June 29, 1965 D. W. BONNETT 3,192,134

HIGH AND LOW BURNER GUN FLUE COKE OVEN WITH WASTE GAS RECIRCULATION AND DECARBONIZING AIR

Filed Oct. 19, 1961 3 Sheets-Sheet 1

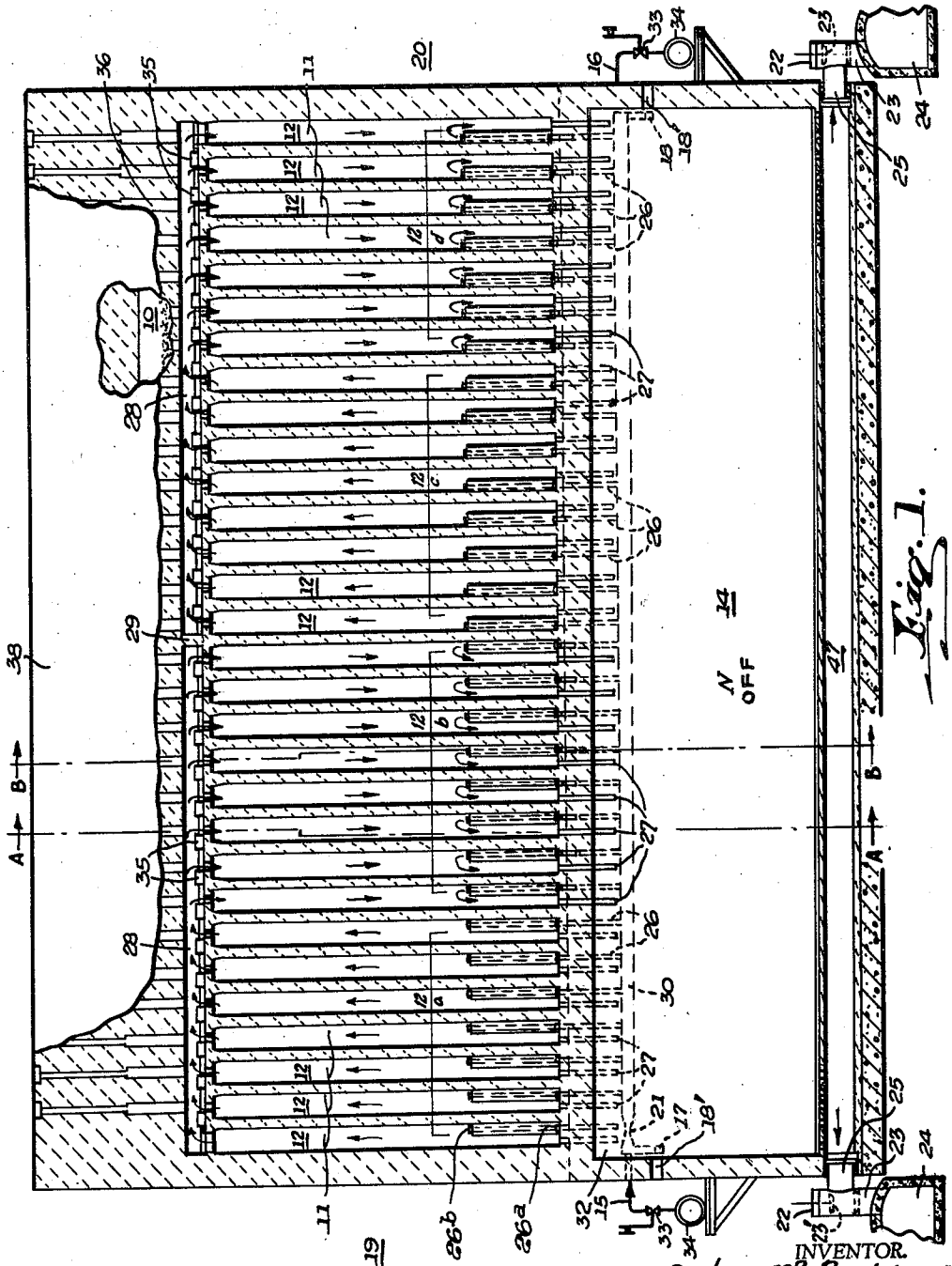


Fig. 1.

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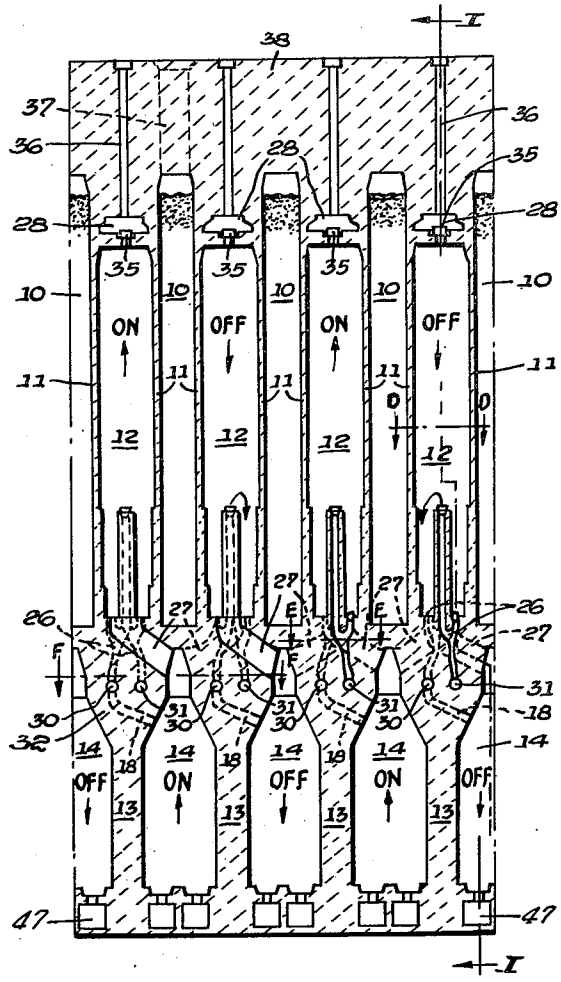


Fig. 2.

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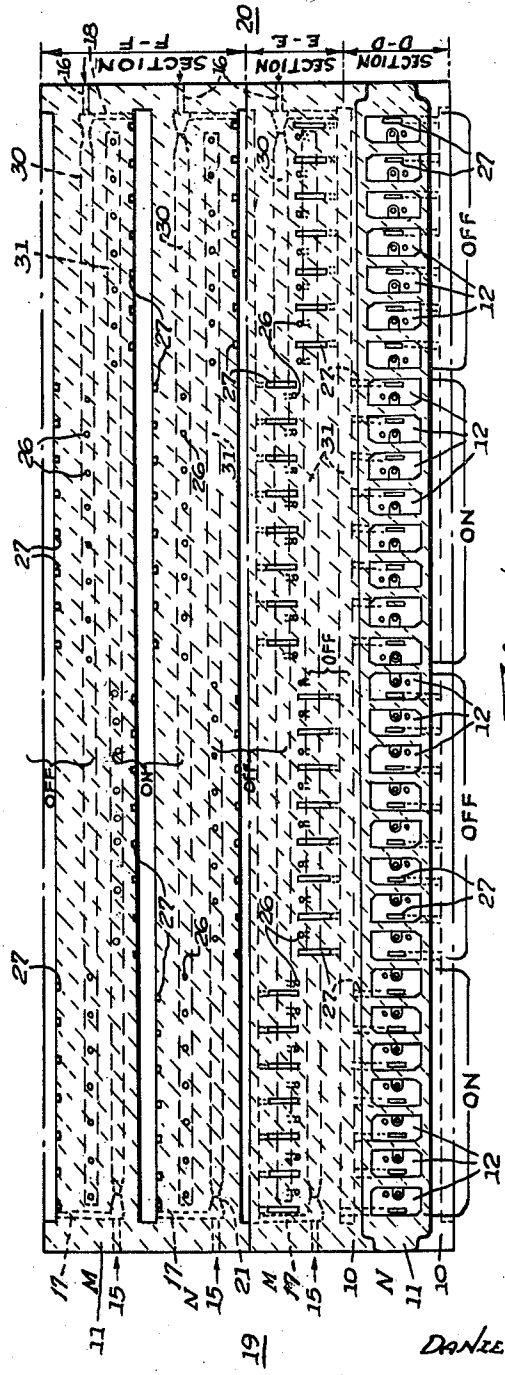


Fig. 3.

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HIGH AND LOW BURNER GUN FLUE COKE OVEN WITH WASTE GAS RECIRCULATION AND DECARBONIZING AIR

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4 Claims. (Cl. 202—241)

The present invention relates to improvements in "gas gun" regenerative coke ovens having two sets of vertical combustion flues and two gun flues in each heating wall for operation in alternation with each other for upflow combustion and downflow of combustion products, and designed for rich gas underfiring with waste gas recirculation. More particularly, the invention relates to ovens of this type having a double divided vertical flue system in each heating wall with high and low burners in each flue, to provide uniform heating from top to bottom of the heating walls alongside the adjacent coking chambers.

The invention is especially designed for high ovens in which the distribution of the heat of rich fuel gas to the tops of the flues is difficult when fuel gas of high calorific value is used for the underfiring fuel gas, such as the coke oven gas which is given off by the carbonization of coal in the oven chambers, due to the fact that they burn with a short intense flame and deposit free carbon in the gun flues and high and low burners, unless diluted with recycled waste gases of combustion to produce a leaner fuel gas mixture, like blast furnace or producer gas. These gases burn with a longer flame of lesser intensity. The rich fuel gas when diluted with waste gases also burn with a longer flame of lesser intensity and do not clog the gas gun flues and burners with free carbon.

It has been the practice to provide for decarbonization of the gun flues and burners, while they are "off" combustion, with air from outside the battery, to eliminate the clogging of the gun flues and burners when using rich fuel gas as the fuel gas for the underfiring, or alternatively it has also been the practice to recirculate waste gases of combustion from inside the battery to the rich fuel gas while "on" flow through the gun flues and burners, to eliminate the clogging with free carbon and to provide an elongated flame of lesser intensity, like that obtained as aforesaid with blast furnace or producer gas for the combustion in the vertical flame flues. While these measures have been satisfactory for low burner operation and low coke ovens, they have not been entirely satisfactory when used with high burners for high ovens.

The objective of the present invention is to provide uniform heating from top to bottom in the heating walls, especially for high ovens where the uniform heating of the tops of the flues and coal charges in the adjacent coking chambers is and has been difficult, and to do this without clogging of the gun flues and low and high burners with free carbon during the "on" operation of such gun flues, burners, when underfiring these ovens with rich fuel gas, such as coke oven or like fuel gas.

Accordingly, this is accomplished by providing a recirculation duct at each of the opposite ends of each pair of gun flues in each heating wall at the level of the tops of the regenerators. Each duct connects the gun flues for one of the two sets of vertical combustion flues in each heating wall with the top of the regenerator that is communicably connected for inflow of air and out flow of waste gas to the other set of combustion flues in the same heating wall. Thus, in each reversal period of operation of the two sets of regenerators, vertical flues, and gun flues, the gun flues for the updraft sets of vertical flues in the heating walls are connected to receive waste for dilutions of the rich gas from a regenerator operable

for outflow of waste gas while these gun flues are opened to the rich fuel gas main, and the gun flues for the downdraft sets of vertical flues in the heating walls are also all connected to receive air for decarbonization of the gun flues and high and low burners while these gun flues are closed off from the rich fuel gas main. Consequently, waste gas recirculation is taking place in the gun flues for all the updraft flues while air circulation is taking place in the gun flues for all the downdraft vertical combustion flues. This combination involving merely a simple short duct at the pusher and coke side end of each heating wall in a battery of horizontal coking retort ovens keeps the rich fuel gas feed system free of carbon. The concurrent waste gas recirculation lessens the tendency for carbon formation and the decarbonizing air assists in eliminating it if and when it might form. The air for decarbonizing is hot from the waste gas regenerators so that an improvement in fuel economy results, since no cold air is used for decarbonizing and, as no cold air is used, the gas guns on the outside of the battery which feed the gun flues remain at a more stable temperature. Decarbonizing air from outside the battery can be entirely eliminated when the draft in the off gun flue is sufficient to draw enough air from an inflow air regenerator through the venturi used to aspirate the waste gas into the gun flue when it is "on." This would make the decarbonization by air automatic and eliminate the need for air piping to attain the decarbonization.

The invention is not limited in all its aspects to the double divided heating flue system, nor high ovens, nor high burners, since much of the advantage of the system of simple recirculation ducts at the end of the heating walls is also useful with single divided heating flue systems as well as multiplex systems of single and double hairpin flues, low ovens, with only low burners. Hence, the invention as claimed is not to be confined to the specific use and embodiment herein described as the best mode of practicing the invention.

In the accompanying drawings forming a part of this specification and showing for purposes of exemplification a preferred form and manner and best mode of embodying the present invention:

FIGURE 1 is a vertical cross-sectional view taken transversely of a battery of horizontal coking chambers on the line I—I of FIGURE 2;

FIGURE 2 is a composite vertical cross-sectional view taken longitudinally of the battery on the lines A—A and B—B of FIGURE 1;

FIGURE 3 is a composite horizontal sectional view taken on the lines D—D, E—E and F—F of FIGURE 2.

The same reference characters indicate the same parts in each of the several views of the drawings.

Referring to the drawings, there is shown an upper longitudinal row of alternate horizontal coking chambers **10** and intermediate heating walls **11**, each constituted of a row of vertical combustion or flame flues **12**, and a lower row of alternate regenerators **14** and intermediate pillar walls **13** with the regenerator chambers in the form of through regenerators **14** parallel to and below the coking chambers **10**, and the pillar walls **13** beneath the heating walls **11** and parallel therewith.

The regenerators **14** are communicably connected by regenerator ducts **27** with the vertical combustion flues **12** for operation in alternation with each other as two sets for concurrent "on" inflow preheating of air to, and "off" outflow of the waste gases of combustion from the heating flues **12**. The heating flues **12** also operate as two sets in alternation for concurrent "on" upflow combustion in one set and "off" downflow of the hot waste gases of combustion from the flues in the other set. For this, each heating wall **11** is provided with horizontal flow

duct means in the form of two end to end horizontal flues 28 separated by a wall 29 at the longitudinal median line of the battery. Each horizontal flue 28 is located at the top of the row of vertical flues 12. Each horizontal flue 28 connects an exterior quarter group of flues 12*a* with an interior quarter group of flues 12*b* on the pusher side 19 and 12*c* and 12*d* on the coke side 20 halves of the battery. This forms the two sets of "on" and "off" flues for each heating wall in which the flow may be "on" upflow in the quarter group 12*a*, 12*c* in alternation with simultaneous "off" downflow of the hot waste gases of combustion in the other quarter group of flues 12*b*, 12*d*, in accordance with the well-known reversal in operation of the two sets of regenerators. The alternate regenerators M are connected by the ducts 27 to operate as one of the sets of regenerators with two of the quarter groups in each half of a heating wall that are not connected with each other by a horizontal flue 28 in each of two adjacent heating walls and the intermediate regenerators N are likewise connected by the ducts 27 to operate as the other set of regenerators with the remaining two quarter groups of flues that are not interconnected with each other by a horizontal flue 28 in each of two adjacent heating walls.

Each heating wall 11 is also provided with two gun flues 30, 31 which extend throughout the entire length of the heating walls in the capitals 32 of the pillar walls 13, which capitals form the base or bottoms of the heating walls 11 and their flues 12. One gun flue 30 in each heating wall communicates by low 26*a* and high 26*b* burner rich gas riser ducts 26 with two of the quarter groups of flues 12 of one set and the other gun flue 31 in each heating wall communicates by low 26*a* and high 26*b* burner rich gas riser ducts 26 with the two other quarter groups of flues 12 that form the other set of heating flues.

For combined recirculation of hot waste gases of combustion during "on" flow in the gun flues 30, 31 and burner ducts 26 and concurrent decarbonization with hot regeneratively preheated air of the gun flues 30, 31 and burner ducts 26 when idle to flow of rich fuel gas during "off" flow, a single recirculation duct, 17, 18, is provided at each of the opposite ends 19 and 20 of the heating walls 11 in the capitals 32. The recirculation ducts 17 at the pusher side 19 connect a gun flue 31 with a regenerator 14 that is connected by regenerator ducts 27 with the two quarter groups of flues 12 that are fed with rich fuel gas by the other gun flue 30 through its low and high rich gas riser ducts 26. The recirculation ducts 18 at the coke side 20 connect a gun flue 30 with a regenerator 14 that is connected by the regenerator ducts 27 with the two quarter groups 12*a*, 12*c* that are fed with rich fuel gas by a gun flue 31.

Air for combustion of rich gas in the heating flues is supplied through air valves 22 to a regenerator reversal flow box 23 for each regenerator. This box also contains a valve 23′ for exhaust of waste gas to a waste heat flue 24, which leads to a smoke stack, not shown. The reversal boxes 23 communicate, each through a port 25, with one end of the sole flues 47. As shown, a pair of sole flues 47 are provided for each regenerator chamber. These sole flues each communicate through calibrated orifices in its top with the filler mass of the regenerator to discharge the air to be preheated thereunto and to withdraw waste gases of combustion off from the bottom of the regenerative filler mass in alternation in accordance with the well-known reversal in operation of regenerative masses. Each sole flue 47 of a pair is provided with a reversal flow box at both its pusher side 19 and coke side 20 ends and with separate waste heat flues 24 at both sides of the battery.

The vertical heating flues 12 are interconnected at their tops by horizontal flow ducts means 28 for operation of the flues of each wall in quarter groups, for concurrent operation of an exterior quarter group 12*a* and an interior quarter group 12*c* as "on" combustion flues in alternation with an interior group 12*b* and an exterior group 12*d* as "off" waste gas combustion products flues. In operation in alternation the gases from the two "on" groups during any one reversal tend to divide equally and pass in equal amounts to two concurrently operable "off" groups in a wall without the need for a partition wall 29. But due to the taper of the oven chambers, which increase in width from the pusher side to the coke side, to facilitate the pushing out of the finished coke cakes from the oven chambers, the coke side requires more heat units than the pusher side half because the coal mass is thicker, so that the partition walls 29 are of greater advantage in dividing the flow of gases to provide such greater volume of heat on the coke side half, without also providing partitions in the through regenerator chambers.

Regeneratively preheated air and non-regeneratively preheated rich fuel gas is supplied to the two exterior and two interior quarter groups of vertical flame flues in alternation. This is attained by operating the regenerators as two sets for concurrent "on" and "off" operation in alternation with each other, with alternate regenerators M as one set for "on" and "off" operation in alternation with the intermediate regenerators N as the other set for concurrent "off" and "on" operation. This is done by connecting the conventional reversing mechanism, not shown, for operating the valves 22, 23′ for the flow reversal boxes 23 to open the air valves 22 and close the waste heat valve 23′, for alternate regenerators M while closing the air valve 22 and opening the waste heat valve 23′ for the intermediate regenerators N in one half of each 25 to 30 minutes, regenerative cycle, and then close the air valves 22 and open the waste heat valves 23′ for the alternate regenerators M and open the air valves 22 and close the waste heat valves 23′ for the intermediate regenerators N for the next half of each regenerative cycle.

The intermediate regenerators M are each communically connected by regenerator ducts 27 with the pusher side exterior quarter group of flues 12*a* and coke side interior quarter group of flues 12*c* of alternate heating walls and with the pusher side interior quarter group of flues 12*b* and the coke side exterior quarter group of flues 12*d* of the intermediate heating walls on opposite sides of the coking chambers 10 above the alternate regenerators M.

The alternate regenerators N are likewise communicably connected by regenerator ducts 27 with the pusher side exterior quarter group of flues and coke side interior quarter group of flues of intermediate heating walls and with the pusher side interior quarter group of flues and the coke side exterior quarter group of flues of the alternate heating walls on opposite sides of the coking chambers 10 above the intermediate regenerators.

The rich fuel gas is fed to the vertical heating flues 12 by metal gas guns at 15 and 16 through two gas gun flues 30, 31 for each wall, guns 15 entering from the pusher side 19 and the other guns 16 entering from the coke side 20 of the battery. The two gas gun flues 30, 31 each extend along the bases of the heating walls 11 in the capital 32 of the pillar walls 13 and are connected by the gas risers 26 in such manner that each gun flue 30, 31 communicates only with the inner quarter group of flues nearest the side of the battery at which its gas gun enters, skips the outer quarter group of flues on that side of the battery, skips the inner quarter group on the opposite side of the battery, and communicates with the exterior quarter group of flues on the opposite side of the battery, to terminate at the outer recirculation duct 17 or 18 at the outer end of the heating wall, so that each end flue is not fed with rich gas by a metal gun in the region of the venturi 21 where the gas pressure is low due to the jet action of the feed gas. Only one of these gas gun flues 30 or 31 is active at any one time so that only alternate groups of vertical flues in each heating wall are fed with rich fuel gas on one reverse by one of the gun flues 30, 31.

The reversal of operation of the gun flues 30, 31 for

each heating wall **11** is effected by conventional reversing mechanism, not shown, which operates the levers for the gas valves **33** which control the flow of rich fuel gas from the rich fuel gas mains **34**.

The drafts in the individual vertical flues **12** are regulated by sliding bricks **35** located in the horizontal flues **28** which are adjustable through the access passages **36** in the oven roof through which coal to be coked is charged into the tops of the coking chambers **10** through coal charging holes **37** in the oven roof **38**.

In operation, conventional reversing mechanism, not shown, is set to operate air and waste heat valves for all alternate regenerators M to open their air valves **22** and close their waste heat valves **23'** and to concurrently close the air valves **22** and open the waste heat valves **23** for all intermediate regenerators N.

At this time, the reversing mechanism operates the rich gas supply valves **33** on the pusher side **19** to the metal guns at **15** for gun flues **31** to close the valves **33** to the gun fues **31** for all the intermediate heating walls and open the valves **33** to the metal guns **15** for gun flues **31** for all the alternate heating walls. At this time, the reversing mechanism also operates the rich gas supply valves **33** on the coke side **20**, to open all the valves **33** to the metal guns **16** for the gun flues **30** for all the intermediate heating walls and to close the valves **33** to the metal guns **16** for gun flues **30** for all the alternate heating walls.

Air from the alternate through regenerators M flows through regenerator ducts **27** to the vertical heating flues of the pusher side **19** interior groups of flues of the alternate heating walls M and the pusher side **19** exterior group of flues of the intermediate heating walls N, as wall as to the coke side **20** exterior groups of flues in the alternate heating walls M and the coke side **20** interior groups of flues in the intermediate heating walls N. The gas and air then pass through the rich gas riser ducts **26** and regenerator air ducts **27** to enter the pusher side exterior and coke side interior groups of flues in the intermediate heating walls wherein they burn. The waste gases of combustion flow through the horizontal flues **28** to, and down through the pusher side interior and coke side exterior groups of flues to leave through their regenerator ducts **27** and pass out to the two waste heat flues **24** through the intermediate regenerators N and sole flues **47**. Similar upflow combustion occurs in the pusher side interior and coke side exterior groups of flues in the alternate heating walls M, the hot waste gases of combustion flowing down through the pusher side exterior and coke side interior groups of flues in the alternate heating walls to the intermediate regenerators N their sole flues **47** and two waste heat tunnels or flues **24**.

On reversal, the flow is in the reverse direction through the intermediate regenerators N and up through the groups of flues connected thereto and down through the flue groups connected to the alternate regenerators M to the waste heat tunnels.

During such reversals in operation, there is no inflow of fuel gas to through conduits **30, 31** conduits while their flues **12** are passing waste gas down through their ducts **27** to the regenerators M or N, since they are cut off from the gas mains **34** by the valves **33**. However, air is drawn in through these conduits at their time from the tops of "on" regenerators through the recirculation ducts **17**.

During such reversals, there is inflow of fuel gas from the metal gas guns at **15, 16**, in the form of a jet into each venturi **21** of those channels **30, 31** which are open to the gas mains **34** through the opened valves **33**. These jets of gas when released in the venturi **21** create a vacuum causing the waste gas from the tops of the "off" regenerator to enter and mix with the fuel gas while it is flowing along in the conduits or gun flues **30, 31** to the low and high rich gas riser burners for the flues. The combined actions of waste gas dilution and decarbonizing aeration in the gun flues and high and low burner risers during their "on" and "off" operations insures continuity of unclogged lines and elongation of the flames to the tops of the heating flues **12**.

The tops of the regenerators can be readily seen clear through the battery through the peep holes **18'** and cleaned when necessary from this vantage point. The waste gas leaves the regenerators through two sole flue channels and two waste heat flues which permits building new higher ovens on old foundations having two such waste heat flues **24**, and without requiring metal lined sole flues **47** to prevent loss of air pressure for the flues to the waste heat sole channels **47**, as is disclosed in my copending application Serial No. 146,163, filed October 19, 1961, entitled "Double Divided Gun Flue Horizontal Coking Retort Oven."

The novel gas gun flue decarbonizing air and waste gas recirculation feature for the aforesaid double divided heating flue system is also equally applicable to compartmentalized regenerator chamber sections individualized to end to end reverse flow groups of flues, and is also equally applicable to rich gas conduit systems for single divided and hairpin flue heating systems along the heating walls.

The invention as hereinabove set forth is embodied in a particular form and manner but may be variously embodied within the scope of the claims as hereinafter made.

I claim:

1. In a coking retort oven, a horizontal heating wall constituted of two sets of vertical combustion flues each operable in alternation with the other for upflow combustion and downflow of combustion products, said flues each having a regenerator air inlet port at its bottom for inflow of regeneratively preheated air thereto from a regenerator and for outflow of waste gases of combustion from the flue to said regenerator, a pair of horizontal rich fuel gas gun flues operable in alternation with each other for inflow of rich fuel gas, said gun flues extending lengthwise of the heating wall at the bottom of said flues, with rich fuel gas riser ducts leading from one of the two gun flues to the bottoms of the flues of one set, and with rich fuel gas riser ducts leading from the other of the two gun flues to the bottoms of the flues of the other set, a waste gas recirculation duct at each of the opposite ends of the horizontal heating walls, one of said waste gas recirculation ducts connecting one of said gun flues with a regenerator, which regenerator is operable for inflow of air while said one gun flue is idle to flow of rich fuel gas to its set of vertical flues and the other of the two gun flues is in operation for inflow of rich gas to its set of vertical flues, and which regenerator is operable for outflow of hot waste gases of combustion while said one gun flue is operable for inflow of rich fuel gas to its set of vertical flues and the other of the two gun flues is then idle to flow of rich fuel gas to its set of vertical flues, the other of said waste gas recirculation ducts connecting the other of said gun flues with a regenerator, which regenerator is operable for inflow of air while said other gun flue is idle to flow of rich fuel gas to its set of vertical flues and said one of the two gas gun flues is in operation for inflow of rich fuel gas to its vertical combustion flues, and which regenerator is operable for outflow of hot waste gases of combustion while said other gun flue is operable for inflow of rich fuel gas to its set of vertical combustion flues and said one of the two gun flues is then idle to flow of rich fuel gas to its vertical flues and means for introducing rich fuel gas in the form of a jet into the ends of the gun flues at the region of juncture of the waste gas recirculation duct therewith.

2. In a coking retort oven, a horizontal heating wall constituted of two sets of vertical combustion flues each operable in alternation with the other for upflow combustion and downflow of combustion products, said flues each having a regenerator air inlet port at its bottom

for inflow of regeneratively preheated air thereto from a regenerator and for outflow of waste gases of combustion from the flue to said regenerator, a pair of horizontal rich fuel gas gun flues operable in alternation with each other for inflow of rich fuel gas, said gun flues extending lengthwise of the heating wall at the bottom of said flues, with rich fuel gas riser ducts leading from one of the two gun flues to the bottoms of the flues of one set, and with rich fuel gas riser ducts leading from the other of the two gun flues to the bottoms of the flues of the other set, a waste gas recirculation duct at each of the opposite ends of the horizontal heating walls, said waste gas recirculation ducts connecting each one of the gun flues with a regenerator, one flue with a regenerator operable for inflow of air and outflow of waste gas in alternation with the off and on operation of the gun flue, and the other flue with a different regenerator operable for outflow of waste gas and air inflow in alternation with the on and off operation of the other gun flue.

3. In a coking retort oven, a horizontal heating wall constituted of two sets of vertical combustion flues each operable in alternation with the other for upflow combustion and downflow of combustion products, said flues each having a regenerator air inlet port at its bottom for inflow of regeneratively preheated air thereto from a regenerator and for outflow of waste gases of combustion from the flue to said regenerator, a pair of horizontal rich fuel gas gun flues operable in alternation with each other for inflow of rich fuel gas, said gun flues extending lengthwise of the heating wall at the bottom of said flues, with rich fuel gas riser ducts leading from one of the two gun flues to the bottoms of the flues of one set, and with rich fuel gas riser ducts leading from the other of the two gun flues to the bottoms of the flues of the other set, a waste gas recirculation duct at each of the opposite ends of the horizontal heating walls, each of said ducts connecting one of the gun flues with a regenerator in communication through the aforesaid regenerator air inlet ports with the vertical combustion flues with which the other gun flue is communicably connected by the aforesaid rich fuel gas riser ducts, and means for introducing rich gas in the form of a jet into the ends of the gun flues at the region of juncture of the waste gas recirculation duct therewith.

4. In a horizontal gas gun flue coke oven battery comprising: a series of alternate horizontal coking retort oven chambers and intermediate heating walls arranged side by side in a row, each heating wall comprising interior and exterior groups of flues in end to end relation along the heating wall and communicably connected at their tops for upflow combustion and downflow of combustion products in alternation; regenerators separated by pillar walls below said row of coking chambers and heating walls and operatively disposed in two sets for operation in alternation with each other for inflow and outflow; regenerator ducts in the base of the heating walls and communicably connecting the regenerators of one set with the pusher side exterior groups and coke side interior groups of flues in the alternate heating walls, and with the pusher side interior groups and coke side exterior groups of the intermediate heating walls; regenerator ducts in the base of the heating walls and communicably connecting the regenerators of the other set with the pusher side exterior groups and coke side interior groups of heating flues of the intermediate heating walls and with the pusher side interior groups and coke side exterior groups of heating flues of the alternate heating walls; a gas gun flue extending inwardly of each heating wall from the pusher side of the battery, with each gun flue extending along the pillar walls for the heating wall in the region of the bottoms for the heating flues to the coke side of the battery, each such gas gun flue being provided with a gas gun inlet for rich fuel gas on the pusher side of the battery and being connected by rich gas riser ducts with the bottoms of the vertical heating flues of the pusher side interior group and coke side exterior group of flues of its heating wall; a second gas gun flue extending inwardly of each heating wall from the coke side of the battery, with each gun flue extending along the pillar wall for the heating wall in the region of the bottoms for the heating flues to the pusher side of the battery, each such gas gun flue being provided with a gas gun inlet for rich fuel gas on the coke side of the battery and being connected by rich gas riser ducts with the bottoms of the vertical heating flues of the coke side interior group and pusher side exterior group of flues of its heating wall; the regenerators of said one set and the pusher side gas gun inlets for the gas gun flues for alternate heating walls and coke side gas gun inlets for the gas gun flues for the intermediate heating walls, being operable in alternation with the regenerators of the other set and the pusher side gas gun inlets for the gas gun flues for the intermediate heating walls and coke side gas gun inlets for the gas gun flues for the alternate heating walls, for inflow combustion in, and outflow of combustion products from, the vertical flues of the groups that they serve as aforesaid, whereby all portions of the coal masses in the coking chambers may be concurrently heated by flame heating on each side part and waste gas heating on each of the opposite side parts in alternation with each reversal in operation of the flues and regenerators in correspondence with the reversal in operation of the regenerators, a waste gas recirculation duct at each of the opposite ends of the heating walls, each of said ducts at opposite ends of a heating wall communicably connecting one of the gun flues in its heating wall with the top of a regenerator in communication with the vertical heating flues with which the other gun flue is communicably connected by the aforesaid rich gas riser ducts.

References Cited by the Examiner

UNITED STATES PATENTS

1,678,803	7/28	Van Ackeren	202—141
1,704,239	3/29	Becker	202—141
2,043,945	6/36	Beimann	202—141
2,507,554	5/50	Van Ackeren	202—151
2,515,815	7/50	Willputte	202—141
2,516,929	8/50	Van Ackeren	202—151
3,123,540	3/64	Van Ackeren	202—141

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