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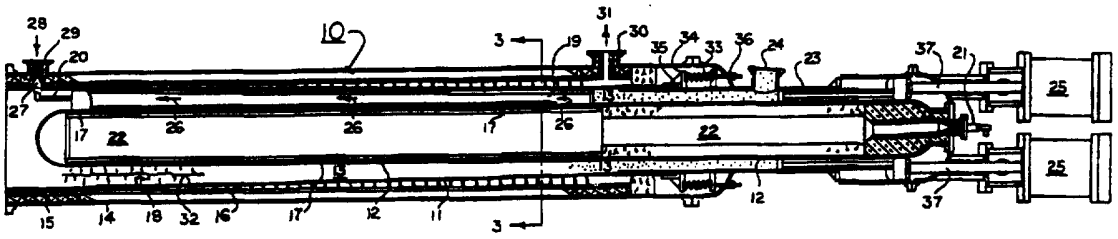
(54) Title: METHOD FOR COKING COAL



(57) Abstract

This invention discloses a new method for the production of coke from coals. In the present invention, coke is continuously produced by heating a moving charge of coal inside the annular cross-section (13) defined by two concentric tubes (11, 12). The coking chamber (13), which includes a large diameter tube (11) and a concentric smaller diameter tube (12), is force fed with a coal such as metallurgical coal. The coal is bi-directionally heated along a controlled temperature gradient between the inner wall of the small diameter tube (12) and the outer wall of the large diameter tube (11). The coal is transformed to coke as it travels longitudinally along the axis of both tubes. Coke is discharged from the chamber at the end opposite to which it was charged and is cooled before being exposed to the atmosphere. Gases generated during the coking process are collected and treated. All of these operations are accomplished in a closed system to prevent pollution.

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TITLE

METHOD FOR COKING COAL

Background of the Invention

The invention relates to a new method of carbonizing coal as for example the carbonization of metallurgical coal to produce coke which is used in furnaces that produce molten iron. Specifically this new method is an improvement over U.S. Patent No. 2,922,752 issued to Reintjes; this patent discloses the converting of coal into coke by force-feeding the coal into individual tubes (coking chambers) which are heated in such a way as to have the coal heated indirectly. Since coal is a bad conductor of heat, Reintjes' coking chambers are kept small in diameter (12 in./30.48 cm) in order to make possible to heat the coal effectively; this results in requiring a great multitude of coking chambers with their attendant individual charging mechanisms, valves and controls, in order to achieve a certain productive capacity; such multitude of coking chambers makes a commercial facility uneconomical to construct and complex to operate.

The present invention overcomes the deficiencies of Reintjes by providing an efficient method of making coke in a space (annulus) created between a large diameter (7 ft./2.1 m) tube and a smaller diameter (5 ft./1.5 m) tube, both tubes being concentric and being heated in such a way as to have the coal heated by the inner wall of the large diameter tube and by the outer wall of the smaller diameter tube. This approach provides a coking

chamber with increased surface area for heating to which the coal is exposed; consequently, the number of coking chambers required for the same productive capacity is diminished appreciably when compared to Reintjes, resulting in the reduction of the capital requirement and the simplification of the operation of a commercial coke making facility.

For example, to heat 4.7 tons of coal per hour to an average temperature of 1150°F (621°C) Reintjes apparatus consisted of thirty (30) coking chambers of 20 feet (6.1 m) in length (see top of Column 5 of Reintjes' patent). In the instant invention two (2) coking chambers of 48 feet (14.6 m) in length will heat 5.6 tons of coal per hour to an average temperature of 1853°F (1012°C). Taking all the factors into account this translates to one coking chamber in the instant invention producing the equivalent of about twelve (12) coking chambers of Reintjes.

Drawings

The embodiment of the invention is illustrated in the accompanying drawings, in which:

Figure 1 is a longitudinal cross-section of the novel coking chamber.

Figure 2 is an elevation of the chamber as viewed from the coke discharge end.

Figure 3 is a section taken at 3-3 of Figure 1.

Figure 4 is a configuration of a partial commercial plant as viewed in elevation from the coke discharge end with the coking chambers arranged side by side.

Figure 5 is a top view of Figure 4, rotated 90° clockwise.

Figure 6 is a configuration of the commercial plant as viewed from the top showing the coal preparation, the coking operation, the gas treating system and the heat recovery steam generation.

Figure 7 is a section taken at 7-7 of Figure 6; it shows the coking chambers arranged one above the other.

Description of the Invention

Reference is made to Figures 1, 2 and 3, in which numeral 10 is the coking chamber. This chamber is mainly composed of large diameter tube 11 and small diameter tube 12; a space 13 is the annulus formed between the tubes 11 and 12. A tubular envelope denoted by numeral 14 contains both tubes 11 and 12 and seals chamber 10 from the atmosphere to conserve heat and to prevent polluting emissions; insulation material 15 is attached to the inner wall of envelope 14 to minimize heat loss. Between insulation 15 and the outer wall of tube 11, flue 16 is provided for directing combustion gases to heat the wall of tube 11 from outside. Internally of tube 12, flue 17 is provided for directing combustion gases to heat the wall of tube 12 from inside. This arrangement makes possible for the coal contained in annulus 13 to be

heated bi-directionally to make coke in the annulus as depicted by numeral 18 shown in Figure 1.

Tube 12 is supported by webbs, preferably positioned at 120° apart and denoted by numeral 19, 19(a) and 19(b); webb 19 is made hollow for the passage of gas and is mounted on the outer wall of tube 12, and webbs 19(a) and 19(b) are mounted on the inner wall of tube 11; tubes 11 and 12 are free to grow upon expansion. Hollow webb 19 which serves for the return of the combustion gases from the coal end to the coke end of coking chamber 10 is in direct communication with flue 17 at the coal end; webb 19 at the coke end is equipped with conduit 20 in order to interconnect to flue 16 which in turn surrounds the outer wall of large diameter pipe 11. Conduit 20 is made in the form of a snake to compensate for expansion and contraction. A burner denoted by numeral 21 is disposed at the coal charging end of tube 12; internally of tube 12, flue gas carrier conduit 22 is provided to direct the products of combustion from burner 21 to the coke end of chamber 10 and thence into flue 17 in order to heat the wall of tube 12 from the inside by spiraling the combustion gases against the inner wall of tube 12, the combustion gases exiting at the coal end into webb 19. At the coal charging end of coking chamber 10, pushing piston 23 is provided to force-feed the coal in a progressive mode into annulus 13, the coal being fed through port 24 from a lockhopper device shown in Figures 5, 6, and 7; while the coal is pushed into one end of chamber 10, coke is pushed out the other end of chamber

10 (left of Figure 1). Piston 23 which is made in the form of a bored cylinder circumscribing the outer wall of the tube 12, is moved forward and backwards by hydraulic cylinders 25, pushing rods 37 engaging piston 23.

Operationally, hot, lean combustion gases rich in oxygen from burner 21 enter chamber 10 internally of tube 12 and are directed through conduit 22 to the end of tube 12 where they are forced into flue 17 and made to spiral intimately against the inner wall of tube 12 along its length while flowing towards the coal charging end of coking chamber 10; thus, heating the coal/coke contained in the annulus 13 from inside of tube 12. The flue gas, when reaching the coal end, is directed into webb 19 and returned to the coke end of tube 12 as indicated by arrows 26, and is delivered via snake pipe 20 to booster burner 27 which is located at the coke end of chamber 10. At this point additional fuel shown by arrow 28, is added through port 29 to raise the temperature of the oxygen rich combustion gases prior to directing them into flue 16 in order to raise the temperature of the gases to the desired level and effectively heat the wall of tube 11 from the outside and because of the high thermal conductivity of the wall of tube 12 in turn heat the coal/coke contained in annulus 13. Once these combustion gases reach the coal charging end they are exhausted through port 30 of chamber 10, marked by arrow 31. During the heating of the coal in annulus 13, the coal is essentially heated in two opposing directions; namely by the outer wall of tube 12 with the heat radiating

eccentrically and by the inner wall of tube 11 with the heat radiating concentrically. The heat input into burner 21 and the heat input into booster burner 27 are balanced in such a way as to have uniform coke made by forming a cleavage or parting line denoted by number 32, in the middle of annulus 13. The coal gas evolving during the coking is directed towards the coke discharge end of chamber 10. In order to prevent the mixing of the coal gas with the flue gas a spring assembly denoted by numeral 33 is provided to maintain a seal with gland 34 and packing 35; rod assembly 36 is also provided for adjustment of tension.

Referring to Figure 4, several coking chambers, such as chamber 10, are assembled side by side to form a battery. Coke quenching (cooling) leg 38 is mounted downstream of chamber 10 and is interconnected by means of elbow 39 in order to direct the coke into leg 38. Valve 40 supports the coke while it is being quenched (cooled below its ignition point) with a gas such as steam, which is introduced via port 41. Gas collector 42 which collects the raw gas from the coking of the coal is also used to collect the gases generated during the quench. The raw gas and the quenching gases are treated in a downstream operation. Valves 43 and 44 make possible the isolation of coking chamber 10 for maintenance. To provide an environmentally closed system, the quenched coke is discharged into a tube which serves as a lockhopper, denoted by numeral 45, via drop-pipe 46. Valves 47 and 48 lock and unlock lockhopper 45

in order to prevent emissions escaping into the atmosphere and loss of system pressure when discharging the coke into the atmosphere. The coke discharge is handled by means of feeder 49 and conveyor 50. Figure 5 is a plan view of Figure 4 with the corresponding components being denoted with the same numerals. The coal delivery pipe (not shown in Figure 4) is represented by numeral 51 and the coal lockhopper by numeral 52.

Figure 6 which represents the commercial coke making plant, embodies the new method; it is equipped with several coking chambers, such as chamber 10, to form a battery. The coal preparation building is marked by numeral 53 and the coal bunker by numeral 54. From the coal bunker the coal is delivered by any conventional system to lockhopper 52 in order to supply coal to pushing piston 23. A gas treating plant denoted by numeral 55 is provided to clean the raw gas collected from the coking chambers and from the quenching of the coke. A heat recovery steam generator denoted by numeral 56 is also provided in order to cool the gas after cleaning and prior to its delivery to the point of use; the steam raised during the cooling of the clean gas can be used for quenching the coke and for driving rotating equipment such as turbines. An overhead crane marked by numeral 57 is used to service the battery. Figure 7 which is a section of Figure 6, shows the coal being delivered into lockhopper 52 which is used as a device to prevent polluting emissions and loss of pressure, with

valves 58 and 59 controlling its locking and unlocking, when it is supplied with coal.

The details of construction described above are for the purpose of description and not limitation since other configurations are possible without departing from the spirit of the invention.

WHAT IS CLAIMED IS:

1. A method for continuously producing metallurgical coke from coal comprising:

continuously carbonizing coal into metallurgical coke in the absence of oxygen by heating a forced stream of coal in an annulus of an elongated coking chamber, said annulus formed by an outer wall of a small tube and an inner wall of a large tube, said coal is bi-directionally heated in said annulus on said outer wall and said inner wall by conductive heat as said coal passes through said elongated coking chamber, wherein said carbonization occurs from each wall in order to form a cleavage essentially in a middle portion of said annulus.

2. A method of continuously producing metallurgical coke as recited in claim 11, further comprising delivering coal to a coal charging end of said elongated coking chamber through a lockhopper device.

3. A method of continuously producing metallurgical coke as recited in claim 11, further comprising discharging said coke from the coking chamber into a quenching chamber wherein said coke is cooled below an ignition point of said coke.

4. A method of continuously producing metallurgical coke as recited in claim 13, wherein said coke is cooled by steam.

5. A method of continuously producing metallurgical coke as recited in claim 13, further comprising discharging the cooled coke into the atmosphere through a lockhopper device.

6. A method of continuously producing metallurgical coke as recited in claim 11, further comprising collecting gases generated during the carbonization of said coal.

7. A method of continuously producing metallurgical coke as recited in claim 11, wherein said coal is forced into said elongated coking chamber by a pushing piston so that said coal is compacted into said annulus at a coal charging end whereby said coke is forced from an opposing end of said elongated coking chamber.

8. A method of continuously producing metallurgical coke as recited in claim 11, wherein heat for conductively heating said coal is applied by directing products of combustion against said walls.

9. A method of continuously producing metallurgical coke as recited in claim 18, wherein the products of combustion are first applied to the wall of the small tube and then directed to the wall of the large tube.

10. A method of continuously producing metallurgical coke as recited in claim 19, further comprising increasing the thermal energy in the products of combustion before directing the products to the wall of the large tube.

11. A method for continuously producing metallurgical coke from coal comprising:

providing at least one elongated coking chamber having an annulus formed by an outer wall of a small tube and an inner wall of a large tube;

delivering coal to a coal charging end of said coking chamber; and

continuously carbonizing said coal into metallurgical coke in the absence of oxygen by heating a forced stream of coal in the annulus of said elongated coking chamber, said coal is bi-directionally heated in said annulus on said outer wall and said inner wall by conductive heat as said coal passes through said elongated coking chamber, wherein said carbonization occurs from each wall in order to form a cleavage essentially in a middle portion of said annulus.

12. A method of continuously producing metallurgical coke as recited in claim 21, wherein said coal is delivered to said coking chamber through a lockhopper device.

13. A method of continuously producing metallurgical coke as recited in claim 21, further comprising discharging said coke from the coking chamber into a quenching chamber wherein said coke is cooled below an ignition point of said coke.

14. A method of continuously producing metallurgical coke as recited in claim 23, wherein said coke is cooled by steam.

15. A method of continuously producing metallurgical coke as recited in claim 23, further comprising discharging the cooled coke into the atmosphere through a lockhopper device.

16. A method of continuously producing metallurgical coke as recited in claim 21, further comprising collecting gases generated during the carbonization of said coal.

17. A method of continuously producing metallurgical coke as recited in claim 11, wherein said coal is forced into said elongated coking chamber by a pushing piston so that said coal is compacted into said annulus whereby said coke is forced from an opposing end of said elongated coking chamber at a discharge end.

18. A method of continuously producing metallurgical coke as recited in claim 21, wherein heat for conductively heating said coal is applied by directing products of combustion against said walls.

19. A method of continuously producing metallurgical coke as recited in claim 28, Wherein the products of combustion are first applied to the wall of the small tube and then directed to the wall of the large tube.

20. A method of continuously producing metallurgical coke as recited in claim 29, further comprising increasing the thermal energy in the products of combustion before directing the products to the wall of the large tube.

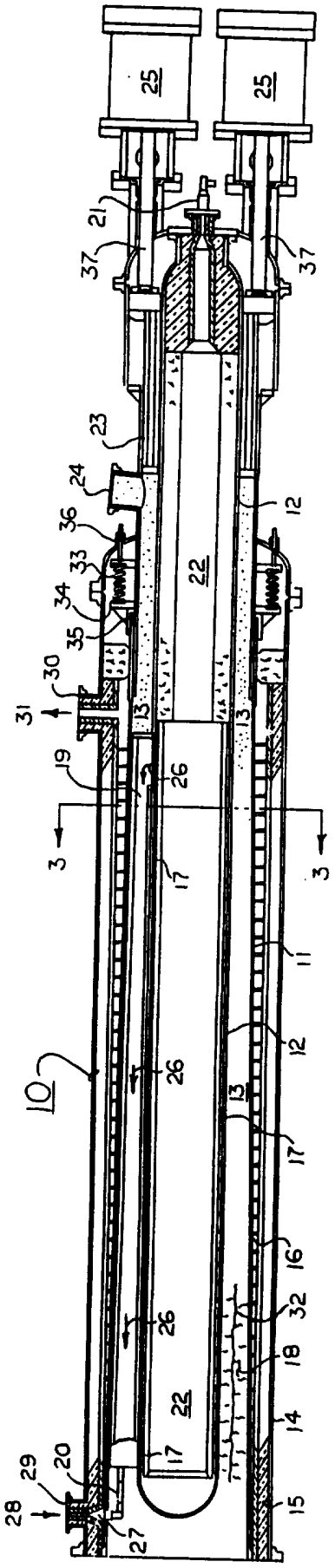

FIG. 1

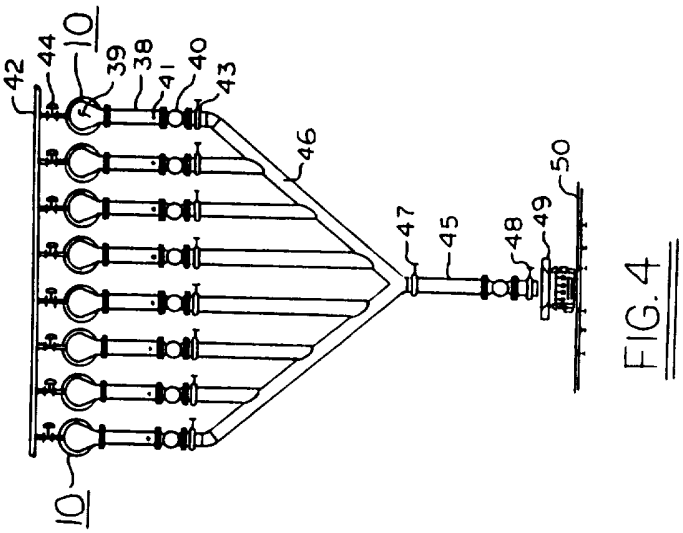

FIG. 4

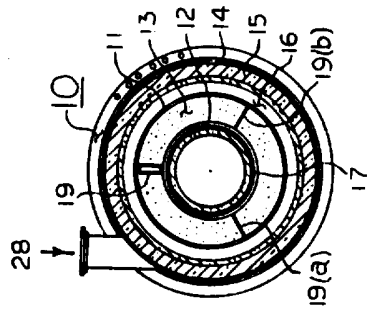

FIG. 3

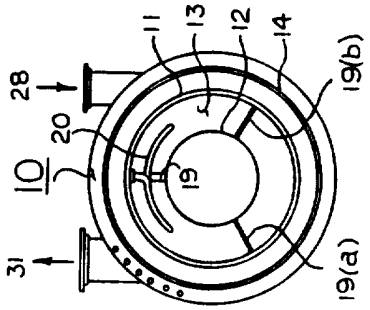

FIG. 2

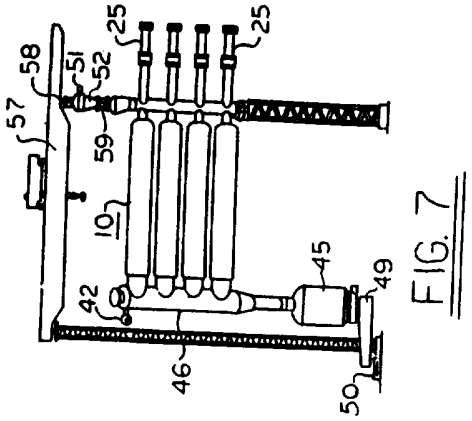

FIG. 7

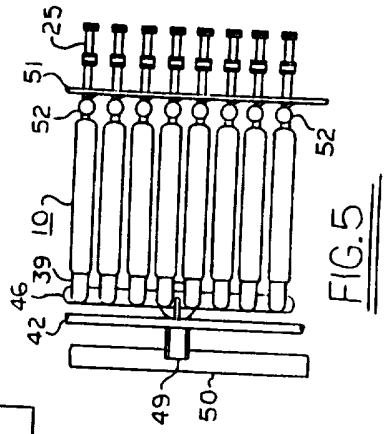

FIG. 5

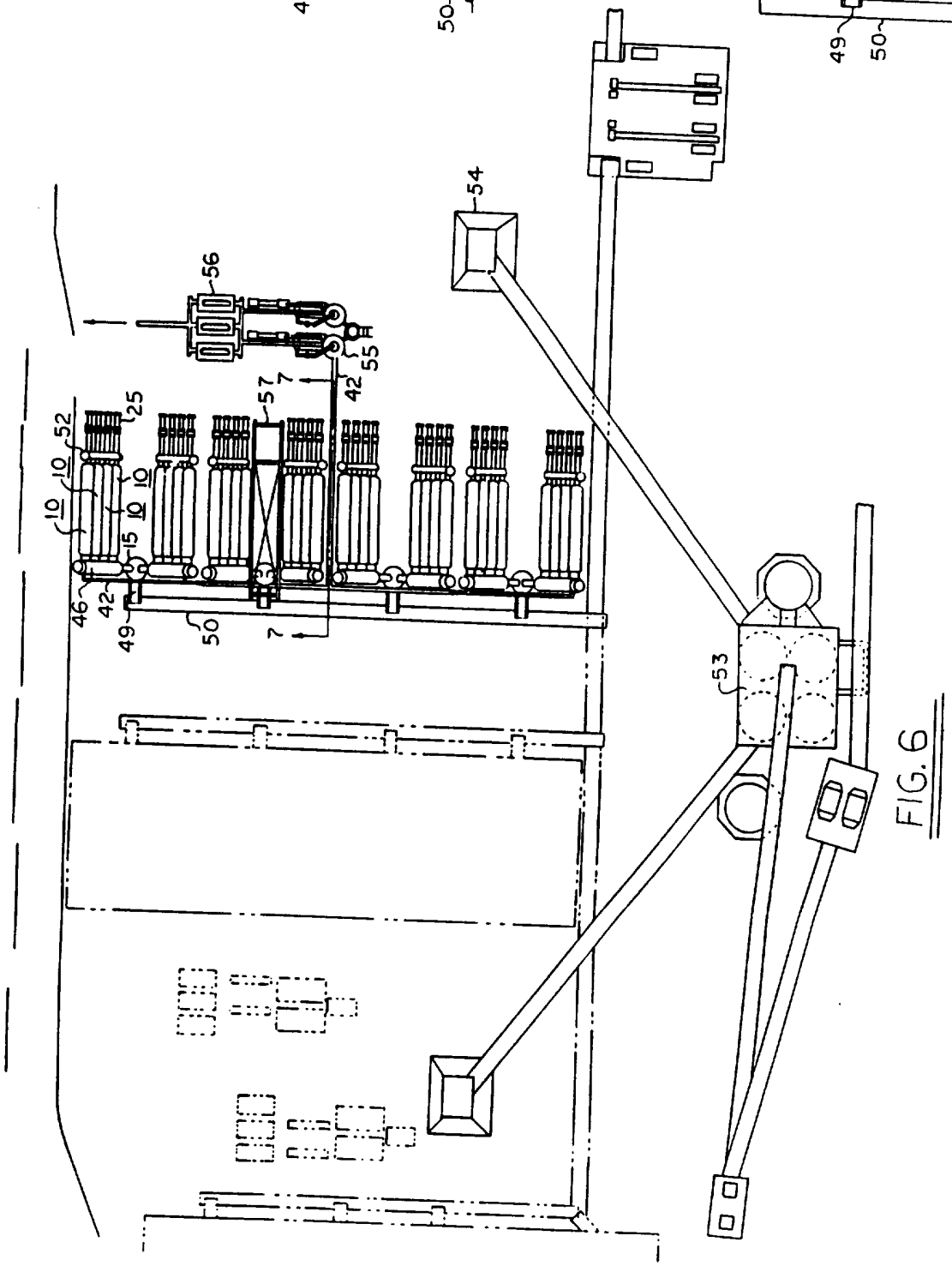

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :C10B 47/00, 49/00, 51/00; B01J 8/04; F27B 5/14; C21B 9/00
US CL : 201/15, 40, 44; 202/96, 99; 422/196, 197; 432/209, 218
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 201/15, 40, 44; 202/96, 99; 422/196, 197; 432/209, 218

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,356,530 (CALDERON) 18 OCTOBER 1994, see figure 3.	1-20
A	US, A, 5,279,278 (LOGTENS ET AL) 18 JANUARY 1994, see figure.	1-20
A	US, A, 4,810,472 (ANDREW ET AL) 07 MARCH 1989, see entire document.	1-20
Y	US, A, 4,469,488 (CALDERON) 04 SEPTEMBER 1984, see figure.	1-20
A	US, A, 4,389,283 (CALDERON) 21 JUNE 1983, see entire document.	1-20
A	US, A, 4,098,589 (BUSWELL ET AL) 04 JULY 1978, see entire document.	1-20

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/14184

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 2,224,823 (KLEIN ET AL) 10 DECEMBER 1940, see figure.	1-20
A	US, A, 1,953,040 (BRANDEGEE) 27 MARCH 1934, see figure.	1-20
A	US, A, 1,018,331 (MATHESIUS) 20 FEBRUARY 1912, see figure.	1-20