said enclosure, said electrodes extending through the apertures in said first furnace cover, a second furnace cover, gas burner means disposed in said second furnace cover, and means for moving said second furnace cover vertically and for swinging said second furnace cover horizontally about a second vertical axis equally spaced from each of said furnace bodies and spaced from said first vertical axis so that each of said first and second furnace covers may be alternately swung from positions above one of said furnace bodies to a position above the other of said furnace bodies.

4. In an electric arc furnace the combination of first and second spaced apart furnace bodies, a sealed enclosure mounted for rotation about a first vertical axis disposed equidistantly from each of said furnace bodies, means for pressurizing and conditioning the atmosphere in said enclosure, a plurality of electrodes extending vertically through said enclosure, electrode positioning means including an electrode clamp for each electrode and being disposed within said enclosure means for raising and lowering said electrodes relative to said enclosure, polyphase electrical energizing means including a transformer disposed within said enclosure and being connected to said electrode clamps for providing energizing current to said electrodes, a first furnace cover having a plurality of electrode receiving apertures formed therein, means mounted on said enclosure for supporting said first furnace cover and for moving the same vertically relative to said enclosure, said electrode positioning means being operative to raise and lower said electrodes through the apertures in said first furnace cover, a second furnace cover, heater means disposed in said second furnace cover, and means for moving said second furnace cover vertically and for swinging said second furnace cover about a second vertical axis equally spaced from each of said furnace bodies and spaced from said first vertical axis so that each of said first and second furnace covers may be alternately swung from positions above one of said furnace bodies to a position above the other of said furnace bodies.

5. In an electric arc furnace the combination of first and second spaced apart substantially identical furnace bodies, a sealed enclosure mounted for rotation about a first vertical axis disposed equidistantly from each of said furnace bodies and having a portion extending radially outward from said axis a distance sufficient to extend over said furnace bodies, a plurality of electrodes extending through the lower end of said enclosure portion, electrode positioning means disposed within said enclosure for raising and lowering said electrodes relative to said enclosure, transformer means disposed within said enclosure and being electrically connected to said electrodes for providing energizing current thereto, a first furnace cover having a plurality of electrode receiving apertures formed therein, means for suspending said first furnace cover below said enclosure portion and for moving said cover vertically, said electrode positioning means being operable to raise and lower said electrodes through the electrode receiving apertures in said first furnace cover, support means pivotally mounted about a second vertical axis equally spaced from each of said furnace bodies and spaced from said first vertical axis, a second furnace cover mounted on said support means and spaced from said second vertical axis and said furnace bodies so that each of said first and second furnace covers may be alternately swung from positions above one of said furnace bodies to a position above the other of said furnace bodies, means for raising and lowering said second furnace cover relative to said furnace bodies, and gas burner means disposed in said second furnace cover.

6. In an electric arc furnace the combination of first and second spaced apart substantially identical furnace bodies, a sealed enclosure having a first enclosure portion, means for rotating said first enclosure portion about a first vertical axis disposed equidistantly from each of said furnace bodies, a second enclosure portion mounted adjacent one side of said first enclosure portion and extending radially outward therefrom a distance sufficient to extend over said furnace bodies, a plurality of electrodes extending through the lower end of said second enclosure portion, electrode positioning means disposed within said second enclosure portion and including an electrode clamp engageable with each of said electrodes and means for raising and lowering said electrode clamps relative to said second enclosure portion, transformer means disposed within said first enclosure portion, electrical conductor means extending between said enclosure portions for connecting said transformer means to said electrodes, a first furnace cover having a plurality of electrode receiving apertures formed therein, means for suspending said first furnace cover below said second enclosure portion and for moving said cover vertically, said electrode positioning means being operable to raise and lower said electrodes through the electrode receiving apertures in said first furnace cover, horizontally extending arm means pivotally mounted about a second vertical axis

equally spaced from each of said furnace bodies and spaced from said first vertical axis, a second furnace cover mounted on said arm means and spaced from said second vertical axis a distance equal to that between said second vertical axis and said furnace bodies so that each of said first and second furnace covers may be alternately swung from positions above one of said furnace bodies to a position above the other of said furnace bodies, means for raising and lowering said second furnace cover relative to said furnace bodies, and gas burner means extending through said second furnace cover.

7. In an electric arc furnace the combination of first and second spaced apart substantially identical furnace bodies, a sealed enclosure having a first enclosure portion, first means for rotating said first enclosure portion about a first vertical axis disposed equidistantly from each of said furnace bodies, a second enclosure portion mounted adjacent one side of said first enclosure portion and extending radially outward therefrom a distance equal to that from said first enclosure portion to said furnace bodies, means for pressurizing and conditioning the atmosphere in said sealed enclosure, a plurality of electrodes extending through the lower end of said second enclosure portion, electrode positioning means including an electrode clamp disposed within said second enclosure portion and engageable with said electrodes and means for raising and lowering said electrode clamps relative to said second enclosure portion, transformer means disposed within said first enclosure portion and being electrically connected to said electrodes for providing energizing current thereto, a first furnace cover having a plurality of electrode receiving apertures formed therein, means for suspending said first furnace cover below said second enclosure portion and for moving said cover vertically, said electrode positioning means being operable to raise and lower said electrodes through the electrode receiving apertures in said first furnace cover, horizontally extending arm means pivotally mounted about a second vertical axis equally spaced from each of said furnace bodies and spaced from said first vertical axis, a second furnace cover mounted on said arm means and spaced from said second vertical axis a distance equal to that between said second vertical axis and said furnace bodies, second means for pivoting said arm means about said second vertical axis so that each of said first and second furnace covers may be alternately swung from positions above one of said furnace bodies to a position above the other of said furnace bodies, means for raising and lowering said second furnace cover relative to said furnace bodies, and gas burner means extending through said second furnace cover.

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