July 31, 1962 L. G. TUCKER, JR 3,047,474

RECIRCULATION UNDERJET COKING RETORT OVEN

Filed Nov. 14, 1956 3 Sheets-Sheet 1

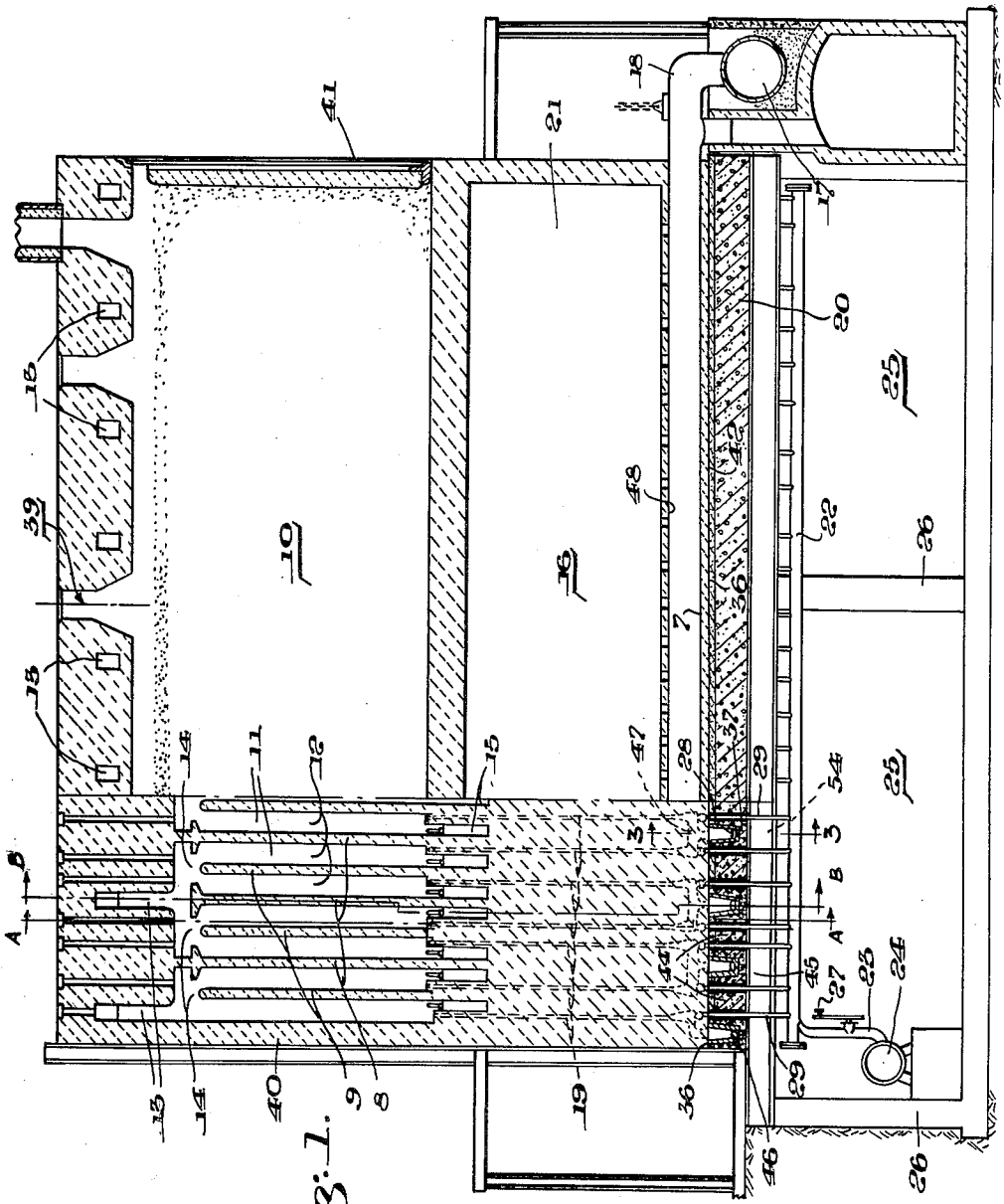


Fig. 1.

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Filed Nov. 14, 1956 3 Sheets-Sheet 2

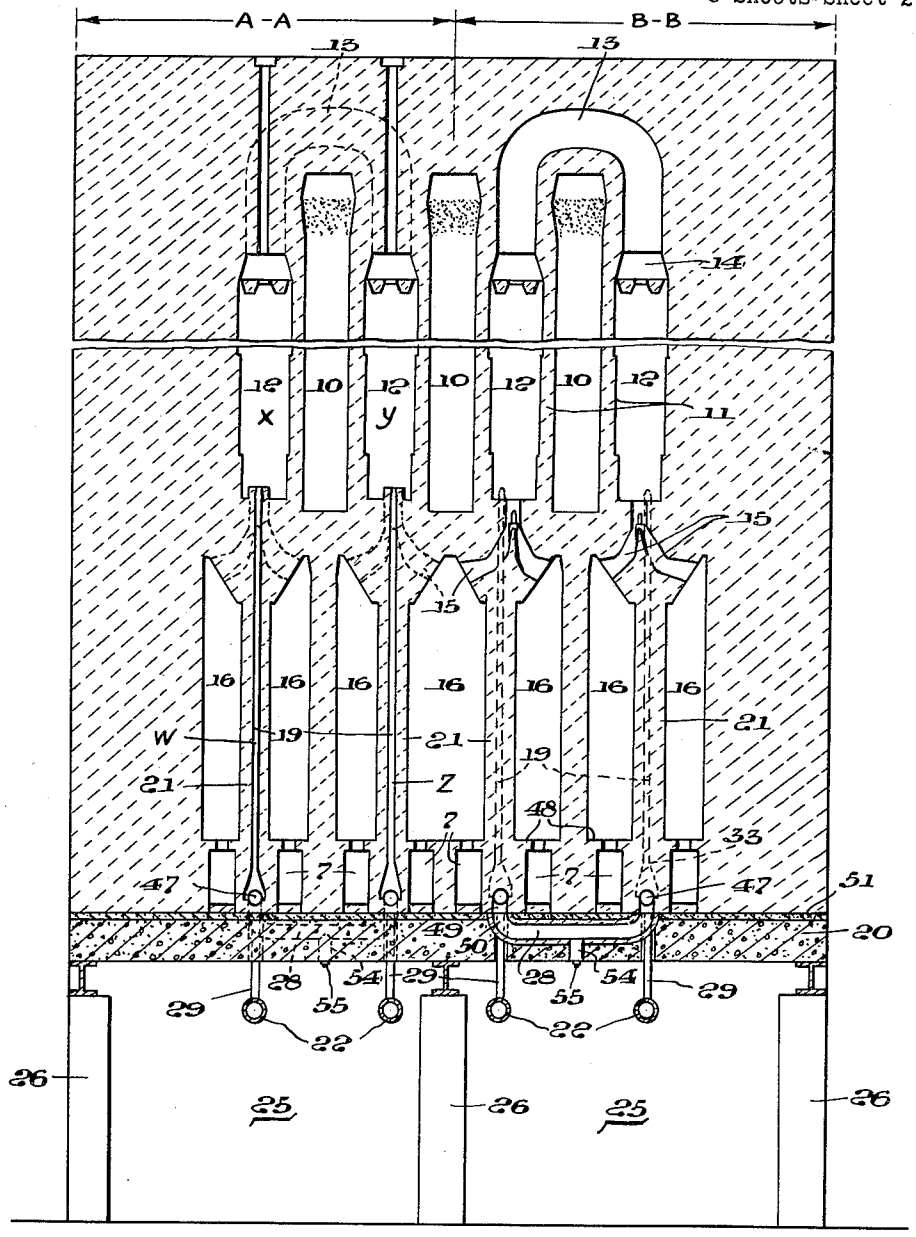


Fig. 2.

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Filed Nov. 14, 1956 3 Sheets-Sheet 3

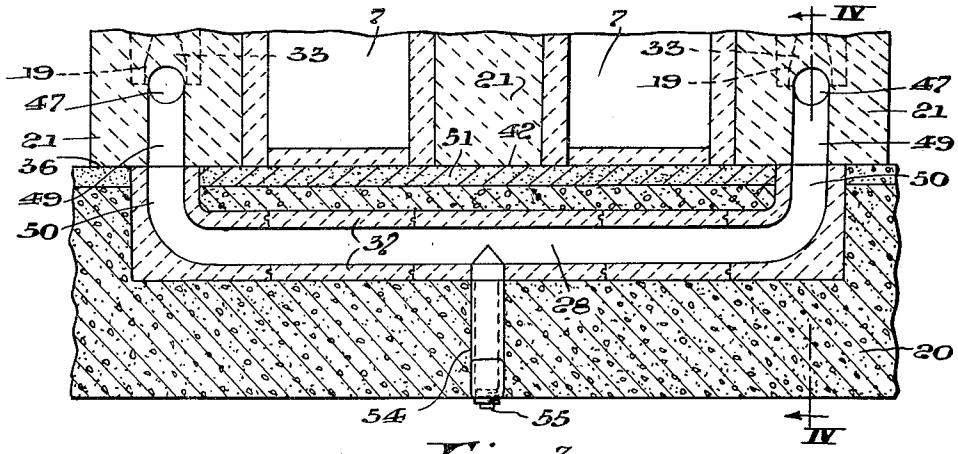


Fig. 3.

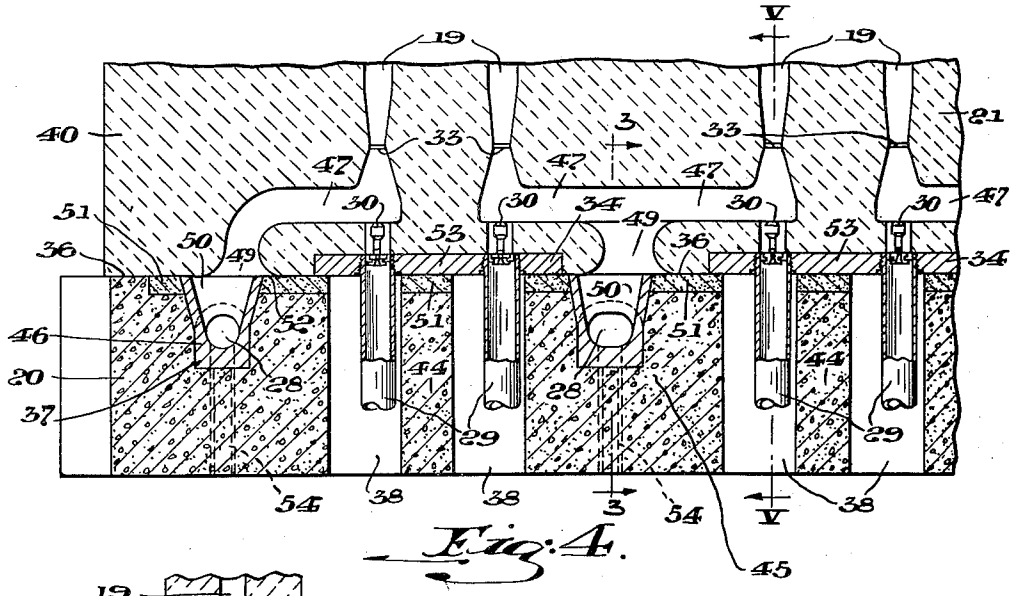


Fig. 4.

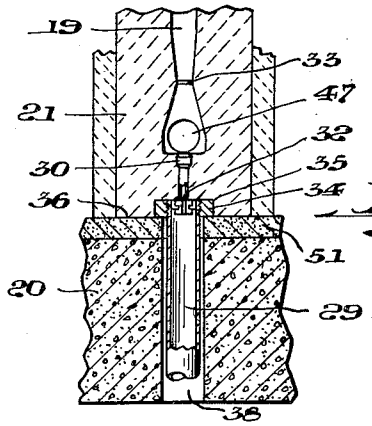


Fig. 5.

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United States Patent Office 3,047,474 Patented July 31, 1962

3,047,474

RECIRCULATION UNDERJET COKING RETORT OVEN

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Filed Nov. 14, 1956, Ser. No. 622,170
6 Claims. (Cl. 202—143)

This invention relates to improvements in coking retort oven batteries, and more particularly to improvements in the construction and operation of ovens of the recirculating duct type of the common assignee's Joseph van Ackeren Patents 2,306,678 of December 29, 1942, and 2,507,554 of May 16, 1950, having the further improved features of the common assignee's Joseph van Ackeren copending application Serial No. 236,808 filed July 14, 1951, now Patent No. 2,799,632 of July 16, 1957, of which the present invention is a continuation improvement in part.

The general object of the present invention is the further improvement of the oven of said inventions whereby to continue the more simple and compact oven mat design as disclosed in the primary Patent 2,306,678, aforesaid, with the recirculating ducts immovable in the concrete mat, but with the rich gas riser pipes and their discharge nozzles interconnected with silica brickwork of the regenerator walls for movement in unison therewith relative to the concrete mat, for automatic centering of the rich gas discharge nozzles with venturies of the rich gas channels in the regenerator walls, as in the aforesaid improvement Patent 2,507,554, to insure correct recirculation of waste gas through the recirculation ducts to the rich gas in the underjet rich gas risers, notwithstanding the relative movement of the silica brickwork along the concrete mat as the brickwork of the battery is heated.

An advantage of the present improvement is that it continues the compact design of the concrete mat of the first mentioned Patent 2,306,678, but with self centering of the rich gas nozzles with the venturi ducts, as in said Patent 2,507,554 and application 236,808, in a manner that eliminates need for either the expensive silica brickwork intermediate the mat and the regenerator sole channels with the consequence of an increase in height of the battery as in the first improvement Patent 2,507,554 or the complex mat design of shiftable ducts in pockets in the concrete mat as in the second improvement of the aforesaid application 236,808 now Patent No. 2,799,632 of July 16, 1957, for the purpose of insuring the coaxial alignment of the rich gas discharge nozzles with their venturi ducts.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings forming a part hereof.

In the preferred embodiment of the invention, the improvement is incorporated in a modern cross regenerative horizontal coke oven battery of the cross over flue interconnected vertical combustion flue type mounted on a concrete mat above an accessible basement space, and provided with rich gas supply means in the basement space for supply of rich fuel gas to the vertical combustion flues by means of underjet rich gas riser conduits or ducts in the regenerator walls and leading individually from the basement space upwardly to the bottom of the vertical combusion flues. The rich gas riser channels or ducts of the flues interconnected by crossover flues are connected with each other by recirculating ducts immovably embedded in the oven mat below the top of the same and extending from one regenerator wall to another underneath the sole channels of intervening regenerators. The recirculating ducts extend longitudinally of the battery and are spaced from each other crosswise of the battery to serve a pair of rich gas risers on opposite sides of each end of each duct in the duct interconnected

regenerator walls. The ends of the ducts extend upwardly to the top of the mat and terminate in an upwardly open flared outlet flush with the top of the mat. Each one of the recirculating ducts is located in the vertical plane of one of the alternate partition walls forming a crosswise row of vertical flues in the heating walls at the sides of the intervening coking chambers. The rich gas riser channels are located in the regenerator walls in vertical planes closer to the intermediate partition walls than to the alternate partition walls forming the rows of vertical combustion flues. Each underjet duct or gas riser channel of a pair on opposite sides of an alternate partition wall is provided with a lateral branch conduit extending towards the vertical plane of the alternate partition wall in the region of the regenerator wall at a level below the tops of the sole channels and the branch conduits of each pair of gas riser channels terminate in a downwardly opening common inlet flush with the base of the regenerator wall, to register with the upwardly opening outlet of the recirculating duct in the mat in the vertical plane of the alternate partition wall between the pair of rich gas riser channels. With this arrangement there is provided, as shown on the drawings, sufficient space in the concrete mat below the regenerator walls between each two duct interconnected pairs of rich gas risers or underjet ducts to incorporate the recirculating duct for both branch conduits for coaction with the recirculation duct when immovably located at a fixed point in the mat, as in the first Patent 2,306,678, and yet allow for underjet gas riser pipes having a fixed connection with the regenerator walls, as in the second Patent 2,507,554, for centering action of the rich gas riser pipes provided with nozzles, to maintain them in alignment with the rich gas riser channels or underjet ducts in the walls, during movement of the regenerator walls relative to the supporting concrete mat when heated.

The invention, however, is not limited in all its aspects to use of the novel features and attributes of the invention in conjunction with the preferred and best mode of the crossover flue interconnected combustion flue type of coke oven battery, since many of the novel features are of like utility with other types of heating flue systems involving concurrent "on" and "off" operation of rich gas risers in regenerator walls separated by regenerator chambers and requiring the waste gas recirculating duct beneath the regenerator chamber to induce recirculation of waste gas from a downflow vertical combustion flue through its idle "off" rich gas feed channel into the "on" rich gas feed channel in another regenerator wall on the other side of an intervening regenerator chamber, for dilution of the rich gas before it enters the combustion flues on the opposite side of an intervening coking chamber, under the pressure of flow of the entering rich gas from a basement beneath the oven mat. Such other types may be modified oven batteries of the type of H. Koppers Patent 818,033, or Berthelot Patents 1,340,104 and 1,361,671 and other ovens in this art. Hence, the invention is not confined in all its aspects to the best mode herein described and illustrated as the preferred embodiment.

Referring to the drawings:

FIG. 1 is a vertical elevational section taken crosswise of a battery of underjet coke ovens embodying the present improvement, said section being taken in part through a heating wall and in part through the adjacent coking chamber;

FIG. 2 is a composite section taken longitudinally of the battery shown in FIG. 1, the sections A—A and B—B being taken respectively along the lines A—A and B—B of that figure;

FIG. 3 is an enlarged fragment of FIG. 2, the section

being taken longitudinally of the battery on the line 3—3 of FIGS. 1 and 4.

FIG. 4 is an enlarged vertical section taken on the line IV—IV of FIG. 3.

FIG. 5 is an enlarged vertical sectional view taken on the line V—V of FIG. 4, and illustrating the installation of the rich gas risers and their nozzles in fixed relation with the silica masonry of the regenerator walls according to the aforesaid Patent 2,507,554.

The same characters of reference designate the same parts throughout the several views of the drawings.

In the embodiments thereof illustrated in the drawings, the various features of the invention are shown incorporated in a battery of combination ovens of the well-known Becker type of which a prominent characteristic is crossover ducts that are disposed to flow combustion-products as they issue from vertically disposed heating flues of an oven heating wall over the top of an adjacent coking chamber and into similar and similarly positioned heating flues of a heating wall adjacent the opposite side of said coking chamber, but it will be understood from the following discussion of the features of the invention that they are especially susceptible of employment to the advantage of any coke oven structure having in its heating system vertically-disposed heating flues with their tops interconnected for purposes of gas-flow in opposite directions. As a specific example of another class of ovens in which the invention can be successfully exploited there may be mentioned those of the aforesaid H. Koppers and Berthelot patents whose heating flues are arranged according to the so called single and double divided construction.

Referring now to the drawings and more specifically to the preferred embodiment of the instant improvement shown in FIGS. 1 and 2, the illustrated Becker type coke oven battery comprises a plurality of coking chambers **10** and heating walls **11** that are disposed in alternation lengthwise of the battery. Heating walls **11** comprise a row of odd and even numbered vertical longitudinal partition walls **9** and **8** forming a plurality of vertically disposed heating flues **12** that are arranged side-by-side crosswise of the battery and are adapted for gas flow purposes in groups of which each comprises, with the exception of the two flues at either end of each heating wall, four heating flues having a common crossover duct **13** whereby combustion-products of one such flue group are flowed upward and over the top of a coking chamber **10** and into a corresponding flue-group adjacent the opposite side of an intermediate coking chamber. Each such group of four flues is structurally subdivided into pairs of flues of which each pair is provided with a common outlet **14** and each pair of flue outlets for a flue group are symmetrically disposed in respect of a said crossover duct. The two heating flues at either end **40**, **41** of a heating wall **11** are furnished with their individual crossover which is proportioned to accommodate the combustion products produced by the larger amounts of underfiring gas burned in flues at that location for the purpose of overcoming the greater radiation from the heating wall ends; any other preferred number of heating flues can, of course, be connected with the end crossover ducts.

The heating flues of the heating walls each communicate individually by conduits **15** with two cross regenerators **16** therebeneath, each such regenerator being arranged to preheat combustion air at such times as the heating flues are being underfired with non-regeneratively preheated fuel gas as, for example, obtains when the ovens of the battery are operated as "coke ovens." One of the regenerators of the pair of regenerators with which each heating flue is communicably connected is, however, also adapted to preheat lean fuel gas delivered thereinto from a lean fuel gas main **17** and gas flow box **18** in the well known manner in those instances where the ovens are operated as "gas ovens" and are therefore underfired with extraneously derived gas. In the underfiring of the heating flues with either regeneratively preheated or non-regeneratively preheated fuel gas, they as well as their combustion air are all introduced into the lower parts of the heating flues exclusively and each at but one level thereof, so that their combustion is initiated at substantially only one place. This type of underfiring will be hereinafter referred to as "one stage" combustion.

At such times as the battery illustrated in FIGS. 1 and 2 are operated as "coke ovens" and are heated by rich fuel gas of higher calorific value that needs no preheating step for its effective combustion, such rich fuel gas is delivered into the bottom of the heating flues according to the underjet principle by means of gas riser channels in the form of ducts **19** that extend from the lower surface of the concrete supporting mat **20** of the battery upwards through a silica regenerator wall **21** to port into the lower parts of the heating flues. Each such duct **19** communicates, by means of pipe connections **29**, with a wall header pipe **22** whereby all the heating flues comprising a single heating wall are simultaneously supplied with the heating gas of high calorific value. Each such wall header pipe **22** of the battery in turn communicates through its pipe connections **23** with a principal supplying main **24** that extends lengthwise of the battery through passageways **25**, formed beneath mat **20** by the battery supporting piers **26**, and communicates with a reservoir of rich gas outside the battery structure. Valve means **27** is adapted for actuation by the gas flow reversing mechanism (not shown) of the battery to supply fuel gas to its associated heating wall in alternation with a heating wall thereadjacent.

In accordance with the instant improvement, as clearly shown in FIG. 2, the two underjet ducts **19** that are associated with corresponding heating flues of adjacent heating walls employing the same crossover duct **13**, are communicably connected adjacent their lower ends by means of recirculating duct **28** located in concrete mat **20**, said recirculating duct thus providing means whereby a circulation of gases is established between the lower parts of the heating flues connected thereby. Recirculating ducts **28** are entirely surrounded by the concrete material of the mat, as shown in said FIGS. 1 and 2, adjacent either the upper or lower surface thereof. The said recirculating ducts are made of high duty clay liner sections.

Rich fuel gas contained under pressure in the wall header pipes **22** of the distributive system therefor is allocated individually to each heating flue of an associated heating wall by means of pipe connections formed into a branch riser pipe **29**, said branch riser pipe having its outlet end removably inserted into the lower part of underjet duct **19** along which it extends to a point substantially at the level of the bottom of the silica regenerator wall **21**, at the top of the concrete mat which contains recirculating duct **28**.

The rate at which rich fuel gas is delivered into the individual underjet ducts **19** and by them conducted into the heating flues is controlled by means of the gas flow nozzle **30**, FIG. 4, which can be secured at a preferred point so that the position of its discharge orifice **32**, FIG. 5, is adjustable in respect of the narrowest central portion of the Venturi member **33**. Rich fuel gas enters the heating flue **12** above in quantities determinable, amongst other factors, by the area of orifice **32** and also by the pressure under which said gas is maintained in the wall header **22**. Nozzle **30** being replaceable, the amount of fuel gas delivered to the heating flue above is optionally variable either by substituting for an existing nozzle a like nozzle having an outlet of different effective area or by altering the gaseous pressure maintained in the associated wall header **22**. From end **40** to end **41** of the heating wall, the orifices of nozzles **30** are preferably graduated in accordance with the taper of the adjacent coking chamber and the thereby occasioned diverse heat requirements of its coal content at different points therealong.

By means of the described gas flow regulating means,

rich fuel gas is injected into the underjet ducts 19 in the form of a jet which exerts an ejector effect on gases contained in the recirculating ducts 28 and causes them to flow upwardly with the jetted fuel gas and to admix therewith as a diluent. When, in FIG. 2, the underjet duct W is delivering fuel gas to the flue X thereabove, its corresponding heating flue Y of the adjacent heating wall and with which said flue X is communicably connected not only by crossover duct 13 but also by means of recirculating duct 28, is filled with combustion products flowing downwardly to outflow regenerators. The said underjet duct Z and its associated recirculating induction duct 28 are thus filled with combustion products derived from the top of heating flue X through crossover 13 and heating flue Y. In consequence, therefore, of the jet of rich fuel gas rising through underjet duct W, those gases induced to flow through recirculating ducts 28 are actually combustion products of rich fuel gas previously burned in flue X. Inasmuch as these combustion products are relatively inert, their mixing with the rich fuel gas as they rise through duct W has the effect of introducing into the lower part of heating flue X a fuel gas of lower calorific value and slower combustion characteristics than would otherwise obtain. This has the beneficial effect of making it possible to maintain a reduced temperature gradient between the tops and bottoms of the heating flues and so promotes uniformity of heat distribution throughout the adjacent coal charge. As is obvious from the drawing of FIG. 2, reversal of flow of gases through the flues X and Y in no ways alters the results obtained.

The apparatus thus furnishes means whereby a rich fuel gas can be continuously and automatically diluted with an inert gas inside of the battery structure and before it enters the heating flues, thus making it possible to retard the combustion rate of a rich fuel gas and to obtain the benefits of underfiring with a gas of optionally regulable low calorific value without increasing the load of recirculated combustion products flowed through the regenerators or disturbing the normal flow through the heating flues of the columns of fuel gas and air introduced at their lower parts.

The combustion products drawn downwardly from the heating flues through the underjet ducts 19 by means of the jet of rich gas are subjected to considerable cooling by the walls of the regenerators and those of the sole channels 7, so that said jet operates on gases having viscosities greatly reduced from those they exhibit when in the heating flues; this fact importantly facilitates their induction into the upflowing underjet ducts by the jet of fuel gas. Their temperature is however not reduced below the dew point of their moisture content and the presence of this water vapor along with their carbon dioxide and small oxygen content acts as an agent that so adequately hinders the accumulation of carbon deposits in the underjet ducts that a decarbonizing step therefor is usually not necessary. Access may be had into each recirculating duct 28 from the battery basement through a conduit 54 for cleaning or regulation by way of cap 55 that is removably mounted on the lower end of the walls of said conduit 54.

As in the aforesaid Patent 2,507,554, the gas line 22, 29 and nozzles 30 are interlocked with the silica brickwork structure 21 that is differentially expansible on top of the concrete mat 20, by means of metal blocks 34 in cement in recesses 35 in the base 36 of the silica walls 21, to move the nozzle 30 in correspondence with the movement of the silica brickwork 21, during its movement in expansion and contraction, relative to the concrete mat 20, and to the clay of the sole channels 7, to thereby hold the nozzle 30 and line 29 and venturi throat 33 in coaxial alignment with each other and with the axis of the upper portions of the rich gas riser underjet ducts 19 in the silica walls 21, as shown in FIGS. 1, 4 and 5.

The recirculating ducts 28 are composed of fire clay pipe sections 37 which are encased in the concrete of the mat 20 in end-to-end relation, and the mat is provided through passages 38 to accommodate the lateral movement of the gas riser pipes 29 and their nozzles 30 when they move in unison with the silica brickwork 21.

When heated up the concrete of the mat 20 expands cumulatively from the longitudinal vertical central plane 39 of the battery towards its two opposite sides 40, 41, to a lesser extent than the silica masonry 21 at the juncture with the top 42 of the concrete. At each side 40, 41, the concrete 20 may move out one and one quarter inches whereas the silica brickwork 21 may move out three inches. The brickwork 21 therefore must be predesigned to be built in the cold so as to have the interconnecting passages 19 offset from those parts 29 thereof, in the mat 20, in different degrees from the center 39 outwards toward the sides 40, 41, of the battery to ensure their proper register when the battery is fully heated up. The movement of the riser pipes 29 is such that there is left insufficient space to contain the recirculating ducts 28 in the mat 20 when such ducts are located in the battery structure as in said earlier inventions with the recirculating ducts 28 in the vertical plane of the intermediate partition walls 8 of the vertical combustion flues 12 alongside the coking chambers 10, since with the rich gas risers 29 in vertical planes on opposite sides of such waste gas ducts 28, the spaces 44 in the mat 20 between the through passages 38 is insufficient in width to accommodate the recirculating duct 28 in an immovable manner in the mat, as will be seen from FIG. 4.

In accordance with the present improvement, to this end, the heating flue gas flow system is revised to connect the rich gas riser underjet ducts 19 that are in planes on opposite sides of the even numbered alternate partition walls 8 with the same recirculation duct 28, rather than connecting the underjet ducts 19 on opposite sides of the odd numbered intermediate partition walls 9 with the same recirculation duct 28 as in my aforesaid inventions. In this manner a wider area 45 is available to incorporate the recirculating duct 28 under the even numbered alternate partition walls 8 with the rich gas underjets 30 retained in their positions in vertical planes on opposite sides of the odd numbered intermediate partition walls 9 and closer to the odd numbered intermediate partition walls 9 than to the even numbered alternate walls 8. This is made possible by provision of a separate recirculating duct 46 for the underjet duct 19 of the end flues at each of the opposite horizontal ends 40, 41, of the heating walls 11.

Each pair of gas riser underjet ducts 30 on opposite sides of an alternate partition wall 8 is individualized to the recirculating duct 28 in the vertical plane of the alternate partition 8 and is connected therewith by branch conduits 47 extending towards said vertical plane at a level below the tops 48 of the sole channels 7 and communicating in common with a downwardly opening inlet 49 flush with the base 36 of the silica regenerator wall 21.

The recirculating ducts 28 terminate at each end in upwardly opening flared outlets 50 to register with the downwardly opening inlets 49 for their corresponding pairs of gas riser underjets 19 in each of the two regenerator walls that the recirculating ducts individually interconnect.

The top surface 42 of the concrete mat 20 is preferably composed of insulating concrete 51. Metal regenerator bearing plates 52 are interposed between the top surface 42 of the mat 20 and the bottoms 36 of the regenerator walls 21, and the interlocking member 34 for each two adjacent rich gas riser pipes 29 on opposite sides of the intermediate partition walls 9 for the vertical flues 12 are formed as a single piece 53.

The invention as hereinabove set forth is embodied in

particular form and manner but may be variously embodied within the scope of the following claims.

I claim:

1. A regenerative coke oven, comprising: a silica brickwork masonry mass constituted of horizontal coking chambers alternating in position side-by-side with flued heating walls; regenerators separated by oven supporting regenerator division walls located below the coking chambers and heating walls, brick sole channels below the regenerators; a concrete oven supporting mat above an accessible basement space beneath the mat; said regenerator division walls resting directly on the top of the concrete mat and being constituted of silica brickwork masonry where they rest on the top of the mat, and said brick sole channels being laid intermediate the silica masonry of the adjacent regenerator division walls and also resting directly on the top of the mat; "on" and "off" rich gas risers extending upwardly through the silica masonry regenerator division walls; rich gas riser pipes having inlet nozzles in axial alignment with the gas risers; waste gas recirculation ducts extending longitudinally of the battery from one regenerator division wall to another underneath the sole channels of the intervening regenerators to interconnect the gas risers in said division walls, said recirculating ducts being located in spaced relation to each other and to the rich gas risers crosswise of the battery and provided at each end with an upwardly open outlet flush with the top part of the concrete mat for communicable connection with the off and on gas risers in the regenerator division walls that they interconnect; and branch ducts located in the silica brickwork of the regenerator division walls, for communicably connecting the outlets at the ends of the recirculating ducts with the rich gas risers in the regenerator division walls, each branch duct comprising a downwardly opening inlet flush with the base of its regenerator division wall and aligned with the upwardly open outlet at one end of its recirculation duct and a discharge outlet leading to its gas riser in the silica masonry at the level at which the aforesaid gas inlet nozzles discharge therein and which includes the novel combinational arrangement of parts in which the rich gas nozzles are fixed to the silica brick of the regenerator division walls for movement in unison therewith with the riser pipes freely movably disposed in passages in the concrete for such movement, to insure the discharge of the rich gas in the form of a jet into the rich gas risers in the silica masonry coaxially of the latter, and the waste gas ducts are immovably disposed within the concrete below the top of same.

2. A coking retort oven as claimed in claim 1, and in which a venturi throat is disposed within the gas risers at a level above the discharge outlets of the branch ducts.

3. A regenerative coke oven, comprising: a silica brickwork masonry mass constituted of horizontal coking chambers alternating in position side-by-side with flued heating walls; regenerators separated by oven supporting regenerator division walls located below the coking chambers and heating walls; sole channels below the regenerators; a concrete oven supporting mat above an accessible basement space beneath the mat; said regenerator division walls resting directly on the top of the concrete mat and being constituted of silica brickwork masonry where they rest on the top of the mat, and said sole channels being intermediate the silica masonry of the adjacent regenerator division walls and also resting directly on the top of the mat; "on" and "off" rich gas risers extending upwardly through the silica masonry regenerator division walls; rich gas riser pipes having inlet nozzles in axial alignment with the gas risers; waste gas recirculation ducts extending longitudinally of the battery from one regenerator division wall to another underneath the sole channels of intervening regenerators to interconnect the gas risers in said division walls, said recirculating ducts being located in spaced relation to each other and to the rich gas risers crosswise of the battery and provided at each end with an upwardly open outlet flush with the top of the concrete mat for communicable connection with the off and on gas risers in the regenerator division walls that they interconnect; and forked extension ducts located in the silica brickwork of the regenerator division walls, for communicably connecting the outlets at the ends of the recirculating ducts with the rich gas risers in the regenerator walls, each forked extension duct comprising a downwardly opening central branch with an inlet flush with the base of its regenerator division wall and aligned with the upwardly open outlet at one end of its recirculation duct and oppositely disposed side branches leading to gas risers in the silica masonry at the level at which the aforesaid gas inlet nozzles discharge therein and which includes the novel combinational arrangement of parts in which the rich gas nozzles are fixed to the silica brick of the regenerator division walls for movement in unison therewith with the riser pipes freely movably disposed in passages in the concrete for such movement, to insure the discharge of the rich gas in the form of a jet into the rich gas risers in the silica masonry coaxially of the latter, and the waste gas ducts are immovably disposed within the concrete below the top of same.

4. Apparatus as claimed in claim 3, and in which the flued heating walls are constituted of crossover flue interconnected combustion flues, and in which the gas riser channels of the flues interconnected by crossover flues are connected with each other by the recirculating ducts as aforesaid.

5. A regenerative coke oven, comprising: a silica brickwork masonry mass constituted of horizontal coking chambers alternating in position side-by-side with flued heating walls constituted of longitudinal partition walls forming a plurality of odd and even numbered vertical combustion flues arranged side-by-side crosswise of the battery; regenerators separated by oven supporting regenerator division walls located below the coking chambers and heating walls; a concrete oven supporting mat above an accessible basement space beneath the mat; said regenerator division walls resting directly on the top of the concrete mat and being constituted of silica brickwork masonry where they rest on the top of the mat; "on" and "off" rich gas risers extending upwardly through the silica masonry regenerator division walls; rich gas riser pipes having inlet nozzles fixed to the silica brick of the regenerator division walls for movement in unison therewith in axial alignment with the gas risers therein and having the riser pipes freely movably disposed relative to the concrete in passages therein for such movement, to ensure the discharge of the rich gas in the form of a jet into the rich gas risers in the silica masonry coaxially of the latter; waste gas recirculation ducts immovably disposed within the concrete mat below the top of the same and extending longitudinally of the battery from one regenerator wall to another underneath the intervening regenerators and provided at each end with upwardly open outlets flush with the top part of the concrete mat for communicable connection with the off and on gas risers in the regenerator walls to which their ducts extend, and which includes the novel combinational arrangement of parts in which each one of said recirculating ducts are located in the vertical plane of one of the even numbered alternate partition walls forming a crosswise row of vertical flues in the heating walls interconnected by the ducts; all of said rich gas riser channels being located in the regenerator walls in vertical planes closer to the odd numbered intermediate partition walls than to the even numbered alternate partition walls forming the rows of vertical combustion flues; and each gas riser channel of a pair on opposite sides of an even numbered alternate partition wall being provided with a lateral branch conduit extending towards the vertical plane of the even numbered alternate partition wall and located in the region of the regenerator wall alongside the bottoms of the intervening regenerators, the branch conduits of each pair

of gas riser channels terminating in a downwardly opening common inlet flush with the base of the regenerator wall, to register with the upwardly opening outlet therebelow at the end of the recirculating duct in the vertical plane of the even numbered alternate partition wall between the pair of rich gas riser channels.

6. Apparatus as claimed in claim 5, and in which the flued heating walls are constituted of crossover flue interconnected combustion flues, and in which the gas riser

channels of the flues interconnected by crossover flues are connected with each other by the recirculating ducts as aforesaid.

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