July 16, 1940. P. M. PINCKARD 2,208,053

COKE OVEN

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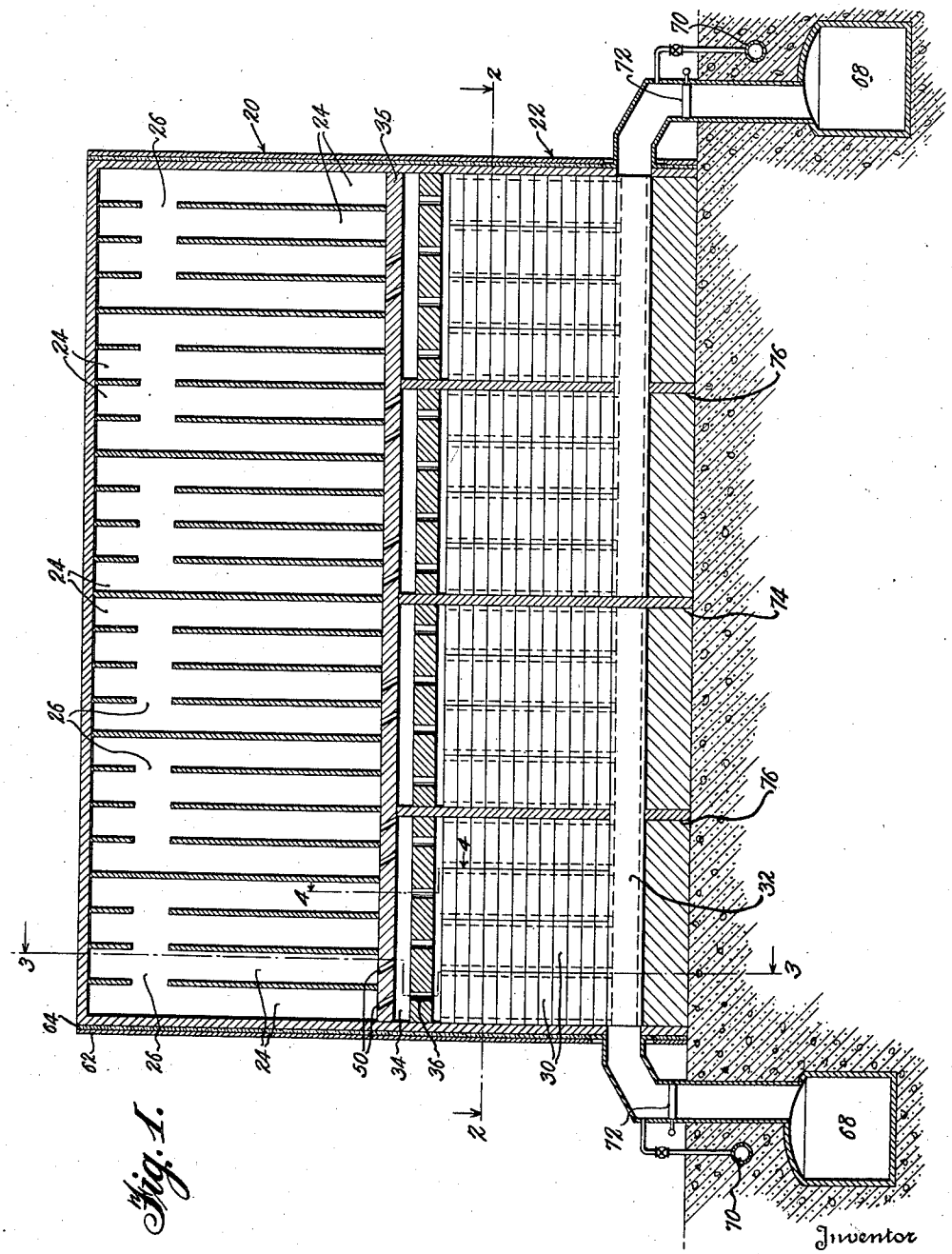


Fig. 1.

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COKE OVEN

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Fig. 2.

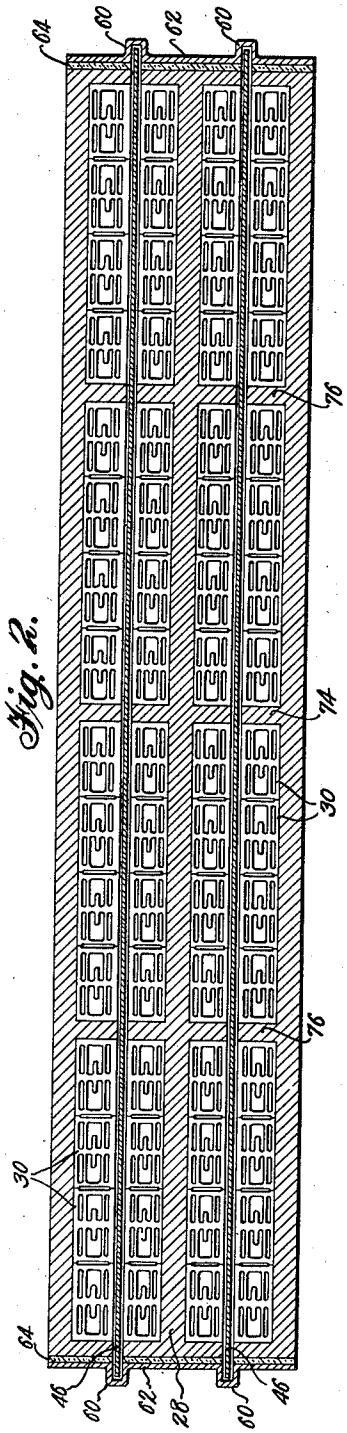


Fig. 8.

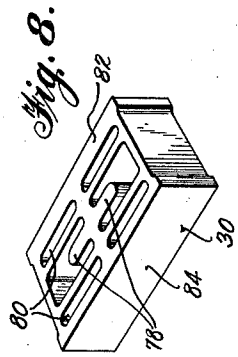


Fig. 6.

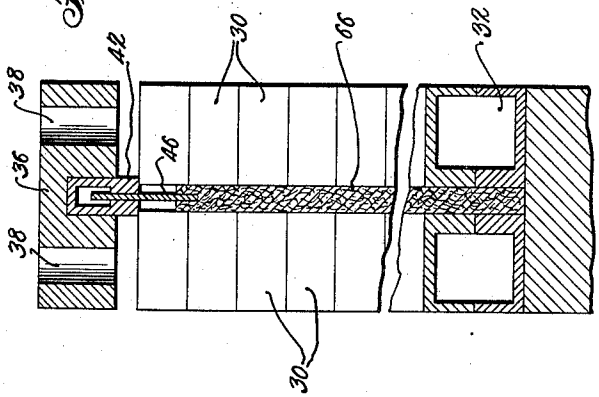
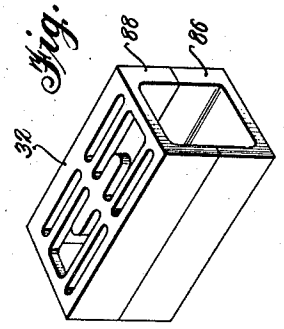


Fig. 7.



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Fig. 3.

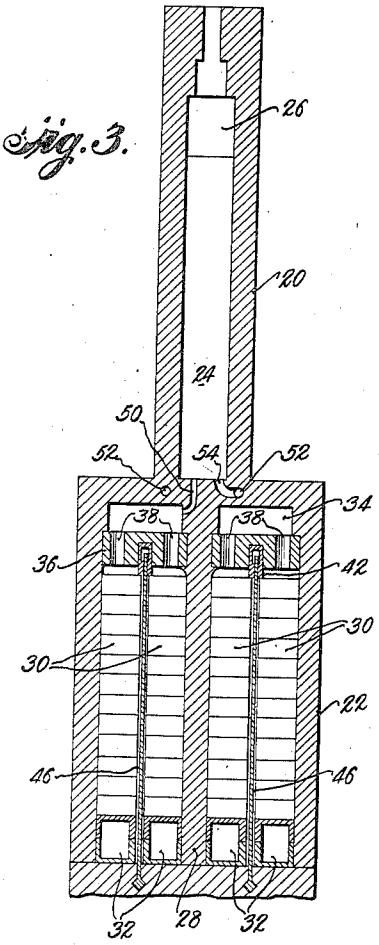


Fig. 4.

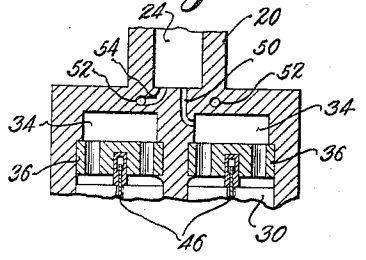
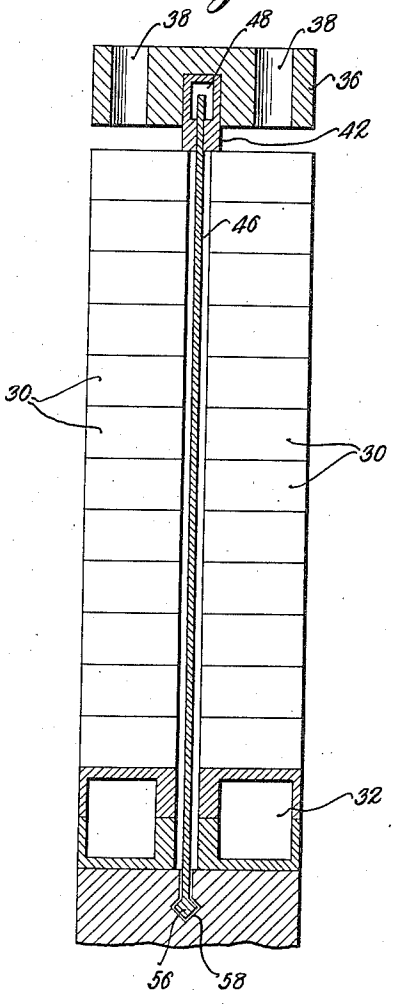


Fig. 5.



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COKE OVEN

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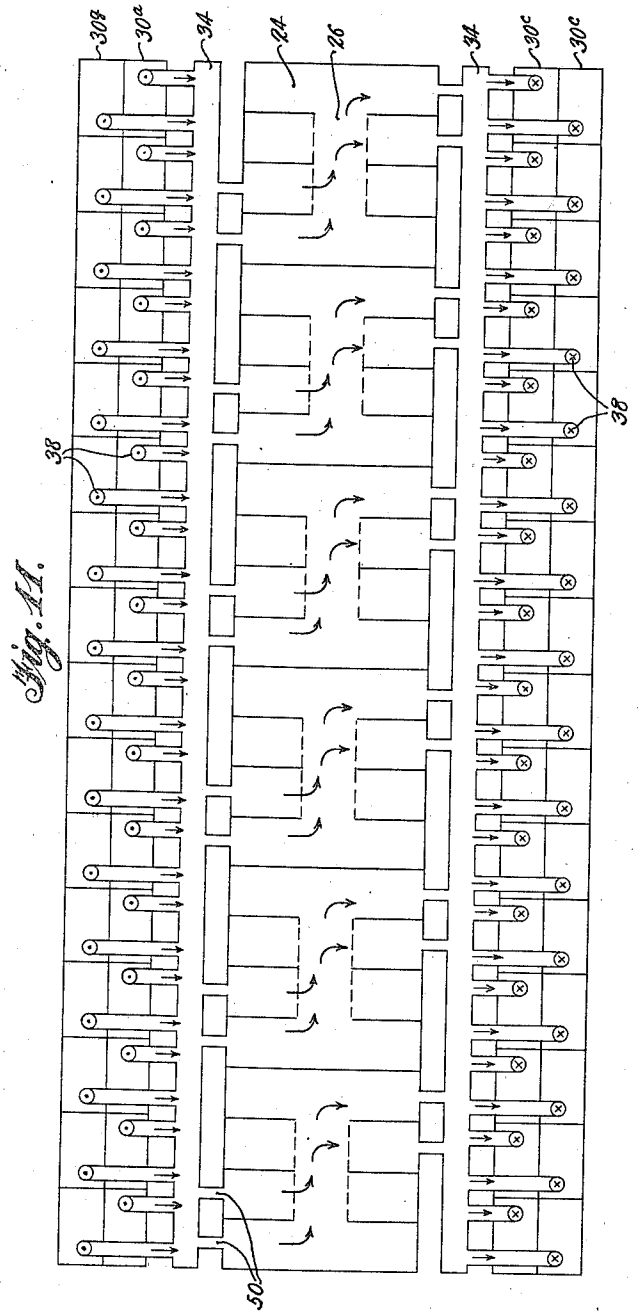


Fig. 11.

Fig. 10.

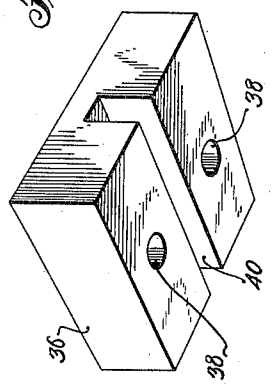
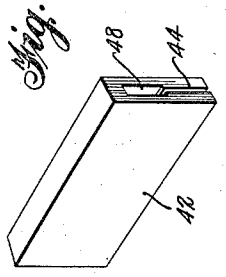


Fig. 9.



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UNITED STATES PATENT OFFICE

2,208,053

COKE OVEN

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Application March 13, 1940, Serial No. 323,809

16 Claims. (Cl. 202—151)

This invention relates to by-product coke ovens and particularly to the regenerators thereof and their relationship with respect to the heating flues.

It has already been proposed to construct a regenerator divided into four sections extending longitudinally of the oven, so that when underfiring with low quality gas, it is possible to avoid counter flow between the gas itself and the products of combustion returning to stack. This has been accomplished by so connecting the four sections and their bus flues that a regenerator section intended for the supply of air will always be interposed between a section supplying gas and a section conveying products of combustion. Such a flow arrangement has been utilized in ovens of the crossover flue type, in which a great many of the advantages have been lost however, because the exchange of heat is split between two heating walls. In a prior United States Letters Patent No. 2,049,136, dated July 28, 1936, and issued to the present inventor, these same fluid flows, in a so-called longitudinally four-divided regenerator, were for the first time applied to the heating of the flues of a single heating wall.

As clearly set forth in the specification of the prior patent referred to, the division of a regenerator into four longitudinally extending sections when applied to the vertical heating flues of a single wall, especially where short horizontal flues are employed, represented marked advantages over the then prior art. Among these advantages are the elimination of counter flow between the regenerator sections on the one hand and the bus flues themselves on the other. As a matter of fact, in accordance with this design, an entire regenerator section extending for the full length of the oven will be handling the same fluid at a particular time, thus avoiding counter flow within different portions of the same section. The advantage of dividing the vertical flues into relatively small groups and utilizing short horizontal flues to connect them was also realized with a resulting reduced stack differential measured from bus flue to bus flue, and improved yields of desirable by-products. This arrangement of flues also assures a very uniform heat exchange, since the flues between which such exchange is taking place are always close together and in the same wall. A further advantage of the construction in the prior patent referred to is the improved fuel gas distribution when operating with high quality or coal gas. Since each of the fuel gas ducts feeds only into alternate pairs of flues, the distribution of fuel will be effected under more uniform pressure conditions to all of these flues and those at the center of the oven will not be inadequately supplied as has been the case in other known constructions.

While retaining the principal advantages of the prior patent referred to, the present invention represents marked improvements thereover. Especially when underfiring with low quality gas, there has been a tendency in the past with known ovens to produce cold bottoms. This has been due to the fact that the high content of nitrogen and carbon dioxide in blast furnace or producer gas appreciably retards combustion with the result that the flame propagation occurs at a point relatively high in the flues, thus failing to supply adequate heat at the lower portions of the heating wall. In a well known type of oven equipped with crossover flues, an effort has been made to eliminate these undesirable cold bottom effects by regulating the suction conditions to approach a plus-minus or neutral condition at the top of the regenerator. But since all brick walls leak, the presence of this plus-minus condition near the top of the regenerator renders the gas in a particular regenerator section more subject to travel by being drawn through one or more of the walls of the regenerator by a stronger pull from some other section. Such a difference in pull might be traceable to a difference in slide brick settings or to a non-uniform setting of the butterfly valves in the wind boxes. Whatever may be the cause, it is entirely eliminated in the construction herein proposed.

In accordance with the present invention, the four longitudinally extending sections into which a regenerator is divided, are further subdivided by low friction checker brick shapes into independent vertical ducts. A vertical wall in the regenerator separates the four sections into two pairs of sections, one pair of which will supply the combustible fluids at a particular time while the other pair is conveying products of combustion to the stack. Following established practice, these flows will be reversed periodically. Above each pair of regenerator sections, but below the heating wall containing the vertical flues, there is provided a sole flue or mixing chamber connected with each of the independent vertical ducts of the sections of a pair, through relatively restricted passages contained in cap bricks mounted above the low friction checker shapes. To further assure separation below the mixing chamber of the fluids handled by the two sections

constituting a pair, a sealing means is provided extending downwardly from the cap bricks towards the bottom of the regenerator. In some instances, the sealing means may include a continuous metallic sheet extending from the cap brick at the top of the regenerator to the floor thereof and throughout the length of the oven. In other instances, such a metallic sheet need not extend all of the way down to the floor, since in accordance with the present construction there is no necessity for attaining a plus-minus condition at the top of the regenerator and consequently, any tendency to leak would be not only greatly reduced in accordance with this construction, but would be confined to a correspondingly higher portion of the regenerator than experienced in prior constructions where a plus-minus is necessary at the top of the regenerator. Where such a metallic plate is used, there will preferably be provision for expansion and contraction due to heating and cooling at the upper edge of the plate and at its ends. The seal at the upper edge may be effected with slotted bricks closely fitting the plate as to thickness but containing a slot which is longer than the portion of the plate which it normally receives. Such slotted bricks may well be received by slots or grooves formed in the cap bricks intermediate of the passages for the relatively restricted communication between the regenerator sections and the sole flues or mixing chambers. The ends of such a metallic sheet may be received in wells suitably formed in metal end walls such as are provided on a number of ovens in current use.

It has long been a dream of operators and designers to approach an approximate balance between pressure conditions in the flues and those produced in the coking chamber to thus minimize gas travel from the chamber to the flues. By virtue of the present construction comprising the improved checker shapes, the generously sized flues, the adequate openings between the regenerators and flues, and the probable elimination of slide brick control, even lower stack differentials may be expected than those previously attained; and as a consequence, coking chamber wall and jamb leakage will be minimized and improved yields of gas, tar, benzol, ammonia and toluol may be reasonably expected. By the provision of a sole flue or mixing chamber above each pair of regenerator sections and below the heating walls, operation with low quality gas becomes really practical for the first time without necessitating such close regulation as would be required were a plus-minus condition required at the top of the regenerator. By this arrangement, the gas and air are mixed and combustion started in the mixing chamber well below the flues, so that when the burning gases enter the flues, heat will be applied at the bottoms of the flues with the attainment of marked advantages which have not been possible heretofore.

A more complete understanding of the present invention will follow from a detailed description in conjunction with the attached drawings wherein:

Fig. 1 is a longitudinal sectional elevation through a heating wall and regenerator of a by-product coke oven embodying the present invention;

Fig. 2 is a sectional plan through the regenerator taken substantially along line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional elevation through the heating wall and regenerator taken substantially along line 3—3 of Fig. 1;

Fig. 4 is a fragmentary transverse sectional elevation taken substantially along line 4—4 of Fig. 1;

Fig. 5 is an enlarged transverse sectional elevation showing a portion of the construction of Fig. 3;

Fig. 6 is a fragmentary view similar to Fig. 5 illustrating a modification;

Fig. 7 is a perspective view of a shape suitable for use as a bus flue;

Fig. 8 is a perspective of a suitable checker brick shape for dividing the regenerator sections into independent vertical ducts;

Fig. 9 is a perspective of a slotted brick suitable to receive a metallic sheet for separating the regenerator sections constituting a pair;

Fig. 10 is a perspective of a cap brick adapted to receive the slotted brick of Fig. 9, and to provide relatively restricted passages for interconnecting the regenerator sections with the mixing chamber; and

Fig. 11 is a diagrammatic showing intended to illustrate the fluid flow in the regenerator sections and vertical flues of an oven embodying the present invention.

The oven of the present invention comprises a heating wall 20 and a regenerator 22. The heating wall is subdivided into a plurality of vertical flues 24, and in the form shown in Fig. 1 of the drawings, these flues are divided into groups of four, each group being provided with a horizontal flue 26 establishing communication between one pair of flues and the next adjacent pair constituting a group.

The regenerator is provided with a vertical wall 28 extending longitudinally thereof, dividing the same into two substantially equal parts. On each side of this vertical partition or wall 28, a pair of regenerator sections is defined by vertical rows of checker shapes 30 communicating at their lower ends with their respective bus flues 32 for the supply of fluid or delivery of products of combustion to stack as the case may be; and at their upper ends with sole flues or mixing chambers 34 located thereabove but below the floor 35 of the heating wall 20. At the upper end of each pair of regenerator sections, but below the sole flue or mixing chamber common to the two sections of each pair, cap bricks 36 are arranged, each cap brick containing a pair of passages 38 affording relatively restricted communication between each regenerator section and the mixing chamber. Each cap brick is also provided with a slot or groove 40 at a point intermediate the restricted passages 38, adapted to receive a slotted brick 42 which is also provided with a slot 44 adapted for the reception of a metallic sealing plate 46. The slot 44 is preferably somewhat longer than required by the width of plate normally received thereby, and in some instances the slot is provided with an enlargement 48 near its upper end to permit expansion and contraction of the plate 46 as it is subjected to varying temperature conditions. For interconnecting the mixing chambers 34 and the vertical flues 24, a plurality of ports 50 are provided, which as depicted in Fig. 1 of the drawings, interconnect a particular mixing chamber with alternate pairs of the flues. The associated mixing chamber or sole flue 34 positioned on the opposite side of the wall or partition 28 will be connected with the remaining flues of the heating wall, one such connection being depicted in Fig. 4 of the drawings.

As illustrated in Figs. 3 and 4 of the drawings, fuel gas ducts 52 are provided in the event that

coal gas is to be employed as the fuel, and in this case also, the ducts are connected with only alternate pairs of flues through suitable nozzles 54.

As shown in the enlarged view of Fig. 5, the sealing plate 46 extends from the cap brick 36 and associated slotted brick 42, down between the low friction checker shapes 30 and between the bus flues 32, to a point therebelow in the masonry with which it is arranged in sealing relationship, as by an enlarged end 56 of the sheet received in a complementary groove 58, which arrangement permits removal of the sheet from the oven if necessary and replacement by a new one. The ends of this sheet 46 may be received in suitable wells 60, Fig. 2 formed in metal sheets 62 which cover the regenerator faces in conjunction with an interposed layer of insulating material 64. In this manner it will be clear that adequate provision has been made for expansion and contraction of the metallic sealing plate 46, longitudinally as well as transversely.

As already pointed out, in an oven embodying flows similar to those herein proposed, but applying them to two heating walls instead of one, the regenerator leakage has been principally at the top of the regenerator, since where there is no counterflow, there is but little tendency for leakage to occur until the neutral or plus-minus condition is reached, which condition is only approached at a point near the top of such regenerators. In the oven of the present invention, the openings employed for interconnecting the regenerator sections with the mixing chamber are relatively larger than the openings connecting the regenerators and flues of the known construction referred to, so that the point at which any such plus-minus condition will be achieved with the present construction will be substantially higher, and accordingly, the danger of leakage in the lower portions of the regenerator will be greatly reduced. Accordingly, in a modified form of the invention depicted in Fig. 6 of the drawings, it is contemplated that the metal sheet 46 extend only slightly below the top of the regenerator and have its lower edge sealed in a suitable cement or other plastic composition 66.

As shown in Fig. 1 of the drawings, the bus flues 32 are provided with the usual arches to stack 68, low quality gas mains 70, valves 72, and other manipulating equipment to regulate and reverse the fluid flows at prescribed intervals. In addition to the central supporting wall 74, supplemental walls 76 may be provided intermediate the central wall and the ends of the oven, but it should be clearly understood that these supplemental walls are for support only and in no way interfere with the flows of the fluids. Upon reference to Fig. 2 of the drawings, it will be noted that the metallic plates 46 extend continuously throughout the length of the regenerator, and that all three of these supporting walls are suitably slotted for this purpose.

The diagrammatic showing of Fig. 11 of the drawings will permit a ready understanding of the flow of fluids in accordance with the present invention, the view amounting to a plan view showing the vertical flues 24 connected by the horizontal flues 26, the sole flues or mixing chambers 34 being removed from under the heating wall and the regenerator sections 30 being moved outwardly from under the mixing chambers. The restricted passages 38 interconnecting the individual vertical ducts of the sections constituting a pair in the regenerator have been illustrated as connected with their respective mixing chambers or sole flues. In accordance with a practice commonly employed in representing current flows in electrical circuits, upward flow has been indicated in these passages by a point or dot, while downward flows have been depicted by a cross or the rear end of an arrow. As already pointed out, all of the independent vertical ducts aligned in a regenerator section will be handling the same fluid at a particular time. The uppermost regenerator section shown in Fig. 11 of the drawings which has been designated 30*g* for convenience, will be supplying gas to the upper mixing chamber 34, while the regenerator section adjacent thereto, designated 30*a* will be supplying air thereto. This gas and air will be combined in the mixing chamber 34 shown at the upper portion of the drawings, whereupon alternate pairs of heating flues will be supplied with the burning mixture through the ports 50. As indicated by the arrows in Fig. 11 of the drawings, burning gases will ascend through alternate pairs of flues, pass through their horizontal flues 26 and descend through the next adjacent pairs of flues to the mixing chamber or sole flue 34 shown at the lower part of the drawings. The products of combustion will then pass through the restricted passages 38, through the regenerator sections designated 30*c* at the lower portion of the drawings, through their respective bus flues, arches to stack, and finally to stack.

At prescribed intervals, the flows are reversed, at which time gas would be supplied through the regenerator section lowermost in the drawing of Fig. 11, air would be supplied through the section immediately thereabove, and the products of combustion would be withdrawn through the sections at the upper portion of the drawings. By alternating the flows in this manner, preheating of the products of combustion is accomplished and excessive temperatures in the regenerator are avoided.

Whereas various arrangements of checker bricks and low friction shapes are possible in association with the present invention, a suitable shape has been depicted in Fig. 8 of the drawings wherein the greatest flow will be possible at the central portion of the shape due to the discontinuous web 78, with a somewhat reduced flow through the outer passages 80. In fact it is proposed that one of the outer walls 82 of these shapes be somewhat thicker than the opposite wall 84, the thicker wall being intended to be adjacent to the metal plate 46 and thus transfer less heat thereto than would be the case with a thinner wall at this point. The bus flues are made up of shapes of the type depicted in Fig. 7 of the drawings which are designed to cooperate with the checker shapes of Fig. 8. These bus flue elements may be constructed of a lower U-shaped section 86 and an upper U-shaped section 88, the upper section having cut-out portions for registry with those of the checker shape of Fig. 8 of the drawings.

Whereas it is not intended to restrict the present invention to any specific materials, a suitable material for the metallic sheet separating the sections of a pair of regenerator sections is "H C Enduro". This product is discussed on page 723 of Sweet's Catalogue of Engineering Materials (1933) as suitable for temperatures ranging up to 2100° F. For the refractory shapes many of the materials produced in kilns or electric furnaces would be entirely satisfactory. It should be noted that the refractory shapes and brick

used in this construction should embody ship-lap joints or interlapping joints wherever feasible.

The oven of the present invention may be built up on a cement mat in accordance with common practice or it may be erected on columns such as have been utilized in conjunction with more recent constructions.

Whereas a number of specific examples of materials, shapes and other characteristics have been given in explaining the present invention, it should be clearly understood that these are purely examples and should not be construed as limitations upon the invention, the true scope of which is set forth in the appended claims.

I claim:

1. In combination with a coke oven having a heating wall with flues therein, a regenerator divided into two pairs of sections extending longitudinally of the oven, means sub-dividing each section into a plurality of independent vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall and sealing means interposed between the sections of a pair below said mixing chamber.

2. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said heating wall, low friction checker bricks dividing said regenerator into two pairs of sections extending longitudinally of the oven and each section into a plurality of vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall and sealing means interposed between the sections of a pair below said mixing chamber.

3. In combination with a coke oven having a heating wall with flues therein, a regenerator divided into two pairs of sections extending longitudinally of the oven, means sub-dividing each section into a plurality of independent vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall, sealing means interposed between the sections of a pair below said mixing chamber and means interconnecting all of said sections exclusively with said heating wall.

4. In combination with a coke oven having a heating wall with flues therein, a regenerator divided into two pairs of sections extending longitudinally of the oven, means sub-dividing each section into a plurality of independent vertical ducts transversely spaced from the similar ducts of the adjacent section, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall and sealing means interposed between the sections of a pair below said mixing chamber.

5. In combination with a coke oven having a heating wall with flues therein, a regenerator divided into two pairs of sections extending longitudinally of the oven, means subdividing each section into a plurality of independent vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall and metallic sealing means interposed between the sections of a pair below said mixing chamber.

6. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said heating wall, low friction checker bricks dividing said regenerator into two pairs of sections extending longitudinally of the oven and each section into a plurality of vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall and sealing means comprising a metallic sheet interposed between the sections of a pair below said mixing chamber.

7. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said heating wall, low friction checker bricks dividing said regenerator into two pairs of sections extending longitudinally of the oven and each section into a plurality of vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall and sealing means comprising a removable metallic sheet interposed between the sections of a pair below said mixing chamber.

8. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said heating wall, low friction checker bricks dividing said regenerator into two pairs of sections extending longitudinally of the oven and each section into a plurality of vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall and sealing means comprising a metallic sheet interposed between the sections of a pair below said mixing chamber, said sheet extending throughout the length of the oven.

9. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said heating wall, low friction checker bricks dividing said regenerator into two pairs of sections extending longitudinally of the oven and each section into a plurality of vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall, sealing means comprising a metallic sheet interposed between the sections of a pair below said mixing chamber and means receiving an edge of said sheet forming an expansion joint therewith.

10. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said heating wall, low friction checker bricks dividing said regenerator into two pairs of sections extending longitudinally of the oven and each section into a plurality of vertical ducts, each pair of sections having restricted communication with a mixing chamber extending thereabove but below said heating wall, sealing means comprising a metallic sheet interposed between the sections of a pair below said mixing chamber and a slotted brick receiving the upper edge of said sheet in sealing relationship yet permitting expansion thereof.

11. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said wall, checker bricks dividing said regenerator into four sections extending longitudinally of said oven, a vertical partition in said regenerator separating said sections into pairs, means defining a mixing chamber above each pair of sections but below said flues, means providing relatively restricted passages between a pair of sections and their mixing chamber, and a metal plate extending downwardly between the sections of a pair.

12. In combination with a coke oven having a heating wall with a plurality of pairs of flues therein, a regenerator below said wall, checker

bricks dividing said regenerator into four sections extending longitudinally of said oven and each section into a plurality of vertical ducts, a vertical partition in said regenerator separating said sections into pairs, means defining a mixing chamber above each pair of sections but below said flues, means providing relatively restricted passages between the pairs of said sections and their respective mixing chambers, sealing means between the sections of each pair, and means connecting said mixing chambers respectively with alternate different pairs of said flues.

13. In combination with a coke oven having a heating wall with a plurality of pairs of flues therein, a regenerator below said wall, checker bricks dividing said regenerator into four sections extending longitudinally of said oven, a vertical partition in said regenerator separating said sections into pairs, means defining a mixing chamber above each pair of sections but below said flues, brickwork capping each pair of sections providing relatively restricted passages between the pairs of said sections and their respective mixing chambers, sealing means cooperating with said brickwork arranged between the sections of each pair, and means connecting said mixing chambers respectively with alternate different pairs of said flues.

14. In combination with a coke oven having a heating wall with flues therein, a regenerator communicating with said heating wall, means dividing said regenerator into four sections extending longitudinally of the oven, means subdividing each of said sections longitudinally into a plurality of independent vertical ducts, means defining a longitudinally extending mixing chamber below said heating wall for each pair of sections, means defining restricted passages between each of the ducts of said pairs of sections and their respective mixing chambers and sealing means interposed between said subdividing means.

15. In combination with a coke oven having a heating wall with a plurality of flues therein, a regenerator below said wall, checker bricks dividing said regenerator into four sections extending longitudinally of said oven, a vertical partition in said regenerator separating said sections into pairs, means defining a mixing chamber above each pair of sections but below said flues, means providing relatively restricted passages between the pairs of said sections and their respective mixing chambers, sealing means between the sections of each pair, and means connecting one of said mixing chambers with substantially half of said flues and the other of said mixing chambers with the remainder of said flues.

16. In combination with a coke oven having a heating wall with a plurality of pairs of flues therein, a regenerator below said wall, checker bricks dividing said regenerator into four sections extending longitudinally of said oven, a vertical partition in said regenerator separating said sections into pairs, means defining a mixing chamber above each pair of sections but below said flues, means providing relatively restricted passages between the pairs of said sections and their respective mixing chambers, sealing means between the sections of each pair, and means connecting said mixing chambers respectively with alternate different pairs of said flues.

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