

[54] APPARATUS FOR AND METHOD OF  
COLLECTING SMOKE FROM COKE  
OVENS DURING CHARGING

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214/18 PH, 214/35 R  
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[58] Field of Search ....202/262, 263; 214/18 PH, 35,  
214/35 R, 18; 201/1, 41, 40

[56] References Cited

UNITED STATES PATENTS

2,646,395	7/1953	Padgett.....	202/263
3,435,596	4/1969	Horning.....	214/18 PH
1,798,517	3/1931	Becker.....	202/263
1,376,314	4/1921	Becker.....	202/263
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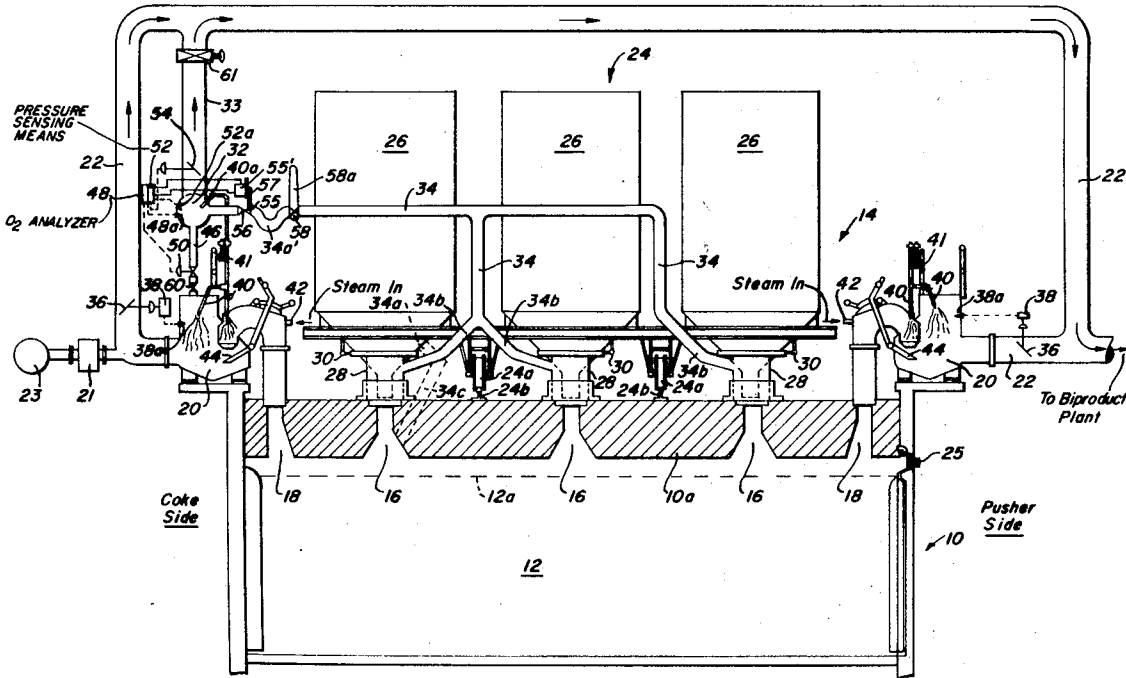
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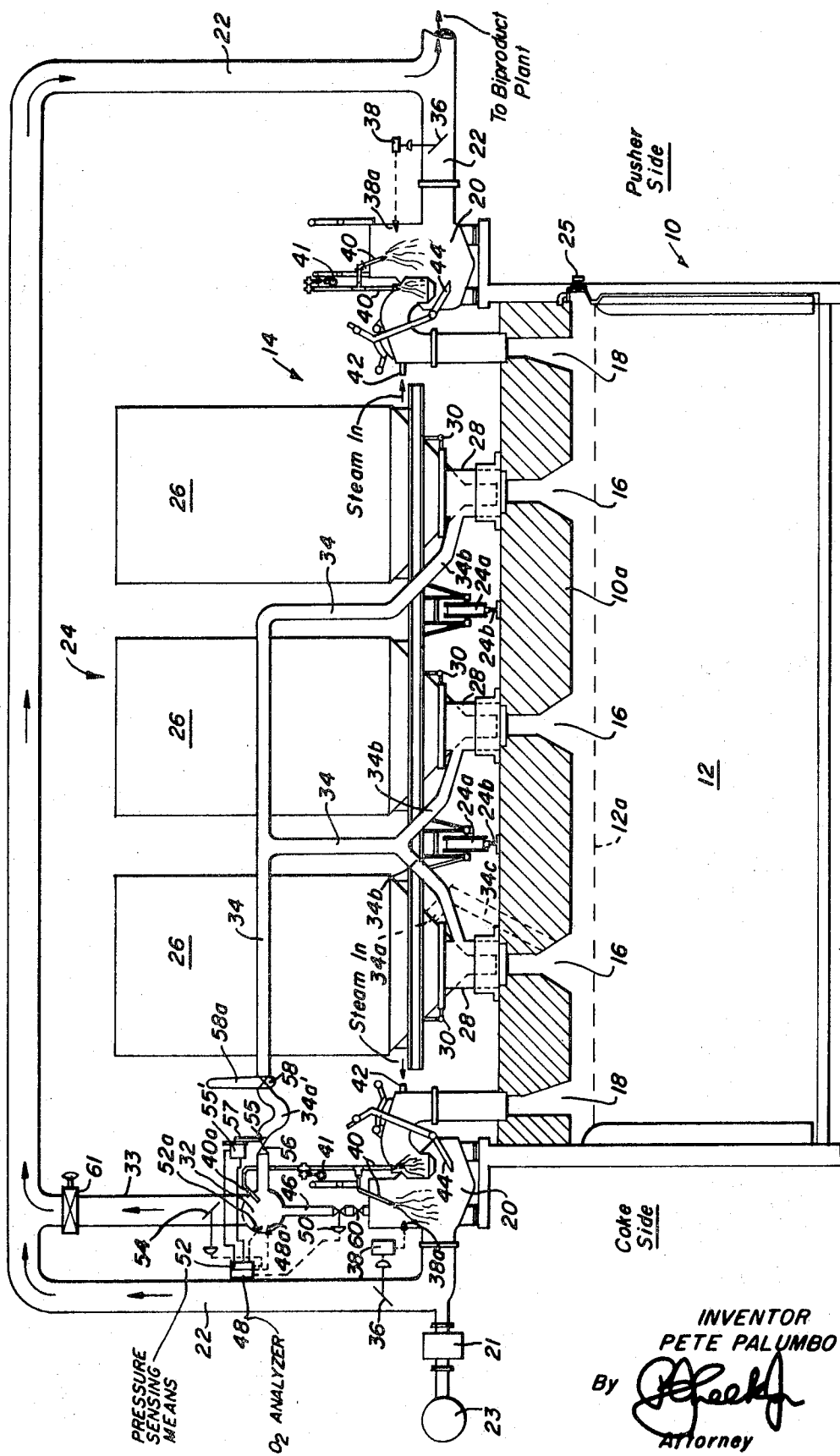
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[57] ABSTRACT

An apparatus for and method of smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of the oven is disclosed. The oven of the apparatus is provided with a charging aperture for receiving the coal and with an exhaust aperture for any gases evolved in the oven. The oven has a collector main connected to the exhaust aperture and an exhaust means connected to the collector main for removing gases from the oven. A Larry car is movable on the oven and has hopper means adapted to contain the coal. The hopper means has discharge means movable into registry with and into sealing engagement with the charging aperture. Gate means are on the hopper means for controlling the flow of the coal through the discharge means and through the charging aperture into the oven. A charging gas collecting main is on the oven in communication with the exhaust means. A conduit means on the Larry car communicates with one of the discharge means, the hopper means, and the charging aperture and is connectable to the charging gas collector main. The exhaust means is operable (when the coal engages the oven and substantial quantities of charging gas and displaced oven gas are evolved) to simultaneously exhaust the charging gas and the oven gas through the exhaust aperture and the charging aperture. The conduit means is operable when connected to the one and to the charging gas collector main to prevent the escape of the charging gas and the oven gas through the hopper means and the discharge means to the atmosphere.

34 Claims, 1 Drawing Figure





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## APPARATUS FOR AND METHOD OF COLLECTING SMOKE FROM COKE OVENS DURING CHARGING

The method includes the steps of moving the discharge means into registry with and into sealing engagement with the charging aperture; controlling the flow of the coal through the discharge means and through the charging aperture into the oven; and exhausting the substantial quantities of charging gas, (developed by engagement of the coal with the oven) and displaced oven gas simultaneously through the exhaust aperture of the oven to a collector main of the oven and through the charging aperture and the conduit means (connected to one of the charging aperture, the hopper means and the discharge means) to prevent escape of the charging gas and the oven gas through the hopper means and the discharge means to the atmosphere.

### BACKGROUND OF THE INVENTION

I am aware of the conventional charging header systems shown in the following patents:

U.S. Pat. No.	Inventor	Issued
1,376,313	Becker	Apr. 26, 1921
1,798,517	Becker	Mar. 31, 1931

Heretofore, in charging a heated coking oven at about 2,100° F. with coal at ambient temperature, the coal is dropped into the hot oven and into contact with the heated walls of such oven so that charging gas and displaced oven gas are evolved at a very high rate. During this high evolution of charging gas and displaced oven gas, the fluid pressure within the oven exceeds the volumetric capabilities of the exhaust aperture in the oven and, as a result, the high-pressure charging gas and oven gas will escape through the hopper of the larry car and through the discharge means or dropsleeves of the hopper, which dropsleeves are in registry with and sealed to the charging apertures of the oven. This escape of the deleterious charging gas and oven gas to the atmosphere creates a serious air pollution problem which is deleterious to the personnel surrounding the coke oven.

### OBJECTS OF THE INVENTION

It is the general object of this invention to avoid and overcome the foregoing and other difficulties of and objections to prior art practices by the provision of an improved apparatus for and method of the smokeless charging of a heated coke oven with coal, the apparatus and method:

- prevent the escape of charging gas and oven gas through the hopper of the larry car and the dropsleeves on the hopper to the atmosphere;
- substantially eliminate pollution of the atmosphere during the charging of a coke oven with coal at a lower temperature than the temperature of the oven;
- prevent the overloading of the exhaust aperture of the oven with evolved charging gas and displaced oven gas during the charging operation;
- prevent the formation of explosive mixtures of the charging gas and displaced oven gas in the improved apparatus;
- maintain a pressure differential between a collector main of the oven associated with the exhaust aperture of the oven and a charging gas collector main so that the main flow of the charging gas and the oven gas is through the conduit means and the charging gas collector main; and
- provide and maintain a first predetermined holding pressure in the charging gas collector main during the coking of the coal in the oven and a second predetermined lower pressure in the charging case collector main during the charging operation.

## BRIEF SUMMARY OF THE INVENTION

The aforesaid objects of this invention, and other objects which will become apparent as the description proceeds, are achieved by providing an improved apparatus for larry method of smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of the oven. The oven of the apparatus is provided with a charging aperture for receiving the coal and with an exhaust aperture for the removal of any gases evolved in the oven. The oven has a collector main connected to the exhaust aperture and an exhaust means connected to the collector main for removing gases from the oven. A larry car is movable on the oven and has hopper means adapted to contain the coal. The hopper means has discharge means movable into registry with and into sealing engagement with the charging aperture. Gate means are on the hopper means for controlling the flow of the coal through the discharge means and through the charging aperture into the oven. A charging gas collecting main is on the oven in communication with the exhaust means. A conduit means on the larry car communicates with one of the discharge means, the hopper means, and the charging aperture and is connectable to the charging gas collector main. The exhaust means is operable (when the coal engages the oven and substantial quantities of charging gas and displaced oven gas are evolved,) to simultaneously exhaust the charging gas and the oven gas through the exhaust aperture and the charging aperture. The conduit means is operable when connected to the one and to the charging gas collector main to prevent the escape of the charging gas and the oven gas through the hopper means and the discharge means to the atmosphere.

The method includes the steps of moving the discharge means into registry with and into sealing engagement with the charging aperture, controlling the flow of the coal through the discharge means and through the charging aperture into the oven, and exhausting the substantial quantities of charging gas (developed by engagement of the coal with the oven) and displaced oven gas simultaneously through the exhaust aperture of the oven to a collector main of the oven and through the charging aperture and the conduit means (connected to one of the charging aperture, the hopper means and the discharge means) to prevent escape of the charging gas and the oven gas through the hopper means and the discharge means to the atmosphere.

### BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of this invention, reference should be had to the accompanying drawing wherein like numerals of reference indicate similar parts throughout the single view and wherein the sole figure is a fragmentary side elevational view, partially in section, of the improved apparatus for the smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of the oven.

Although the principles of the invention are broadly applicable to the smokeless charging of ovens in general with a material at a lower temperature than the temperature of the oven, this invention is particularly adapted for use in conjunction with coking ovens and hence it has been so illustrated and will be so described.

### DETAILED DESCRIPTION

With specific reference to the form of this invention illustrated in the drawing and referring particularly to the single FIGURE shown therein, an apparatus for the smokeless charging of a heated coke oven 10 with coal 12 (having a loaded coal level line 12a) at a lower temperature (i.e., ambient temperature, about 70° F.) than the temperature of the oven 10 (i.e., about 2,100° F.) is indicated by the reference numeral 14.

The oven 10 is provided with charging apertures 16 for receiving the coal 12 and with exhaust apertures or exhaust

pipes 18 for removal of gases evolved in and displaced from the oven 10. The oven 10 has collector mains 20 connected to the exhaust apertures 18 and an exhaust means, such as the exhaust main 22, connected to the collector main 20 for removing the gases from the oven 10. The left-hand collector main 20 is connected to a pitch trap 21 and a flushing liquor return main 23. A coal leveler door 25 is provided in the oven 10 adjacent the right-hand exhaust aperture 18.

A larry car 24 is movable by means of wheels 24a on tracks 24b mounted on the battery top 10a of the oven 10. The larry car 24 has hopper means, such as the hoppers 26, adapted to contain the coal 12. The hoppers 26 each have a discharge means, such as an dropsleeves 28, which dropsleeves 28 are movable into registry with and into sealing engagement with an associated charging aperture 16. In addition, each hopper 26 has a gate means, such as a shear gate 30, for controlling the flow of the coal 12 through the dropsleeve 28 and through the charging aperture 16 into the oven 10.

A charging gas collecting main 32 is mounted on the oven 10 in communication with the exhaust main 22. Conduit means, such as the charging gas conduit 34 is mounted on the larry car 24 and communicates at one end adjacent each charging aperture 16 with one of the dropsleeve 28, the hopper 26, and the charging aperture 16 via conduits 34a, 34b, and 34c respectively. In the sole figure, the conduit 34 is connectable at the other end by means of a flexible snorkel-type connection 34a' to the charging gas collector main 32.

When the coal 12 engages the heated oven 10, substantial quantities of charging gas and displaced oven gas are evolved. The exhaust main 22 is operable during the charging operation to simultaneously exhaust the charging gas and the oven gas through the exhaust apertures 18 and the collector main 20 and through the charging apertures 16, the conduits 34, 34a, or 34b or 34c, and the charging gas collector main 32. The conduit 34 is operable when connected to either the dropsleeve 28 (by conduit 34a), the hopper 26 (by conduit 34b), or the charging aperture 16 (by conduit 34c) and to the charging gas collector main 32 to prevent the escape of a charging gas and the oven gas through either the hoppers 26 or the dropsleeves 28 to the atmosphere.

#### COLLECTOR MAIN CONTROL MEANS

As shown in the drawing, for the purpose of maintaining a first predetermined pressure, such as about +10 mm. water, in the collector main 20, a collector main control means is associated with the collector main 20. This collector main control means has a collector main valve 36, of the butterfly valve type, in the collector main 20 for controlling the pressure in the collector main 20. The valve 36 is connected to a collector main sensing means, such as a pressure controller 38 of the diaphragm type manufactured by Askania Control Co., New Haven, Connecticut. The pressure controller 38 has a probe 38a which probe 38a is disposed in the collector main 20 for detecting the pressure in the collector main 20. The pressure controller 38 is, of course, connected to the valve 36 and is operable to position the valve 36 so as to maintain the first predetermined pressure, such as about +10 mm. of water, in the collector main 20.

#### COLLECTOR MAIN SPRAY MEANS

In order to cool the charging gas and displaced oven gas being exhausted through the exhaust apertures 18, a first spray means, such as the spray 40, is mounted in the exhaust aperture 18 and in the collector main 20 and directs a flow of cooling fluid, such as water contaminated by coal byproducts such as tars, ammonia, phenol, cyanides, chlorides and the like from a flushing header 41 into the charging gas and oven gas to cool it from a temperature of about 1,100° F. to a temperature of about 180° F. during the charging operation and to cool the coke oven gas during the coking cycle from about 1,600° F. to about 180° F.

#### ASPIRATOR MEANS

Aspirator means, such as the steam aspirators 42 are mounted in the exhaust apertures 18 for creating an auxiliary suction in the collector mains 20 to aid and to enhance the evacuation of the charging gas and oven gas through the collector mains 20. Manual damper means, such as the damper 44, are also mounted at the exit from the exhaust aperture 18 to control the flow of the charging gas and oven gas through the exhaust aperture 18.

#### RECYCLE DEVICE

Connecting means, such as the recycle conduit 46, is disposed between the collector main 20 and the charging gas collecting main 32. Gas analyzer means, such as the oxygen analyzer 48, of the paramagnetic type manufactured by Beckman Co., Cleveland, Ohio, is connected by its probe 48a to the charging gas collecting main 32 for sampling the oxygen content of the charging gas and the oven gas in such main 32. Connecting valve means, such as the valve 50, is disposed in the recycle conduit 46, is connected to the gas analyzer 48 and is operable by the gas analyzer 48 to control the flow of recycle charging gas and oven gas through the connecting recycle conduit 46 to maintain the oxygen content of such charging gas and oven gas in the charging gas collector main 32 below the explosive mixture level of about 5.0 percent (lower limit) to about 30 percent (upper limit) of gas in air.

#### CHARGING GAS COLLECTOR MAIN CONTROL MEANS

For the purpose of controlling the pressure in the charging gas collector main 32 between an idling pressure set point of about +2 mm. of water (when the oven 10 is coking the coal 10) and a second set point of about -25 mm. of water pressure (when the oven 10 is being charged with the coal 12) charging gas collector main control means are provided. During the charging operation, the second set point or the second predetermined pressure, such as about -25 mm. of water, (well below the first predetermined pressure of about 10 mm. of water pressure in the collector main 20) is employed so that the main flow of the charging gas and the oven gas is through either the conduits 34a or 34b or 34c, (or any combination thereof) conduit 34 and the charging gas collector main 32. Charging gas collector main sensing means, such as a pressure controller 52 of the diaphragm type manufactured by Askania Control Co., New Haven, Connecticut, is connected to the charging gas collector main 32 for sensing the pressure in the charging gas collector main 32. In addition, the pressure regulator 52 is connected to a valve 54 of the butterfly type in the charging gas collector main conduit 33 to maintain the second predetermined pressure of about -25 mm. of water in the charging gas collector main 32 during the charging operation.

When the flexible snorkel connection 34a' is made at 55 between the conduit 34 and the charging gas collector main 32, an actuating means, such as a normally open microswitch 55' mounted on an arm 57, is closed, thus moving the pressure controller 52 from its first or idle set point of about +2 mm. of water to its second set point (during charging) of about -25 mm. of water.

#### ALTERNATIVE EMBODIMENTS

It will be understood by those skilled in the art that alternatively for the purpose of controlling the flow through the conduit 34 to the charging gas collecting main 32, a first valve means, such as the shutoff valve 56, is employed. In order to alternately shut off the conduit 34, connect the conduit 34 to the charging gas collector main 32 or vent the conduit 34 to the atmosphere through a stand pipe 58a, second valve means, such as the three-way charging valve 58, is employed. To control fluid flow through the connecting recycle conduit 46, a third valve means, such as the recycle shutoff valve 60, is employed. A fourth valve means, such as a charging main shutoff valve 61 is disposed in the charging main conduit 33.

For the purpose of cooling the charging gas and oven gas collector main 32, a second spray means, such as the spray 40a, is mounted in the charging gas collector main 32 and directs its cooling fluid, such as flushing liquor, on such gases to cool these gases from a temperature about 600° F. to a temperature of about 180° F.

Alternatively the pressure controller 52 may use a separate probe 52a.

#### METHOD

From the above description of the previous embodiments it will be apparent to those skilled in the art that an improved method of smokeless charging of a heated coke oven 10 with coal 12 at a lower temperature (i.e., about 70° F.) than the temperature (i.e., about 2,100° F.) of the oven 10 is provided. The method includes the steps of:

- a. moving a discharge means, such as the dropsleeve 28, of a coal-containing hopper 26 into registry with and into sealing engagement with a charging aperture 16 in the oven 10;
- b. controlling the flow of the coal 12 i.e., by gate 30) through the dropsleeve 28 and the charging aperture 16 into the oven 10; and
- c. exhausting the substantial quantities of charging gas developed by engagement of the coal 12 with sidewalls of the oven 10 and of displaced oven gas simultaneously through the exhaust aperture 18 of the oven 10 to a collector main 20 of the oven 10 and through the charging aperture 16 and the conduit 34 (connected to one of the charging aperture 16, the hopper 26, and the dropsleeve 28) to prevent escape of the charging gas and the oven gas through the hopper 26 and the dropsleeve 28 to the atmosphere.

#### SUMMARY OF THE ACHIEVEMENTS OF THE OBJECTS OF THE INVENTION

It will be recognized by those skilled in the art that the objects of this invention have been achieved by providing an improved apparatus 14 for and method of smokeless charging a heated coke oven with coal 12, which method and apparatus:

- a. prevents the escape of charging gas and oven gas through the hopper 26 of the larry car 24 and the dropsleeves 28 on the hopper 26 to the atmosphere;
- b. substantially eliminate pollution of the atmosphere during the charging of a coke oven 10 with coal 12 at a lower temperature (i.e., about 70° F.) than the temperature (i.e., about 2,100° F.) of the oven 10; c. prevent the overloading of the exhaust apertures 18 of the oven 10 with evolved charging gas and displaced oven gas during the charging operation;
- d. prevent the formation of explosive mixtures of the charging gas and displaced oven gas in the improved apparatus 14;
- e. maintain a pressure differential between a collector main 20 of the oven 10 associated with the exhaust aperture 18 of the oven 10 and a charging gas collector main 32 so that the main flow of the charging gas and the oven gas is through the conduit 34 and the charging gas collector main 32; and
- f. provide and maintain a first predetermined holding pressure (i.e., about +2 mm. of water) in the charging gas collector main 32 during the coking of the coal 12 in the oven 10 and a second predetermined lower pressure (i.e., about -25 mm. of water) in the charging gas collector main 32 during the charging operation.

While in accordance with the patent statutes, a preferred and alternative embodiments of this invention have been illustrated and described in detail it is to be particularly understood that the invention is not limited thereto or thereby.

I claim:

1. Apparatus for the smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of said oven, said apparatus having:

- a. said oven provided with:

1. a charging aperture for receiving said coal, and
  2. an exhaust aperture for gases evolved in said oven,
  - b. said oven having:
    1. a collector main connected to said exhaust aperture, and
    2. exhaust means connected to said collector main for removing gases from said oven,
  - c. a larry car movable on said oven and having hopper means adapted to contain said coal;
    1. said hopper means having:
      - a. a discharge means movable into registry and into sealing engagement with said charging aperture, and
      - b. gate means on said hopper means for controlling the flow of said coal through said discharge means and said charging aperture into said oven;
  - d. a charging gas collector main on said oven in communication with said exhaust means;
  - e. conduit means on said larry car in communication with one of said discharge means, said hopper means and said charging aperture and connectable to said charging gas collector main;
  - f. said exhaust means being operable, when said coal engages said oven and substantial quantities of charging gas and displaced oven gas are evolved, to simultaneously exhaust said charging gas and said oven gas through said exhaust aperture and said charging aperture;
  - g. said conduit means being operable, when connected to said one and to said charging gas collector main, to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere; and
  - h. charging gas collector main control means in said charging gas collector main for controlling the pressure in said charging gas collector main at a second predetermined pressure during the charging of said oven with said coal; said second predetermined pressure being below a first predetermined pressure in said collector main so that the main flow of said charging gas and said oven gas is through said conduit means and said charging gas collector main.
2. For a heated oven provided with a charging aperture for receiving coal at a lower temperature than the temperature of said oven and with an exhaust aperture for gases evolved in said oven, and having a collector main connected to said exhaust aperture; and exhaust means connected to said collector main for removing gases from said oven, apparatus for the smokeless charging of said oven with said coal, said apparatus having:
- a. a larry car movable on said oven and having hopper means adapted to contain said coal;
    1. said hopper means having:
      - a. a discharge means movable into registry and into sealing engagement with said charging aperture, and
      - b. gate means on said hopper means for controlling the flow of said coal through said discharge means and said charging aperture into said oven;
  - b. a charging gas collector main on said oven in communication with said exhaust means;
  - c. conduit means on said larry car in communication with one of said discharge means, said hopper means and said charging aperture and connectable to said charging gas collector main;
  - d. said exhaust means being operable, when said coal engages said oven and substantial quantities of charging gas and displaced oven gas are evolved, to simultaneously exhaust said charging gas and said oven gas through said exhaust aperture and said charging aperture,
  - e. said conduit means being operable when connected to said one and to said charging gas collector main to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere; and
  - f. charging gas collector main control means in said charging gas collector main for controlling the pressure in said

charging gas collector main at a second predetermined pressure during the charging of said oven with said coal; said second predetermined pressure being below a first predetermined pressure in said collector main so that the main flow of said charging gas and said oven gas is through said conduit means and said charging gas collector main.

3. The apparatus recited in claim 1 and having collector main control means associated with said collector main for maintaining said first predetermined pressure in said collector main when said oven is coking said coal.

4. The apparatus recited in claim 3 wherein said collector main control means has a collector main valve means in said collector main for maintaining said first predetermined pressure and collector main sensing means in said collector main for detecting the pressure in said collector main, said sensing means being connected to said collector main valve means, and operable to position said collector main valve means to maintain said first predetermined pressure.

5. The apparatus recited in claim 1 and having a first spray means connected to said collector main for cooling said charging gas and said oven gas in said collector main.

6. The apparatus recited in claim 1 and having aspirator means connected to said collector main for creating an auxiliary suction in said collector main.

7. The apparatus recited in claim 1 and having damper means in said collector main.

8. The apparatus recited in claim 1 and having connecting means communicating with said collector main and said charging gas collector main.

9. The apparatus recited in claim 8 and having gas analyzer means connected to said charging gas collector main for sampling the oxygen content of said charging gas and said oven gas and connecting valve means in said connecting means, connected to said gas analyzer means and operable by said gas analyzer means to control the flow of recycle charging gas and oven gas through said connecting means to maintain the oxygen content of said charging gas and said oven gas below the explosive mixture level.

10. The apparatus recited in claim 1 and having connecting means communicating with said collector main and said charging gas collector main and connecting valve means in said connecting means connected to said charging gas collector main control means and operable by said charging gas collector main sensing means to maintain the oxygen content of said charging gas and said oven gas below the explosive mixture level.

11. The apparatus recited in claim 1 and having a first valve means in said conduit means for controlling flow through said conduit means to said charging gas collector main.

12. The apparatus recited in claim 1 and having a second valve means in said conduit means for alternately shutting off said conduit means, connecting said conduit means to said charging gas collector main, and venting said conduit means to the atmosphere.

13. The apparatus recited in claim 8 and having a third valve means in said connecting means for controlling flow through said connecting means.

14. The apparatus recited in claim 1 and having a second spray means connected to said charging gas collector main for cooling said charging gas and said oven gas.

15. The apparatus recited in claim 1 wherein said one is said discharge means.

16. The apparatus recited in claim 1 wherein said one is said hopper means.

17. The apparatus recited in claim 1 wherein said one is said charging aperture.

18. The method of smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of said oven, said method including the steps of:

- a. moving a discharge means of a coal-containing hopper means into registry with and into sealing engagement with a charging aperture in said oven;

b. controlling the flow of said coal through said discharge means and said charging aperture into said oven;

c. exhausting the substantial quantities of charging gas, developed by engagement of said coal with said oven and of displaced oven gas simultaneously through an exhaust aperture of said oven to a collector main of said oven and through said charging aperture and conduit means connected to one of said charging aperture, said hopper means and discharge means to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere; and

d. controlling the pressure in said charging gas collector main at a second predetermined pressure during the charging of said oven, said second predetermined pressure being below a first predetermined pressure in said collector main so that the main flow of said charging gas and said oven gas is through said conduit means and said charging gas collector main; sensing the pressure in said charging gas collector main; and maintaining said second predetermined pressure in said charging gas collector main.

19. The method recited in claim 18 and including the step of maintaining a first predetermined pressure in said collector main when said oven is coking said coal.

20. The method recited in claim 18 and including the steps of sensing the pressure in said collector main and maintaining a first predetermined pressure in said collector main.

21. The method recited in claim 18 and including the step of spraying said charging gas and said oven gas in said collector main with a cooling fluid.

22. The method recited in claim 18 and including the step of aspirating said collector main to create an auxiliary suction therein.

23. The method recited in claim 18 and including the step of damping said collector main.

24. The method recited in claim 18 and including the steps of connecting said collector main to a charging gas collector main, and connecting said conduit means to said charging gas collector main.

25. The method recited in claim 24 and including the steps of analyzing the oxygen content of said charging gas and oven gas in said charging gas collector main, and controlling the flow of recycled charging gas and oven gas to said charging gas collecting main to maintain the oxygen content of said charging gas and said oven gas in said charging gas collector main below the explosive mixture level.

26. The method recited in claim 18 and including the steps of connecting said collector main and said charging gas collector main, and maintaining the oxygen content of said charging gas and said oven gas below the explosive mixture level.

27. The method recited in claim 24 and including the steps of maintaining the pressure in said charging gas collector main at a first predetermined pressure during the coking of said coal in said oven.

28. The apparatus recited in claim 1 and including actuating means on said conduit means and said charging gas collector main and connected to said charging gas collector main control means, said actuating means being operable when said conduit means is connected to said charging gas collector main to change said charging gas collector main control means from a first set point utilized during the coking of said coal in said oven to said second predetermined pressure during the charging of said oven.

29. Apparatus for the smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of said oven, said apparatus having:

- a. said oven provided with:
  1. a charging aperture for receiving said coal, and
  2. an exhaust aperture for gases evolved in said oven,
- b. said oven having:
  1. a collector main connected to said exhaust aperture, and
  2. exhaust means connected to said collector main for removing gases from said oven,

- c. a larry car movable on said oven and having hopper means adapted to contain said coal;
- 1. said hopper means having:
  - a. a discharge means movable into registry and into sealing engagement with said charging aperture, and
  - b. gate means on said hopper means for controlling the flow of said coal through said discharge means and said charging aperture into said oven;
- d. a charging gas collector main on said oven in communication with said exhaust means;
- e. conduit means on said larry car in communication with one of said discharge means, said hopper means and said charging aperture and connectable to said charging gas collector main;
- f. said exhaust means being operable, when said coal engages said oven and substantial quantities of charging gas and displaced oven gas are evolved, to simultaneously exhaust said charging gas and said oven gas through said exhaust aperture and said charging aperture;
- g. said conduit means being operable, when connected to said one and to said charging gas collector main, to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere; and
- h. collector main control means associated with said collector main for maintaining a first predetermined pressure in said collector main when said oven is coking said coal;
- i. said collector main control means having a collector main valve means in said collector main for maintaining said first predetermined pressure and collector main sensing means in said collector main for detecting the pressure in said collector main, said sensing means being connected to said collector main valve means, and operable to position said collector main valve means to maintain said first predetermined pressure.
- 30. Apparatus for the smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of said oven, said apparatus having:
  - a. said oven provided with:
    - 1. a charging aperture for receiving said coal, and
    - 2. an exhaust aperture for gases evolved in said oven,
  - b. said oven having:
    - 1. a collector main connected to said exhaust aperture, and
    - 2. exhaust means connected to said collector main for removing gases from said oven,
  - c. a larry car movable on said oven and having hopper means adapted to contain said coal;
    - 1. said hopper means having:
      - a. a discharge means movable into registry and into sealing engagement with said charging aperture, and
      - b. gate means on said hopper means for controlling the flow of said coal through said discharge means and said charging aperture into said oven;
  - d. a charging gas collector main on said oven in communication with said exhaust means;
  - e. conduit means on said larry car in communication with one of said discharge means, said hopper means and said charging aperture and connectable to said charging gas collector main;
  - f. said exhaust means being operable, when said coal engages said oven and substantial quantities of charging gas and displaced oven gas are evolved, to simultaneously exhaust said charging gas and said oven gas through said exhaust aperture and said charging aperture;
  - g. said conduit means being operable, when connected to said one and to said charging gas collector main, to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere;
  - h. connecting means communicating with said collector main and said charging gas collector main; and
  - i. gas analyzer means connected to said charging gas collector main for sampling the oxygen content of said charging

gas and said oven gas and connecting valve means in said connecting means, connected to said gas analyzer means and operable by said gas analyzer means to control the flow of recycle charging gas and oven gas through said connecting means to maintain the oxygen content of said charging gas and said oven gas below the explosive mixture level.

31. The method of smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of said oven, said method including the steps of:

- a. moving a discharge means of a coal-containing hopper means into registry with and into sealing engagement with a charging aperture in said oven;
- b. controlling the flow of said coal through said discharge means and said charging aperture into said oven;
- c. exhausting the substantial quantities of charging gas, developed by engagement of said coal with said oven and of displaced oven gas simultaneously through an exhaust aperture of said oven to a collector main of said oven and through said charging aperture and a conduit means connected to one of said charging aperture, said hopper means and discharge means to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere; and
- d. sensing the pressure in said collector main and maintaining a first predetermined pressure in said collector main.

32. The method of smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of said oven, said method including the steps of:

- a. moving a discharge means of a coal-containing hopper means into registry with and into sealing engagement with a charging aperture in said oven;
- b. controlling the flow of said coal through said discharge means and said charging aperture into said oven;
- c. exhausting the substantial quantities of charging gas, developed by engagement of said coal with said oven and of displaced oven gas simultaneously through an exhaust aperture of said oven to a collector main of said oven and through said charging aperture and a conduit means connected to one of said charging aperture, said hopper means and discharge means to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere;
- d. connecting said collector main to a charging gas collector main, and connecting said conduit means to said charging gas collector main; and
- e. analyzing the oxygen content of said charging gas and oven gas in said charging gas collector main, and controlling the flow of recycled charging gas and oven gas to said charging gas collecting main to maintain the oxygen content of said charging gas and said oven gas in said charging gas collector main below the explosive mixture level.

33. The method of smokeless charging of a heated coke oven with coal at a lower temperature than the temperature of said oven, said method including the steps of:

- a. moving a discharge means of a coal-containing hopper means into registry with and into sealing engagement with a charging aperture in said oven;
- b. controlling the flow of said coal through said discharge means and said charging aperture into said oven;
- c. exhausting the substantial quantities of charging gas, developed by engagement of said coal with said oven and of displaced oven gas simultaneously through an exhaust aperture of said oven to a collector main of said oven and through said charging aperture and a conduit means connected to one of said charging aperture, said hopper means and discharge means to prevent escape of said charging gas and said oven gas through said hopper means and said discharge means to the atmosphere;
- d. connecting said collector main to a charging gas collector main, and connecting said conduit means to said charging gas collector main; and

11

e. controlling the pressure in said charging gas collector main at a second predetermined pressure during the charging of said oven, said second predetermined pressure being below a first predetermined pressure in said collector main so that the main flow of said charging gas and said oven gas is through said conduit means and said charging gas collector main; sensing the pressure in said charging gas collector main; and maintaining said second

12

predetermined pressure in said charging gas collector main.

34. The method recited in claim 33 and including the steps of connecting said collector main and said charging gas collector main, and maintaining the oxygen content of said charging gas and said oven gas below the explosive mixture level.

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