MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A
CONVENTION APPLICATION FOR STANDARD PATENT OR A STANDARD PATENT OF ADDITION

Applicant(s): DR. C. OTTO & COMP. GmbH

of Christstrasse 9, 4630 Bochum 1, Germany

hereby apply for the grant of a standard patent for an invention entitled

"METHOD OF CONTROLLING THE RICH GAS HEATING OF COKE OVENS"

which is described in the accompanying complete specification.

DETAILED DESCRIPTION OF THE INVENTION

Title of Invention:

"METHOD OF CONTROLLING THE RICH GAS HEATING OF COKE OVENS"

Location of Measurement:

Address for service:

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Dated this SECOND day of OCTOBER 1981

DR. C. OTTO & COMP. GmbH

By: Registered Patent Attorney
In support of the Convention Application made for a patent for an invention entitled:

"METHOD OF CONTROLLING THE RICH GAS HEATING OF COKE OVENS"

Folkard Wackerbarth and Hans Bahnisch both of Dr. C. Otto & Comp. GmbH,
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do solemnly and sincerely declare as follows:

1. We are the applicant(s) for the patent
   (or, in the case of an application by a body corporate)

2. We are authorised by DR. C. OTTO & COMP. GmbH

3. We are the actual inventor(s) of the invention referred to in the basic application(s)
   (or where a person other than the inventor is the applicant)

4. Carl-Heinz Struck,
   Am Hohwege 32, 4630 Bochum, Germany and Ralf Schumacher,
   Am Lilienbaum 29, 5800 Hagen, Germany

   are the actual inventor(s) of the invention and the facts upon
   which the applicant(s) is/are entitled to make the application are
   as follows:

   The said applicant is the assignee of the actual inventors

5. The basic application(s) referred to in paragraph 2 of this Declaration was/were the first application(s) made in a Convention country in respect of the invention the subject of the application.

Declared at Bochum this 14th day of July 1981

Dr. C. Otto & Comp.

Folkard Wackerbarth and Hans Bahnisch

but at tolerable expenditure, with particular emphasis on improving the vertical temperature distribution in the heating bricks, such tube is
1. A method of controlling flame length and optimizing vertical temperature distribution in rich-gas-heated heating flues of coke ovens, the rich gas being supplied to the heating flues through lines which extend from the sole flue roof of the oven battery through a respective mid-feather thereabove and terminate in a burner head disposed in the bottom part of the heating flue, while the combustion-supporting air heated in the regenerators enters the heating flue through apertures at the flue base, and wherein a blower forces a controllable proportion of the combustion-supporting air needed for combustion of the fuel gas through an annular duct which extends around the burner port to enter into one of the discrete heating flues very near the burner port.
Complete Specification for the invention entitled:

"IMPROVEMENTS RELATING TO METHODS AND APPARATUS FOR AUTOMATIC OR CONTROLLING THE RICH GAS HEATING OF COKE OVENS"

The following statement is a full description of this invention, including the best method of performing it:...
Rich gas heated heating flues of coke ovens, the rich gas being supplied to the heating flues through lines which extend from the nozzle cellar of the oven battery through the respective mid-feather thereabove and terminate in a burner head disposed in the bottom part of the heating flue, while the combustion-supporting air heated in the regenerators enters the heating flue through apertures at the flue base.

Optimum control of heating is beset by problems because of the trend in coke oven construction towards large ovens with chamber heights of up to 8 metres and towards short coking times and because of the statutory limits which the environmental protection agencies of some countries place on NOX constituents in the combustion waste gases. This applies more particularly to the rich gas heating of coke ovens since, as oven height increases, it becomes more and more difficult to adjust the heating so that the vertical temperature distribution in the heating flues is optimal. Also, when coking times are short, the corresponding heating flue temperatures increase the evolution of NOX, the proportion of which in the waste gases of combustion is being restricted continually in more and more countries by environmental protection agencies. It has also proved a very elaborate business so far to obviate the formation of graphite at the burner ports in rich gas heating.

It is an object of the invention to provide simpler solutions of these problems than has previously been the case,
but at tolerable expenditure, with particular emphasis on improving the vertical temperature distribution in the heating flues, so as to reduce the NOx content in the combustion waste gases and minimise graphite formation at the burner heads.

Accordingly, this invention provides a method of controlling flame length and optimizing vertical temperature distribution in rich-gas-heated heating flues of coke ovens, the rich gas being supplied to the heating flues through lines which extend from the sole flue roof of the oven battery through a respective mid-feather thereabove and terminate in a burner head disposed in the bottom part of the heating flue, while the combustion-supporting air heated in the regenerators enters the heating flue through apertures at the flue base, and wherein a blower forces a controllable proportion of the combustion-supporting air needed for combustion of the fuel gas through an annular duct which extends around the burner port to enter into one of the discrete heating flues very near the burner port.

In the preferred embodiment the forced-flow proportion of combustion-supporting air per heating flue is less than 30% by volume, preferably from 5 to 15% by volume, of the total quantity of combustion-supporting air. Cold combustion waste gases may be supplied together with the forced-flow air; in this event the ratio of forced-flow air to combustion waste gases desirably is at most 1 : 2, preferably from 2 : 1 to 1 : 1.

The invention also relates to an apparatus for performing the method of the invention as hereinbefore defined, wherein the feed line to each of the heating flues for rich gas and forced-flow air is a double-walled tube devised from ring
bricks, such tube extending from the solf flue roof through the mid-feather to terminate in a burner port constructed as a double-walled burner and disposed in the bottom part of the heating flue, the inner bore being connected to a rich gas supply line while an outer annular duct opening in the base of the heating flue around and very near the burner port is connected to a feed line for forced-flow air and, where applicable, for combustion waste gas heated in the regenerators.

The quantities of air entering the discrete heating flues are of course never exactly the same as in the conventional form of air distribution and there is a spread of quantities for various reasons. To obviate this disadvantage most of the combustion-supporting air can be introduced conventionally, in the form of combustion-supporting air heated in the regenerators, through apertures at the heating flue base, but in a total amount such that the heating flues which are most disadvantaged in this distribution would suffer a slight shortage of air and in the absence of any further action would burn with a slightly sooty flame. These heating flues would be supplied with an extra proportion of forced-flow air, whereas less of such air would be supplied to the other heating flues which have an increasing oxygen proportion in the combustion waste gas. Consequently, the total excess of air can be so reduced that the oxygen constituent of the combustion waste gas can be kept down to less than 3%. The quantity of waste gas therefore decreases, and so therefore does the need for fuel firing. Also, the reduced excess of oxygen reduces the formation of NOx. NOx formation is reduced even more by the lower-than-usual entry temperature of the combustion-supporting gas, which flows through the less hot inner tube of the
double-walled tubular burner to enter the heating flue. The initially slower mixing of the combustion-supporting gas with atmospheric oxygen, can be achieved by providing a substantially uniform exit speed of the forced-flow of air which extends like a ring around the existing stream of rich gas by providing that the ratio of the cross-sectional area of the forced-air duct to the cross-sectional area of the inner duct for the combustion-supporting gas is such that the exit speed of the two media will be very similar at an average input of forced air. This slows down the rate of combustion, so that the local flame temperature decreases and NO$_x$-formation is further inhibited. The rich gas flame in the heating flues is lengthened by the method in accordance with this invention, resulting in improved temperature distribution, more particularly when cold flue gas is admixed with the forced-flow air.

It also becomes possible to reduce considerably the formation of graphite at the burner port, since the same is cooler at the orifices of the combustion-supporting gas than is conventionally the case and since this zone is scavenged continuously by forced-flow air and, where applicable, relatively cool combustion waste gas.

The extra flue firing called for as a result of the forced-flow air being less preheated than usual (so that the combustion-supporting gas enters at a lower temperature than usual) is at most 4%. The power consumption for the air blower is less than 0.1% referred to the fuel firing requirements. When it is considered that a 1% reduction of the oxygen content of the waste gas decreases fuel firing consumption by more than 5%, the practice of the method in accordance with this invention also provides an energy gain.
The invention may be performed in various ways and a preferred embodiment thereof will now be described with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic cross-section through a mid-feather with some of the heating flue thereabove and with a double-walled burner extending through the mid-feather;

Figure 2 is a section on the line A-A of Figure 1;

Figure 3 is a section on the line B-B of Figure 1;

Figure 4 is a section on the line C-C of Figure 1;

Figure 5 is a section on the line D-D of Figure 1; and

Figure 6 is a diagram showing the forced air distribution system for the flues.

Figure 1 is a diagrammatic section through a mid-feather 1 with a heating flue 2 disposed thereabove, and a rich-gas burner 3 extending into the bottom part of flue 2. The burner tube 3 is a double-walled tube and extends from a sole flue roof 4, through mid-feather 1 and a heating-flue base 5 into the heating flue 2. As shown in Figure 2, the double-walled burner is constructed from outer or jacket bricks 6 formed with a central cylindrical bore 7 and a substantially annular brick 8 which is received in the bore 7 and whose outer diameter is smaller than the diameter of bore 7.

Figures 2 to 4 show how the construction of the double-walled burner 3 varies at different heights. In the burner part which extends into the heating flue (Figure 2), namely the top four rows in the case of of the embodiment shown, the inner brick 8 takes the form of a simple hollow cylinder whose outer wall, together with the wall of the brick 6 bounding the bore 7, defines an annular duct, passage or the like 9.

In the inner brick 8 of the layers further down the burner tube
have three lands 10 (Figure 3) which extend radially as far as the wall of the bore in the outer brick 6 and engage therewith to leave three symmetrically arranged ducts 11. In the bottom four or five rows of bricks adjacent the roof 4, the lands 10 have lugs 12 (Figure 4) which improve stability and which engage in notches in the outer bricks 6.

Rich gas is supplied in known manner to a central passageway 13 in the inner brick 8 by way of individual feed lines 14 (Figure 1) which branch off a main (not shown) where they pass through the roof 4 each line 14 has a support collar 15 serving to support the bottom inner brick 8 of each burner. Below the collar 15 an annular feed chamber 16 extends around the line 14. This chamber 16 serves to supply the forced-flow air and communicates with the passages or ducts 11.

As can be seen in Figure 5, each chamber 16 has a tangential spigot 17 which communicates, by way of control valve 18 and an individual feed line 19, with a forced-air main 20.

As Figure 1 shows, the individual outer bricks used for the double-walled burner 6 are vertically staggered in relation to the individual inner bricks. Preferably, the bricks are made of a refractory material. Each row of bricks has a tongued and grooved connection to the row below.

Figure 6 is a diagrammatic view of the distribution system for the forced-air quantity control and control of the ratio of air to waste gas used for fuel firing, such gas being introduced as required together with the forced-flow air; the example taken is that of twin flue heating. The drawing shows five heating walls having twin flues; even and odd numbers are used to denote the burner in each half of
the twin flue. In the heating scheme shown, either the even-numbered burners or the odd-numbered burners of all the heating walls are supplied during a changeover period. Alternatively, an alternate arrangement using even-numbered burners in one heating wall and odd-numbered burners in the next can be used.

The mains 20a, 20b are divided into two separate networks, one supplying the odd-numbered burners and the other the even-numbered burners. By means of changeover valves 21a, 21b the supply of forced-air can be changed over synchronously and at the cadence of heating. The forced air, possibly together with waste gas for fuel firing, is forced from a line 23 into the mains 20a, 20b by means of a blower 22. The waste gases go through a line 24 to a stack 25; a proportion can be diverted as required through a line 26. Proportional control is provided by valves 27 and quantity control in dependence upon the oxygen content of the waste gases is provided by a bypass control comprising a valve 28 disposed in a bypass 29.
The claims:
1. A method of vertical tempering flues of coke oven battery where the flues through the oven battery terminate in a heating flue, with the regenerator at the flue base proportion of the combustion of the flue gases very near 2. A method of proportion of combustion wastage of less than 30% of the total quantity of air used.
5. A method herein described for.
6. An apparatus any one of claims used for heating flues for walled tube dev.
The claims defining the invention are as follows:

1. A method of controlling flame length and optimizing vertical temperature distribution in rich-gas-heated heating flues of coke ovens, the rich gas being supplied to the heating flues through lines which extend from the sole flue roof of the oven battery through a respective mid-feather thereabove and terminate in a burner head disposed in the bottom part of the heating flue, while the combustion-supporting air heated in the regenerators enters the heating flue through apertures at the flue base, and wherein a blower forces a controllable proportion of the combustion-supporting air needed for combustion of the fuel gas through an annular duct which extends around the burner port to enter into one of the discrete heating flues very near the burner port.

2. A method according to claim 1, wherein the forced-flow proportion of combustion-supporting air per heating flue is less than 30% by volume, preferably from 5 to 15% by volume, of the total quantity of combustion-supporting air.

3. A method according to claim 1 or claim 2, wherein cold combustion waste gases are supplied together with the forced-flow air.

4. A method according to claim 3 wherein the ratio of forced-flow air to combustion waste gases is at most 1:2, preferably from 2:1 to 1:1.

5. A method according to claim 1 and substantially as herein described.

6. An apparatus for performing the method according to any one of claims 1 to 5, wherein the feed line to each of the heating flues for rich gas and forced-flow air is a double-walled tube devised from ring bricks, such tube extending from the sole flue roof to the burner port disposed in the flue bore being connected to the annular duct opening and very near the force-flow air at gas heated in the regenerators.

7. An apparatus for performing the method according to claim 6, wherein each individual brick above another and central bore and latter bore as to inner wall and the

8. An apparatus for performing the method according to claim 6, wherein the annular duct is disposed on the inner brick of the inner wall and the

9. An apparatus for performing the method according to claim 6, wherein the inner bricks preferably three, contact the outer between the lands

10. An apparatus for performing the method according to claim 6, wherein any one of claims 1 to 5, wherein the feed line to each of the heating flues for rich gas and forced-flow air is a double-walled tube devised from ring bricks, such tube extending from.
the sole flue roof through the mid-feather to terminate in a burner port constructed as a double-walled burner and disposed in the bottom part of the heating flue, the inner bore being connected to a rich gas supply line while an outer annular duct opening in the base of the heating flue around and very near the burner port is connected to a feed line for force-flow air and, where applicable, for combustion waste gas heated in the regenerators.

7. An apparatus according to claim 6, wherein the inner bore and the outer duct of the burner are defined by individual bricks forming an outer jacket and disposed one above another and each formed with a substantially circular central bore and by inner annular bricks so disposed in the latter bore as to leave open passages between the outer brick inner wall and the inner brick outer wall.

8. An apparatus according to claim 7, wherein at the burner port, preferably in the zone where the burner extends into the heating flue, the inner bricks are tubular and an annular duct is defined between the outer brick inner wall and the inner brick outer wall.

9. An apparatus according to claim 7 or claim 8, wherein the inner bricks have, near the mid-feather, a number, preferably three, of symmetrically arranged lands which contact the outer brick inner wall, flow passages being left between the lands.

10. An apparatus according to claim 9, wherein the lands of the lower inner bricks, preferably of the four or five bottom rows thereof nearest to the sole flue roof, have lugs for engagement in notches in the outer bricks.
11. An apparatus according to any one of claims 7 to 10, wherein the discrete outer bricks are vertically staggered in relation to the inner bricks.

12. An apparatus according to any one of claims 6 to 11, wherein the ratio of the cross-sectional area of the forced-air duct to the cross-sectional area of the inner duct for the combustion supporting gas is such that the exit speeds of the two media will be very similar at an average input of forced air.

13. An apparatus according to any one of claims 6 to 12, wherein the individual rich-gas feed line has near the sole flue roof, a support collar serving to support the bottom inner brick and has below such collar an annular input chamber for the supply of the forced air and, where applicable, of the combustion waste gas, such chamber communicating with the annular duct.

14. An apparatus according to claim 13, wherein the annular chamber has a tangential connection spigot which communicates with the main for forced air and, where applicable, combustion waste gases.

15. An apparatus according to claim 14, wherein a diaphragm or a control valve is disposed between the spigot and the main to control the quantity of gas supplied to the corresponding burner.

16. An apparatus according to any one of claims 6 to 15, wherein the system for the distribution and feeding of the forced air, with or without admixed combustion waste gases, proceeds below the oven roof in the nozzle basement by way of a mains and individual feed lines which branch therefrom and extend to the double-walled tubes.
17. An apparatus according to claim 16, wherein the mains is divided into two separate networks, one of which is connected to the odd-numbered burners and the other of which is connected to the even-numbered burners such that changeover will proceed synchronously at the heating cadence through the agency of two changeover valves in the networks.

18. An apparatus according to any one of claims 6 to 17, wherein a proportioning facility is disposed before the forced-air blower to control the proportion of air to combustion waste, while the quantity of forced air, with or without admixed combustion waste gases, is controlled through the agency of a bypass and valve.

19. An apparatus for supplying gases to the burners of flues in a coke oven, substantially as herein described with reference to the accompanying drawings.

DATED this TWENTYNINTH day of FEBRUARY 1984

DR. C. OTTO & COMP. GmbH

Patent Attorneys for the Applicant
SPRUSON & FERGUSON
Fig. 3

B-B
gas, which flows through the less hot inner tube of the
Fig. 5

D-D

14
16
17
18
19
20
In the inner brick 8 of the layers further down the burner tube.