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Schmidt-Balve et al.

[11] 3,875,016

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[54] METHOD AND APPARATUS FOR CONTROLLING THE OPERATION OF REGENERATIVELY HEATED COKE OVENS

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[21] Appl. No.: 427,670

Related U.S. Application Data

[63] Continuation of Ser. No. 181,532, Sept. 17, 1971, abandoned.

[30] Foreign Application Priority Data

Oct. 13, 1970 Germany 2050153

[52] U.S. Cl. 202/151, 201/1, 201/41, 202/141, 202/142, 202/143, 202/144

[51] Int. Cl. C10b 5/12, F16k 11/00

[58] Field of Search 201/41, 1; 202/141, 142, 202/143, 144, 151

[56] References Cited

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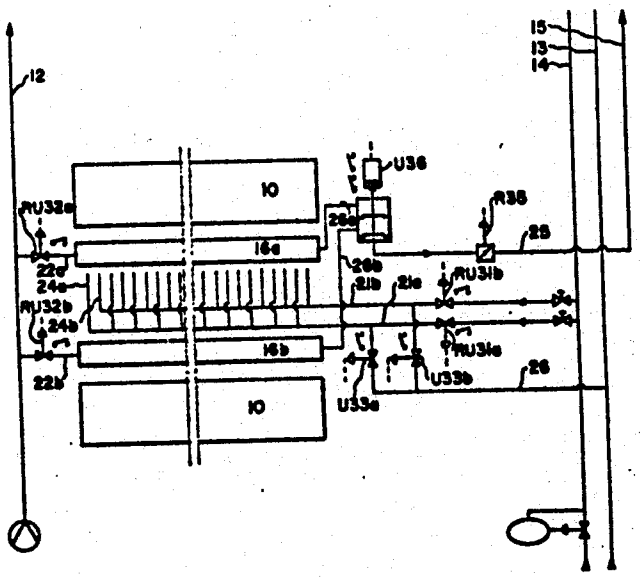
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Assistant Examiner—D. Sanders
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[57] ABSTRACT

A battery of regeneratively heated coke ovens has apparatus for controlling the introduction of combustion gases to the heating walls and related regenerators and the discharge of burned gases from the regenerators so that the most heat is produced only during the first regenerative period. Control valves in the gas and air inlet to each heating wall and in the flue for burned gases from the regenerators are operated to control the flow through them in accordance with the heat requirements of the oven chambers during a coking period.

11 Claims, 5 Drawing Figures



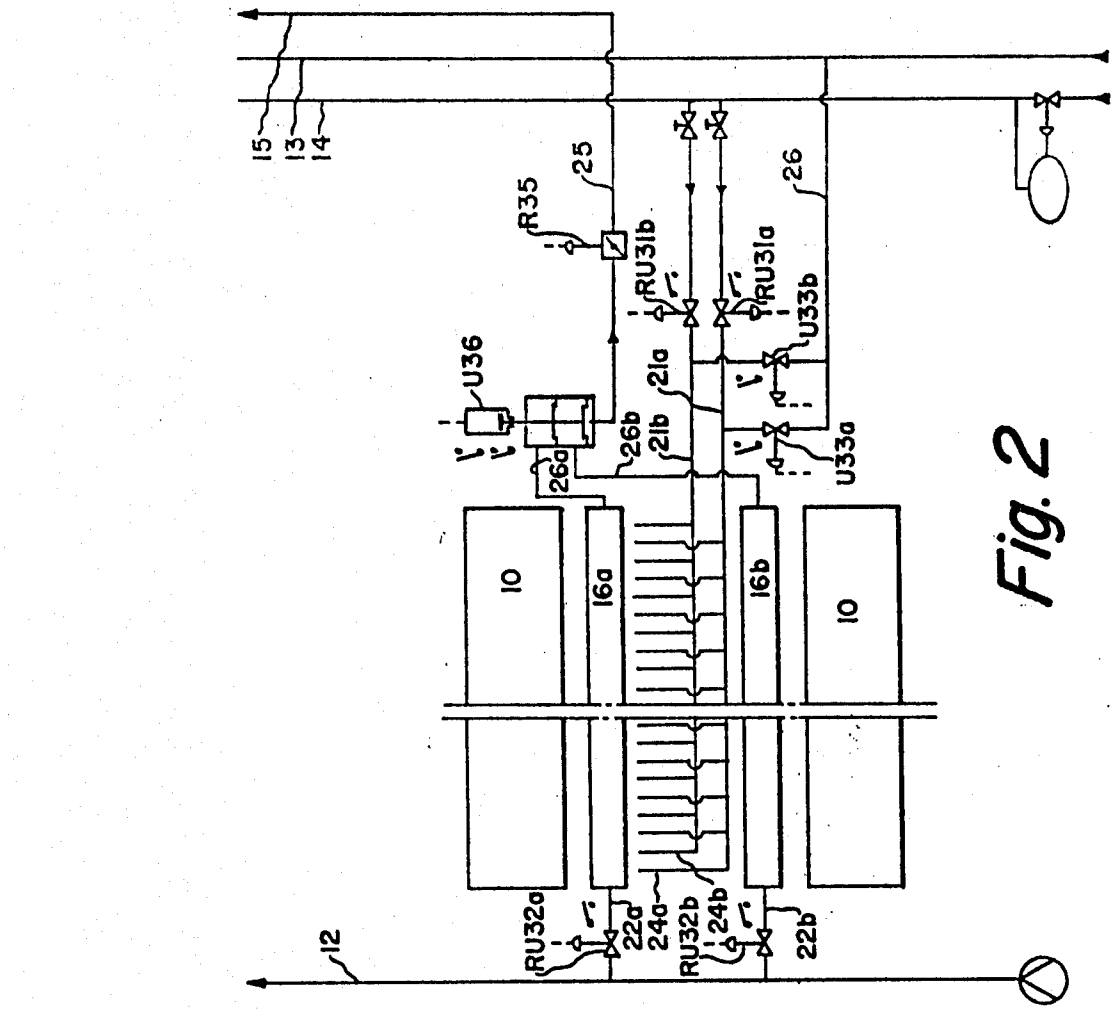

15
13
14
25
R35
RU31b
RU31a
26
U33b
U36
21a
26b
21b
26a
U33a
10
16a
16b
10
12
RU32a
22a
24a
RU32b
24b
22b

Fig. 2

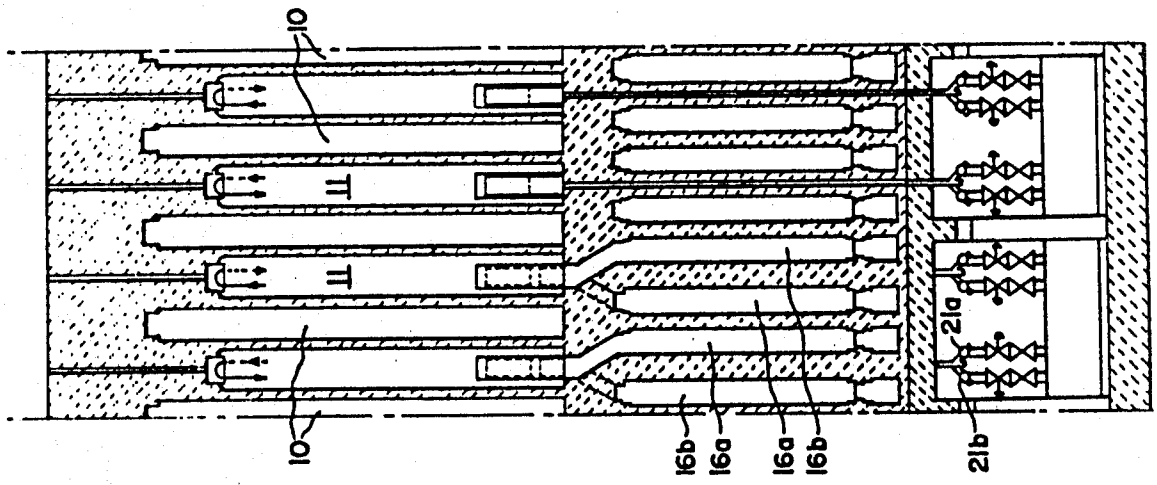

10
10
21a
16b
16a
16a
16b
21b

Fig. 1

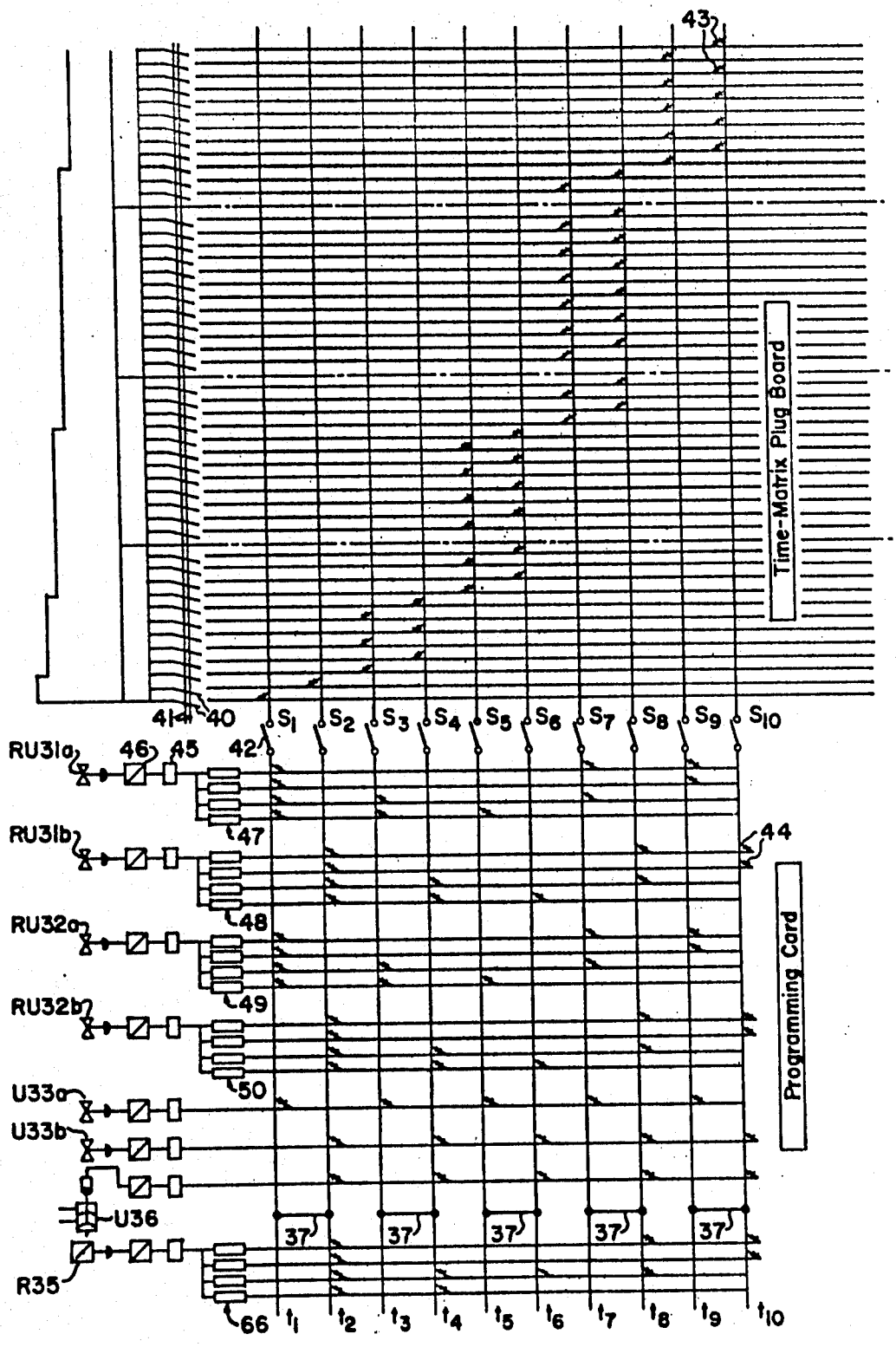

43
Time-Matrix Plug Board
41
40
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
RU31a
46
45
42
47
RU31b
44
RU32a
48
RU32b
49
U33a
50
U33b
U36
37
R35
66
t1
t2
t3
t4
t5
t6
t7
t8
t9
t10
Programming Card

Fig. 3

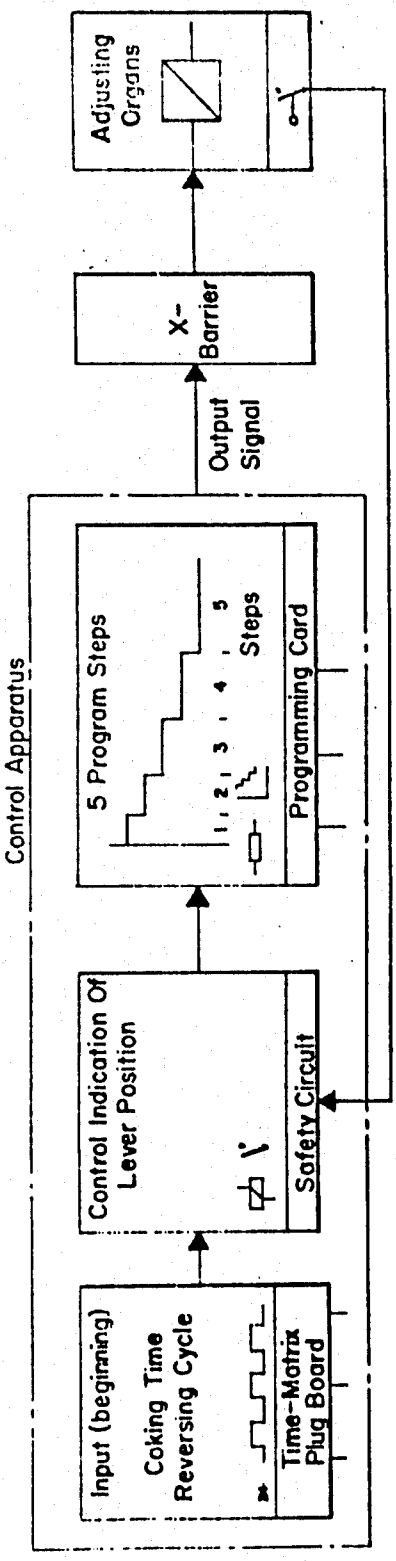

Adjusting Organs
X-Barrier
Output Signal
5 Program Steps
1 2 3 4 5 Steps
Programming Card
Control Indication Of Lever Position
Safety Circuit
Input (beginning)
Coking Time Reversing Cycle
Time-Matrix Plug Board
Control Apparatus

Fig. 4

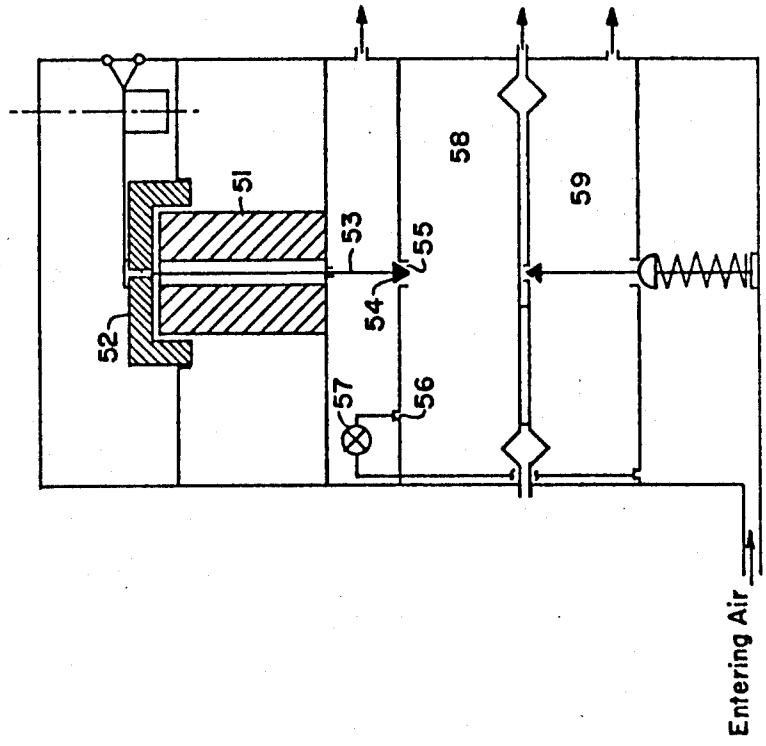

51
52
53
54
55
56
57
58
59
Entering Air

Fig. 5

METHOD AND APPARATUS FOR CONTROLLING THE OPERATION OF REGENERATIVELY HEATED COKE OVENS

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of application U.S. Ser. No. 181,532, filed Sept. 17, 1971, and now abandoned.

BACKGROUND OF THE INVENTION

It has been known for many years, when supplying gaseous fuels such as rich gas, e.g., coal gas, lean gas and air, control devices must be incorporated in the pipe lines for the gases. These control devices are operated at different times so that particular distributions of heat to the individual oven chambers will insure uniform carburization or coking of the coal in the chambers.

During the first few hours of a coking process, the entire mass of coal in a newly charged oven chamber attains only a relatively low temperature, and during this time the water content of the coal charge must be converted into steam. As discussed herein, the coking process starts with the loading of wet coal into a coking chamber and ends with a pushing operation. It is essential to the coking process that the coal charge must necessarily be heated to a certain uniform final temperature whereby a cellular residue exists as a result of the destructive distillation of coal. At the time when a coke oven chamber is pushed, the chamber walls have a temperature of about 1000°C. Heating flues are formed at the other sides of these walls and attain a correspondingly higher temperature. On the average, the temperature in the heating flues will reach about 1200°C but can be as high as 1400°C under a forced coking operation.

As a general rule in a coking process, the shorter the coking time, the higher the temperatures that are needed. After an oven chamber has been loaded with cold wet coal, the surface temperature of the chamber walls drops very sharply. In a given coke oven installation, for example, the temperature will initially drop to about 500°C and after about 2 ½ hours it increases to a temperature of about 700°C. The chemical processes which occur within an oven chamber after the water evaporates from the coal charge are extremely complicated because hydrocarbons are formed which immediately undergo a decomposition and transformation. It is important to bear in mind that a plastic zone or tar seam migrates in a coal charge outwardly from both chamber walls toward the center of the chamber and finally unite with one another.

The manner in which a coal charge attains a desired temperature is described in available literature concerning coking processes. The overall temperature of the coal charge does not materially increase after 2 ½, 5 and even 7 ½ hours in the coke chamber. For example, consider a coke chamber 500 millimeters wide and a given coking time of 30 hours. The coal at the chamber walls attains a temperature of 600°C after 2 ½ hours. The coal at a distance of 50 millimeters from the chamber walls attains a temperature of 100°C after 2 ½ hours. After 7 ½ hours, the coal at 150 millimeters from the chamber walls attains a temperature of 200°C. From these relationships, it can be seen that the coal charge in the coke oven chamber is capable of absorbing large amounts of heat at the beginning of the coking process because the evaporation of water from the coal is a process which consumes an extraordinary large amount of heat. Near the end of the coking period, when the border regions of the coal charge in the coke chamber have almost attained the final coking temperature, it is still necessary to heat the middle portion or central tar seam area of the coal charge up to the final coking temperature. A considerable reduction to the necessary time for a coking process can be achieved if, at the beginning of the coking process, appreciably larger amounts of heat are introduced into the coal charge in a coking chamber.

Up until the time of the present invention, coke ovens were operated in a manner such that the wall between adjacent oven chambers was heated in a steady and uniform manner. The coke pushing and coal charging operations for these chambers were carried out according to a sequence whereby one newly-filled coke chamber was situated on one side of a heating wall while the coke chamber at the other side of that heating wall was approximately midway through the coking process. This may be more clearly understood by considering a group of seven coke oven chambers within a battery of coke ovens wherein the pushing sequence occurs as oven chambers 1, 3, 5, 7, 2, 4 and 6. As a result, the oven chambers lying on the two sides of a heating wall will be pushed at an interval between them corresponding to one-half of the time needed for the coking process.

Studies in recent years have shown especially clearly that the heat required for the coking process is greatest immediately after the charging of the oven. Then it decreases rather sharply so as to assume values which, at the end of the coking period, amount to only a fraction of the originally required heat. With the customary uniform introduction of heat to the heating walls of a coke oven battery, the effect is that, toward the end of the coking time, the outer layers of the coke cake assume a temperature that is higher than is necessary for processing of the coke. At any rate, it is higher than the temperature of the coke layers that are in the center plane of the chamber, which are sufficiently processed for the pushing of the oven and which are hardened. Moreover, the chamber walls assume correspondingly higher temperatures, and there is the danger that those temperatures which correspond to the admissible maximum values that the block material can withstand will be exceeded with a forced heating. Also, there is heat storage in the walls. Heat discharge corresponds to this storage after the charging of the coal.

On the other hand, the general practice for decades was to select the pushing sequence during the operation of a coke oven battery so that the two ovens adjacent to an oven to be pushed are approximately at the half-coking stage. As a result, the greater part of the heat produced in a heating wall is available for heating the coke in a just-charged chamber and the heat flow to the other chambers is less.

Aside from the equalization of the heat supply, a sequence of coke pushing, in which the two ovens adjacent to an oven to be pushed are approximately at the half-coking stage, has the advantage that the harmful effects that occur with the use of an expanding coal cannot be manifested so strongly as if the ovens are possibly pushed in the sequence 1, 2, 3, 4, 5 . . . . With the last-named pushing sequence, ovens with a con-

stantly decreasing swelling pressure are connected to ovens in which the swelling pressure of the coal is the greatest. With the use of such an operating schedule for ovens in which swelling coal is being processed, it has frequently been observed that the chamber walls that are located near the one battery top have cracks and gaping joints, while this is not the case with the walls that are located near the other battery top.

Under the assumption that coal which does not produce any noteworthy swelling pressure is processed, it has already been suggested that operating schedules be used in which adjacent oven chambers are in the same coking stage and, moreover, that the heating wall between two oven chambers which are in approximately the same coking stage be adapted to the heat requirement that exists in the individual phases of the coking time.

SUMMARY OF THE INVENTION

The present invention relates to a control of regeneratively heated coke oven batteries with a feed of gaseous fuel, which changes constantly or in stages during coking, to the heating walls and the related regenerators. It also relates to a changeable discharge of the burned gases from the regenerators. This process has the prerequisite that the oven chambers at both sides of a heating wall are in coking stages that do not have any great time difference.

The method and apparatus for controlling the operation of regeneratively heated coke ovens according to the present invention is particularly characterized by supplying quantities of heat in accordance with an inherent heat requirement for the coking sequence by adjacent oven chambers. The inherent heat requirement has a defined prerequisite that the pushing sequence for the coke ovens must be different from the well-known sequence. According to the present invention, adjacent coke oven chambers must be pushed in the shortest possible time intervals whereby, for example, a battery of 50 coke oven chambers are operated using a pushing sequence for the coke oven chambers Nos. 1, 2, 3, 4, 5, 6, 7 . . . 49 and 50.

The method and apparatus of the present invention provides control means for operating the control valves to adjust, the flow of gases to bring about the production of the maximum amount of heat during the first regenerative period of the total coking time and then less heat for a plurality of regenerative periods, and finally still less heat for the remainder of the coking time. This manner of introducing heat to a heating wall between adjacent oven chambers necessarily requires that the coal charges in adjacent oven chambers are very closely time related in regard to their status while proceeding through various stages in the coking process and, therefore, there is an inherent heat requirement by these adjacent oven chambers which is achieved by the heat produced during the regenerative periods. This manner of heating adjacent coke oven chambers would be totally unacceptable in regard to instances where a newly-charged coke chamber is situated adjacent a coke chamber which has proceeded midway through the coking process.

Since the heat requirement of a coke oven has very variable values during the coking time, the heat requirement at the beginning of the coking time being a multiple of that which is needed shortly before the pressing of the oven, it is not sufficient to design only the feed of the heating gas (regardless of whether it is a so-called strong gas or a weak gas that is first to be preheated in regenerators) so as to be variable. The introduced quantity of combustion air must be controlled to the same extent in order to maintain the desired ratio of gas and air during the combustion process. Because of the different loading of the individual heating walls, which provides the basic feature of such a process, it is not sufficient to allow the suction pressure that prevails in the exhaust flue passage to act on all regenerators. A volume control must be provided between the regenerator bottom passage and the flue passage.

The characteristic feature of the new control for the feeding and exhausting of the gaseous fuel with regenerator coke oven batteries consists in the fact that control or regulating valves are incorporated in the gas inlet and the air inlet to each heating wall and to the related regenerators and in the exhaust for the burned gases from the regenerators. By means of these valves, the flows are controlled as suited to the heat requirement of the adjacent oven chambers in the course of a period that corresponds to the coking time of the ovens. Regenerators that belong to a heating wall are understood to mean those which are exclusively connected to the heating features of the heating wall. Under certain prerequisites, it is also possible to apply the invention to oven systems with which the regenerators work together with several heating walls.

The tasks of the control or regulating valves and the reversing valves that change their position with the regenerative change in suction can be imparted to separate organs. In this case, according to the invention, the control valves for the periodic volume control of the gas and the combustion air, viewed in the direction of flow, can be arranged before the reversing valves for gas and air, and the control valves for the periodic control of the burned gases can be placed behind the reversing valves for the burned gases. It will be recognized that in this way only one control valve at each heating wall is required for each individual medium that is to be controlled. This control valve is active in both half-periods of the regenerative operation.

It is also possible to use valves which act both as a control valve and a reversing valve. Such valves allow the passage of volumes which are within a range between finite values in the one regenerative half-period, while they are closed in the other half period. By means of such combination control and reversing valves, it is possible to work with different quantities of fuel in the two suction directions.

A variable feed and discharge of the gaseous fuel can also be executed in such a way that a fixed value is maintained for the mediums to be introduced or discharged for a longer time period, if necessary for the entire period, but the inlet and outlet in each regenerative half period are completely interrupted during a time segment whose length has variable values in the individual phases of the coking. Thus, flaming, which decreases with a progressive coking, is executed so that no interruption of the feed and discharge takes place in the reversing period at the beginning of the entire time. However, with a progressing coking these time segments are selected so as to be longer and longer. If, for example, the initial flaming is to behave as 4:1 with respect to the flaming at the end of the entire time, the flaming will not be interrupted in the first regenerative half period, while the time segment during which it is

interrupted is gradually increased up to 75% of the half time with a constant value for flaming.

In the sense of the present invention, control or regulating valves also are understood to mean those which pass a constant value of the gaseous mediums timewise during a half time, but also completely block the feed and discharge timewise.

Due to the programmed heating, which is the basic feature of the new control, the coking time can be greatly reduced. However, this is under the assumption that considerably greater gas quantities are introduced to the heating walls in the first hours of the coking time than is the case with the previously standard heating system for coke ovens. Such an introduction of considerably larger gas quantities in the first hours of the coking time also means an increase in the quantities of gaseous combustion agents which are subjected to the regenerative heat exchange. With the same dimensions for the regenerators, such as are customary with previous heating, the storage capacity will naturally not suffice. The regenerators would have to be greatly enlarged. Thus, a much greater cost would oppose the advantage of the new control. Such a cost can be avoided, if a shorter reversing time of, for example, 10 or 15 minutes is used instead of the previously standard reversing time of a half hour for the most part. However, that would have to take place during that part of the coking period in which the introduced gas quantity is greater than the average value that is introduced to the heating walls with the previously standard operating process. Thus, the programmed heating can be operated with the new control so that there is a shorter reversing time in the phases of greater heating and a longer reversing time is selected in the phases of lesser heating.

If control valves and reversing valves are separated, as has been suggested above, a programmed heating can be executed with purely mechanical operating devices. Moreover, it is possible to use control valves whose position is changed constantly within the whole time. Specifically, the change is from an initial maximum value, which constantly drops to a final value. The initial value is much above the average value that is used for the previously standard operation, while the final value represents only a fraction of the previous average value. Cam plates can be arranged for the constant changing of the position of the control valves that are related to each heating wall. Common drives can be provided for their operation for the entire battery or larger oven groups. Care has to be taken that the phase differences that correspond to the coking state of the adjacent oven exist between the actual positions of the individual control valves. With an intermittent operation, such as was given above as a solution (same value for the combustion agent introduction and discharge over longer time segments; variable times for the interruption of that introduction, i.e., interruptions which become longer and longer with the advancing coking), such a mechanical operation, which only needs to be directed towards switching the gas inlet and discharge on and off, can be executed relatively easily by means of a clockwork mechanism.

The control of the introduction and discharge of the combustion agent and the regenerative reversing of a regeneratively heated coke oven battery, however, can also take place electrically. Electrical impulses are converted into pressure values by means of electro-pneumatic signal converters. The control and reversing valves are actuated by means of the pressure medium. The basic elements of such an electro-pneumatic control are, first, a time switch whose period corresponds to the coking time or total time of the ovens. The closing time of each individual contact of this time switch may not be greater than the shortest time within which a reversing or a changing of values has to take place. In general the closing time of all contacts have the same value. The number of contacts corresponds to the maximum value for the reversals and changes which are to be executed within an entire coking time. If the total time, for example, is 12 hours and 12 reversals or changes are to be possible within 1 hour, 12 times 12 or 144 closing contacts must be provided. Each of them is closed for a period of 5 minutes.

Each heating wall is coordinated with a time-matrix plug board. If the heating is to be adjusted in five different stages during an entire coking period, a separate control is used for both direction motions. Thus, five times two or ten vertical conductors are provided in the time-matrix plug board. The provided d.c. voltage, for example 60 volts, is directed to the vertical conductors by the horizontal branches of the plug board by means of diodes during the time in which said voltage is applied to the horizontal branch in question.

Moreover, a programming card that has the same number of conductors as the plug board is coordinated with each heating wall. The connection of the conductors of the plug board and the programming card takes place by means of safety circuits. The programming card has as many branches as the reversing organs which are to be actuated. Moreover, it has still other branches so as to be able to adjust the control valves to different stages. The d.c. voltage, likewise by means of diodes, is transferred from the conductors of the programming card to the individual branches of the programming card. From them it reaches the signal converters assigned to the individual valves. The electrical impulses are converted into pressure values in the converters. The actuation of the control and reversing valves takes place by pneumatic pressure. In order to achieve a stepwise change in the introduction of gas and air and in the discharge of the burned gases within the entire coking period, the electrical impulses pass from the programming card to the electro-pneumatic signal converters through groups of resistances that are connected in parallel in different ways.

The connection of the time-matrix plug board with the programming card of a heating wall takes place by means of relays controlled by safety circuits. This monitors the perfect operation of the sequence of processes by the end contact on the regulating unit. Thus, connections from the matrix plug board to the programming card take place only with a correct execution of the process. If the program for an oven is to be changed, the program card must also be replaced.

When the time switch has returned, if all switches are closed one after another for a short time, opening begins again with the first contact. After the conclusion of a total coking period, the program of the time-matrix plug board also runs out. Hereby, the corresponding phase difference obviously exists between the plug boards of the individual heating walls. The sum of all phase differences is equal to the running time of the time switch. It is recommended that a safety program, which is adjusted to the heating intensity at the end of

the total period, be provided at the end of the program of the time-matrix plug board. A possibility is provided with this safety program for switching over manually if a disturbance exists and an oven cannot be pushed at the right time.

The invention is explained in more detail by means of the attached drawings; specifically

FIG. 1 is a vertical section in a battery's longitudinal direction through several oven chambers and heating walls;

FIG. 2 is a schematic representation of the feeding and discharge of the gaseous operation agent to a heating wall that is between two oven chambers;

FIG. 3 illustrates the circuits of programmed heating with a time-matrix plug board and programming card;

FIG. 4 is a schematic representation of the different stages in the control of heating; and

FIG. 5 is a somewhat schematic representation of an electro-pneumatic signal converter.

In FIG. 1, it is seen that each heating wall 11 is between two oven chambers 10 heated by gaseous fuel. Each heating wall 11 is coordinated with a regenerator 16*a* and a regenerator 16*b*. In the one half period, the combustion air is preheated in regenerator 16*a* and the heat of the burned gases is stored in regenerator 16*b*. In the next half period, regenerators 16*a* and 16*b* change roles.

These are double draft ovens with which the even-numbered heating flues of a heating wall heat up and the odd-numbered flues cool down in a half period. In the next half period, the even-numbered and odd-numbered flues exchange roles. The two pipelines that run through the cellaring, namely lines 21*a* and 21*b*, serve to distribute the gas over a heating wall. As shown in FIG. 2, the gas passages that lead to the odd-numbered flues from pipeline 21*a* are identified as 24*a*. The gas passages 24*b* that lead to the even-numbered flues are connected to pipeline 21*b*. Regenerators 16*a* and 16*b* are also shown. The compressed air distribution line 12, another compressed air line 13, the gas-distribution line 14, and the flue passage 15 are also recognizable schematically. The lines or passages 12 to 15 extend over the length of the battery. Lines 22*a*, which lead to regenerators 16*a*, and lines 22*b*, which lead to regenerators 16*b*, are connected with the distribution line 12 for the combustion air that is introduced under pressure. Specifically, these connections are by control and reversing valves RU 32*a* and RU 32*b*, respectively. The regenerators are connected at their other side to the flue passage 15 for waste heat; specifically, by means of pipelines 26*a*, 26*b* and 25. The valve for switching the waste heat between lines 26*a* and 26*b* is identified as U 36; the valve for controlling the waste gas is designated R 35.

The two gas pipelines 21*a* and 21*b* are connected to the gas distribution pipeline 14; specifically, by means of control and reversing valves RU 31*a* and RU 31*b*. Distribution line 13 serves for the introduction of the degraphitization air. From this line, a distribution line 26, to which either gas line 21*a* or 21*b* is connected by means of reversing valves U 33*a*, or U 33*b*, branches to every heating wall.

The electric control of the programmed heating with the control and reversing valves that are indicated in FIG. 2, is shown in FIG. 3. Here only one time-matrix plug poard, which is provided for a heating wall, and a corresponding programming card are actually visible.

The number 40 identifies the individual contacts; 41 designates the operating mechanism of the time switch. Each time-matrix plug board has ten electrical conductors that are identified as s_1 to s_{10}. They are connected to the corresponding conductors t_1, t_2 . . . t_{10} of a programming card by means of a corresponding switch 42 of a safety circuit. Diodes 43 connect the horizontal electrical branches and the conductors of the time-matrix plug board. Diodes 44 connect the conductors and the horizontal electrical branches of the programming card. The branches of the programming card lead to the electro-pneumatic signal converters 46 by means of so-called X-barriers 45. Here the other pole of the d.c. voltage, which is connected to the branches of the time-matrix plug board by means of switch 40, is applied. The electric impulses are converted into pneumatic impulses by means of the signal converters 46. The reversing and control valves that are represented schematically in FIG. 3 are now actuated by the pneumatic impulses.

Groups of electrical resistances 47, 48, 49, 50 and 66 are series-connected with the control and reversing valves for the fuel gas and the combustion air and likewise with the valve for the waste gas control. From the positions of the diodes it will be seen that the programming card will switch on different resistance groups (of one to four resistances) with the conduction of the d.c. current into the horizontal branches, depending upon which of the contacts 40 are closed. It also will be seen that all four resistances are parallel-connected with the closing of the first contacts 40 (conductors s_1, s_2 and t_1, t_2). Hence, the lowest resistance is present and, therefore, the current strength is the greatest so that the control valves are in their widest open position.

The intensity of the heating (that is, the introduced quantity) is illustrated by the stepped line at the left-hand edge of FIG. 3 beside the time-matrix plug board. The entire course of the coking time is represented graphically. Here, the time is represented as the ordinate and the gas quantity introduced in each time unit is represented as the abscissa. It will be seen that the maximum heating strength is used only during the first regenerative period. Diodes 43 connect the first switch 40 to the first pair of plug board conductors s_1 - s_2 in two half times. From the arrangement of the programming card it will be seen that in the case of its first two conductors t_1 and t_2 all four branches are connected by means of diodes 44. Resistances 47, 48, 49, 50 and 66 are then all parallel. Of necessity, this leads to the greatest current value.

The conductors s_3 and s_4 of the second group are connected during three regenerative periods. With the third and fourth pair of conductors, the times are much longer, as is immediately seen. Because voltage is applied to only one of the two conductors of each pair of conductors according to the programming card, the result is that the other is actually without current. The valves 31*a* and 31*b*, as well as 32*a* and 32*b*, which are switched as control and reversing valves, thus fulfill both a control as well as a reversing function.

It is also seen that valves 33*a* and 33*b* act as pure reversing valves, since either one or the other is loaded in each half time. Insofar as control valve 35 is concerned, a connection 37 between the first and second conductors of each pair sees to it that the diodes 44 which are provided here transmit voltage to the

branches, regardless of whether the voltage is at the first or second conductor.

As has already been noted, only the time-matrix plug board and the programming card for the control of a single heating wall, and the control and reversing valves which belong to that wall, are represented in FIG. 3. The horizontal branches of the time-matrix plug board thus are continued to the right. The diodes 43 are displaced to the extent that the phase of the heating is shifted with respect to the preceding one with each of the following heating walls. The vertical conductors lead to another programming card for each heating wall. Their branches feed, likewise by means of additional resistances 47, 48, 49, 50, 66, electro-pneumatic signal converters which transmit the pneumatic impulses to the control and reversing valves that adjust the introduction and the discharge of the gaseous mediums for the heating wall in question.

The individual parts of the programmed control are indicated schematically in FIG. 4; namely, the time-matrix plug board, the safety circuit, and the programming card, all of which are incorporated in the control apparatus. The impulse of the programming card is transmitted to the X-barrier, from which it passes to the adjusting organs. A limit switch releases switch 42 of the safety circuit. The graduation of the heating during the coking time is indicated with five program steps as at the left upper edge of FIG. 3. The operation takes place with the maximum heating strength only for a relatively short time.

FIG. 5 represents an electro-pneumatic signal converter schematically. The number 51 identifies a permanent magnet into whose ring slot a transducer 52 projects. A rod 53, carrying a valve cone 54 at its lower end, is mounted at its center. The cone more or less blocks orifice 55 for the air entering at 56. 57 is an air density control valve by means of which the air entering at 56 is brought to atmospheric pressure. If the transducer 52 is moved downward with rod 53, the throttle cross-section of the valve 54 is also changed and the pressure in chamber 58 increases. The cascade pressure in chamber 58, corresponding to dynamic pressure, is transmitted by an amplifier 59.

The operation of a battery of coke ovens is designed on the fundamental concept of a consecutive pushing sequence whereby successive adjacent oven chambers are pushed one after another and at short time intervals between each pushing operation. This has been achieved in a manner that brings about a reduction to the necessary coking time of each oven chamber. These aspects, as well as others set forth herein, are realized by the individual and particular manner of controlled heating of each heating wall between adjacent oven chambers. The control means operate the control valves to adjust the flow of gases to bring about the production of the maximum amount of heat during the first regenerative period of the total coking time and then less heat for a plurality of regenerative periods, and finally still less heat for the remainder of the coking time. This manner of introducing heat to a heating wall between adjacent oven chambers necessarily requires that the coal charges in adjacent oven chambers are very closely time related in regard to their status while proceeding through various stages in the coking process and, therefore, there is an inherent heat requirement by these adjacent oven chambers which is achieved by the heat produced during the regenerative periods. The inherent heat requirement is unique to the closely time related status in the coking process of adjacent oven chambers.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A battery of regeneratively heated coke ovens having heating walls and regenerators, and an apparatus for controlling the introduction of combustion gases through supply lines to the heating walls and the related regenerators and the discharge of burned gases from the regenerators, comprising control valves in the gas and air inlet to each heating wall and in the flue for burned gases from the regenerators, and control means operating said valves to control the flow of said gases to produce the maximum amount of heat during the first regenerative period of the total coking time and then less heat for a plurality of regenerative periods and finally still less heat during the remainder of the coking time.

2. In a battery of regeneratively heated coke ovens according to claim 1, said apparatus including means for delivering degraphitization air under pressure to the gas supply lines.

3. In a battery of regeneratively heated coke ovens according to claim 1, said apparatus including reversing valves for gas and air and reversing valves for burned gases, said control valves for gas and air being located upstream from the reversing valves for gas and air, and the control valves for burned gases are located downstream from the reversing valves for burned gases.

4. In a battery of regeneratively heated coke ovens according to claim 1, in which said control valves are adjustable to vary flow in a regenerative half period and can be closed in the other regenerative half period, whereby the control valves also act as reversing valves.

5. In a battery of regeneratively heated coke ovens according to claim 1, said apparatus including a time-matrix plug board for each heating wall, a programming card for each heating wall, a plurality of electrical conductors on each card, electropneumatic signal converters for operating said valves, a time switch whose period corresponds to the coking time of the ovens for transmitting a direct current voltage to the branches of said plug boards, means including diodes for conducting said current from said branches to said cards, and means including diodes for conducting said current from the cards to said signal converters to actuate them.

6. In a battery of regeneratively heated coke ovens according to claim 5, including groups of resistances for transmitting electrical impulses from the programming cards to said signal converters, and means for connecting said resistances in parallel in different predetermined ways to achieve a stepwise change in gas and air feed and discharge of burned gases within a total coking time.

7. In a battery of regeneratively heated coke ovens according to claim 1, said apparatus including cams arranged for the continuous changing of the control valve assigned to each heating wall within a coking period, and common driving means for the cams for the entire

battery, whereby phase differences that correspond to the coking state of the adjacent ovens occur between the actual positions of the individual control valves

8. A method of operating regeneratively heated coke ovens having heating walls and regenerators, comprising using the maximum amount of heat only during the first regenerative period of the total coking time, then using less heat for a plurality of regenerative periods, and then using still less heat for still more regenerative periods, whereby to limit the production of heat to the requirements of the ovens during the coking period.

9. A method according to Claim 8, in which said plurality of regenerative periods are three.

10. A method according to Claim 8, in which said heat is produced by burning a mixture of gas and air, and said heat is reduced by reducing delivery of gas and air to the heating walls and simultaneously reducing the size of the flues from the regenerators.

11. The method according to Claim 8 wherein the oven chambers at both sides of the heating walls receive amounts of heat corresponding to different stages of the coking process, and said stages are characterized by a small time difference in relation to the total coking time of an oven.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,875,016 Dated April 1, 1975

Inventor(s) Helmut Schmidt-Balve and Alfred Albertz

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 10, line 67, after "entire" insert -- battery, whereby phase differences that correspond to the coking state of the adjacent ovens occur between the actual positions of the individual control valves.

8. A method of operating regeneratively heated coke ovens having heating walls and regenerators, comprising using the maximum amount of heat only during the first regenerative period of the total coking time, then using less heat for a plurality of regenerative periods, and then using still less heat for still more regenerative periods, whereby to limit the production of heat to the requirements of the ovens during the coking period.

9. A method according to claim 8, in which said plurality of regenerative periods are three.

10. A method according to claim 8, in which said heat is produced by burning a mixture of gas and air, and said heat is reduced by reducing delivery of gas and air to the heating walls and simultaneously reducing the size of the flues from the regenerators.

11. The method according to claim 8 wherein the oven chambers at both sides of the heating walls receive amounts of heat corresponding to different stages of the coking process, and said stages are characterized by a small time difference in relation to the total coking time of an oven. --

Signed and sealed this 15th day of July 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks