

May 13, 1958

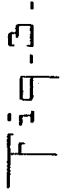
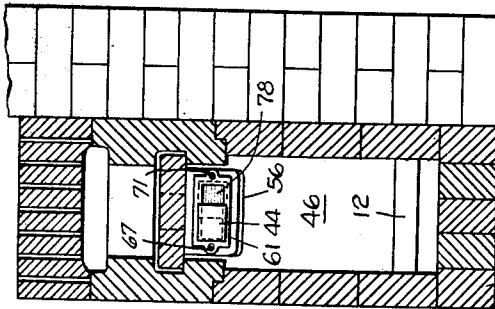
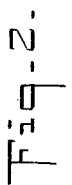
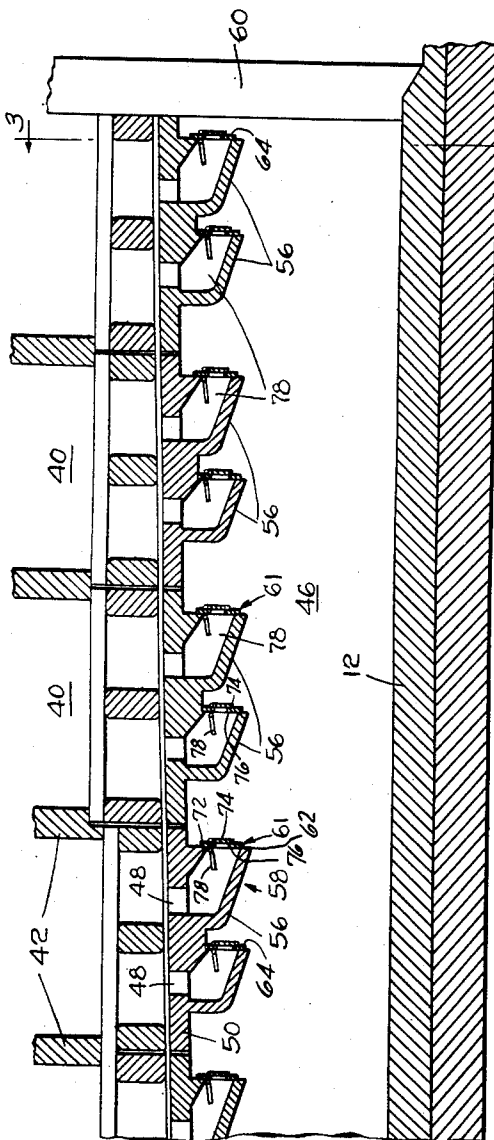
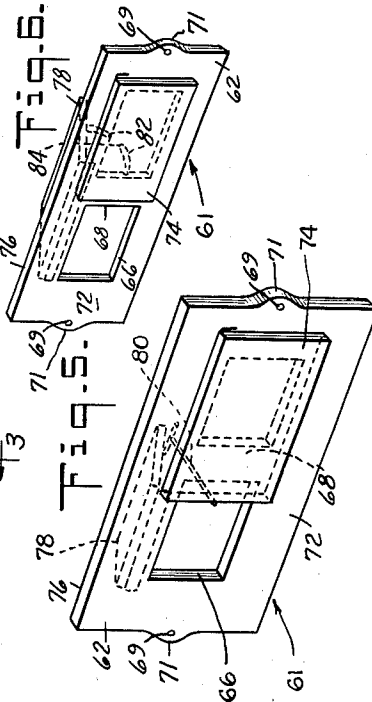
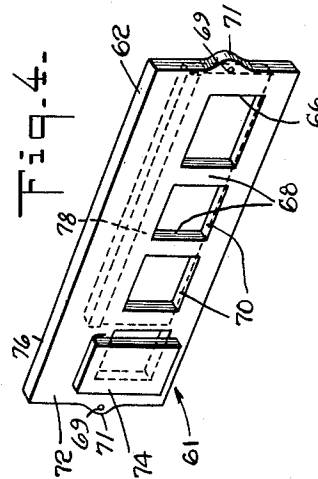
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COKE OVEN

2,834,406

Filed April 5, 1956

2 Sheets-Sheet 1



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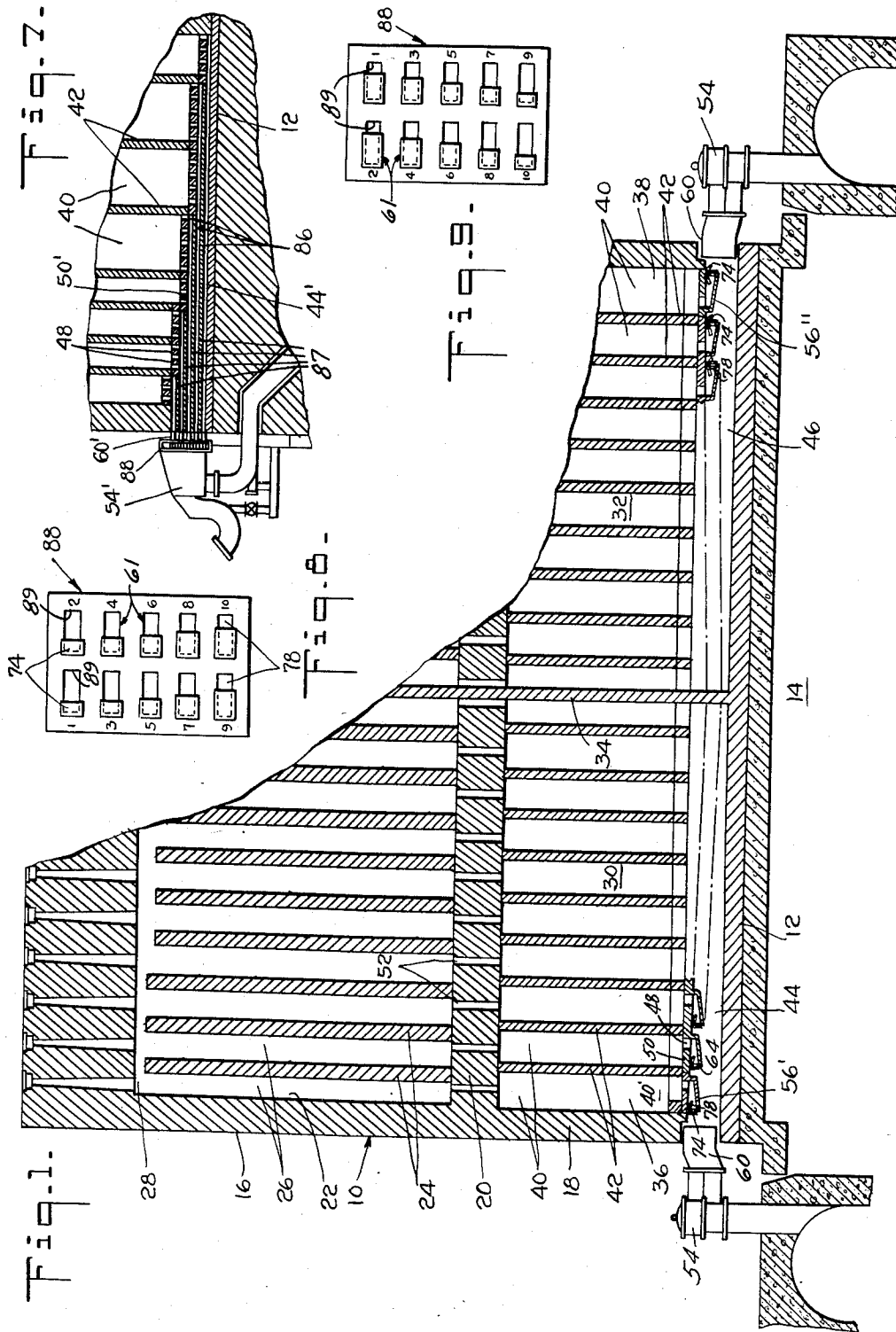
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2,834,406

COKE OVEN

Carl Otto, Manhasset, N. Y.

Application April 5, 1956, Serial No. 576,444

14 Claims. (Cl. 158—7.5)

The present invention relates to the construction of a regenerative by-product coke oven battery of the type comprising horizontally elongated coking chambers extending transversely of the battery and alternating with heating walls each of which includes a horizontal row of vertical heating flues, and regenerator chambers below the coking chambers and heating walls and extending transversely of the battery, and characterized by the connection of the upper ends of a plurality of said flues in each heating wall to an upper horizontal channel or bus flue in said wall, and the connection of the lower ends of the heating flues in each heating wall to the upper edges of associated regenerator chambers, and to the connection of the lower edge of each regenerator chamber to a subjacent sole channel by a port opening or passage. Coke oven batteries of the above mentioned type are now used in the production of metallurgical coke and have been for many years past.

In coke ovens of the type described above and particularly in so-called two-divided coke ovens wherein a pair of isolated elongated horizontal sole channels are provided for introducing and removing hot gases from the regenerator, there is a tendency for the gas to unequally distribute itself in the regenerator passages or chambers which are in communication with the sole channels, and therefore to be unequally distributed in the heating flues. This tendency to unequal distribution is due to an appreciable variation in the air or gas pressure in the sole channels along the length of the latter as a result of the variations in linear velocity of flow in the channel at different points along its length.

There have been many attempts to obviate and eliminate the unequal distribution of air or gas in the regenerator passages and in the flues. However, none of the prior attempts has been entirely satisfactory since they are impractical economically or do not give an entirely satisfactory distribution.

It is therefore one object of the present invention to provide improved means for controlling the distribution of combustion agents through coke oven regenerators and heating flues to thereby closely approximate the heating action referred to as "uniform heating."

Another object of the present invention is to provide new and improved means for controlling the distribution of combustion agents flowing through coke oven regenerators and heating flues which yields substantially uniform heating of the coke oven regardless of direction of flow of the combustion agents through the heating flues.

A further object of the present invention is the provision of valve means associated with each of a number of ports disposed along the length of the sole channels, which valves are selectively responsive to the flow of gaseous fluid through said ports to throttle said flow so as to provide for uniform flow through said regenerator passages regardless of the direction of flow therethrough.

Yet another object of the present invention is the pro-

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vision of valve means for proportionally throttling the flow of gaseous fluid through regenerator passages in order to achieve uniform flow regardless of the direction thereof, which valves are removably positionable in association with the regenerator passages whereby to facilitate the adjustment thereof in order to achieve said uniform flow.

A still further object of the present invention is the provision of valve means of the type hereinbefore mentioned which comprise an apertured plate and two flaps which alternately overlie different portions of the aperture in the plate to reduce the opening therein when a gaseous fluid flows through said aperture in one direction and in the opposite direction.

The above and other objects, characteristics and features of the present invention will be more fully understood from the following description taken in connection with the accompanying illustrative drawings.

In the drawings:

Fig. 1 is a fragmentary transverse sectional view of a coke oven battery embodying the present invention;

Fig. 2 is a view similar to Fig. 1 illustrating on a larger scale some of the salient features of the present invention;

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a perspective view of one form of valve means embodying the present invention;

Fig. 5 is a perspective view of another form of valve means embodying the present invention;

Fig. 6 is a perspective view of a further modification of a valve means embodying the present invention;

Fig. 7 is a view similar to Fig. 2 illustrating another modification of the present invention;

Fig. 8 illustrates the condition of the valve means associated with the structure shown in Fig. 7 when air or lean gas is flowing through said valve means into the regenerator; and

Fig. 9 illustrates the condition of the valve means shown in Fig. 8 when waste gas is flowing in the opposite direction.

Referring now to the drawings in detail, Fig. 1 illustrates a coke oven battery generally designated by the reference numeral 10. This coke oven battery is of the "two-divided type" although my invention is not necessarily limited to this type of battery. The battery 10 comprises a supporting deck 12 which is preferably made of concrete and may or may not form the roof of a conventional basement space 14. Deck 12 provides a support means for the coke oven brickwork which forms an upper story or section 16 and a lower story or section 18 which merge into an intermediate horizontal masonry layer 20. The upper story or section 16 of the battery comprises horizontally elongated coking chambers (not shown) alternating with heating walls 22. Extending between each two adjacent heating walls 22 are a plurality of flue division walls 24 which divide the upper story or section 16 into a plurality of flues 26. In a two-divided oven of the type shown herein all of the flues 26 are in communication with an upper horizontal channel or bus flue 28 which is preferably of a varying cross section so as to compensate for the varying volumes of gases flowing through different portions of the bus flue.

In a two-divided oven the oven is divided into two sections 30 and 32 by a vertical flue division wall 34 which extends from a level substantially even with the tops of the adjacent flue division walls 24 downwardly to deck 12.

The lower story 18 of the battery 10 constitutes a regenerator for preheating combustion air or for preheating a lean fuel gas such as a blast furnace gas. The regenerator is divided by the vertical division wall 34 into

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two sections 36 and 38 and each of these sections is divided into a plurality of passages or flues 40 by division walls 42. Beneath the regenerator passages or flues 40 and extending between two adjacent walls 22 are two end-to-end sole channels 44 and 46 which are isolated from one another by the wall 34. The regenerator flues or passages 40 communicate with their adjacent sole channel 44 or 46 by means of openings or ports 48 in the wall 50 defining the upper periphery of the sole channels. As shown herein and as is normally the case, the openings 48 are all substantially the same size. In order to permit for communication between the regenerator passages 40 and the heating flues 26 passages or openings 52 are provided in masonry layer 20.

With the structure hereinbefore described, air or lean gas is introduced into one of the sole channels, for instance channel 44, and said gas passes through the openings 48 into the regenerator passages 40 upwardly through the passages 52 in the masonry layer 20 and upwardly through the flues in the section 30 across through the flue 28 and thence downwardly through flues 26 and passages 40 in the right hand section of the coke oven and out through the sole channel 46. At other times the lean gas or air can follow a reverse path.

To introduce air or lean gas mixture into the sole channels, reversing valves 54 are provided at opposite sides of the battery. The reversing valves may be of any suitable construction and the present invention is not limited in any manner to the particular construction of the reversing valve. Since reversing valves are well known to those skilled in the art, a detailed description of the construction thereof is deemed unnecessary herein.

As is best shown in Fig. 2, each regenerator passage 40 is provided with a pair of ports, passages or openings 48, although, it will be obvious to those skilled in the art that any number of ports from one on up will be suitable to provide for the passage of gaseous fluid from the sole channel into the regenerator passage or vice versa. Extending downwardly from the wall 50 of the sole channels 44 and 46 are a plurality of orifice members 56 which are preferably made of some highly refractory material such as fire clay. Each orifice member defines a passage 58 extending from the sole channel to a port 48 and serves as a means for directing gaseous fluid flowing in the sole channels into the ports 48 and thus to the regenerator passages 40 and, of course, vice versa. As is best illustrated in Fig. 2, in view of the fact that the maximum amount of gaseous fluid flows at the entrance-exit ends 60 of the sole channels 44 and 46, the cross section of a sole channel adjacent the entrance-exit end is relatively large and the cross section of the sole channel diminishes therefrom in order to maintain proper static pressure within the sole channel. This feature of the construction has been known hereinbefore and although it is preferred, it is not necessary to the practicing of the present invention. That is to say, the sole channel could be, if desired, of uniform cross section throughout.

In accordance with the present invention, the valve means 61 includes a plate 62 which overlies the entrance end or opening 64 in the orifice member 56. The plate 62 is provided with an aperture 66 which aperture may be sub-divided, if desired, by a plurality of reinforcing members 68 whereby to strengthen the plate 62. However, for the purposes of explanation, the plate 62 will be considered to have a single aperture and the sub-divisions 70 of said aperture are due to the desirability for greater mechanical strength. It will be obvious from the following description that if such strength factor were not present the aperture 66 could be continuous and not sub-divided. Pivotaly mounted on one side 72 of plate 62 is a flap or valve member 74, which member is adapted to partially overlie aperture 66. As shown in Fig. 4, the flap 74 is in surface-to-surface engagement with plate 62 when overlying said portion of aperture 66 to thereby prevent flow of gaseous fluid through said portion. Piv-

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otally mounted on plate 62 and preferably on the opposite surface 76 of said plate is another flap or valve member 78 which is adapted to overlie a portion of aperture 66 and, as shown in Fig. 4, when overlying said portion of said aperture to be in surface-to-surface relationship with the surface 76 of plate 62 to thereby prevent flow through said portion. Plate 62, as hereinbefore mentioned, is preferably located adjacent or at the entrance end 64 of the orifice member 56. Preferably, the plate 62 overlies the entire opening 64 whereby to prevent gas from passing into or out of the regenerator passages except through the aperture 66 in said plate. The plate 62 may be held in the described disposition in any suitable manner as by bolts 67 which extend through apertures 69 in ears 71 on plate 62 so that the plate may be readily removed from said opening for reasons which will become more clear hereinafter. Of course, refractory cement or other means for holding plates 62 in place may be used.

With the plates disposed relative to the orifice members as shown in Fig. 2, it will be obvious from a perusal of Fig. 2 that when gas is flowing downwardly in regenerator passages 40 and outwardly from the ports 48 into the sole channel 46 the gas will tend to push flaps 78 against surfaces 76 of plates 62 whereby to seal off the portion of aperture 66 underlying said flap 78. At the same time, the gas will tend to push flaps 74 away from the surfaces 72 of plates 62 whereby to permit passage of gas through those portions of apertures 66 underlying flaps 78. When the flow is reversed, flaps 74 will move into surface-to-surface engagement with surfaces 72 of plates 62 and flaps 78 will move out of surface-to-surface engagement with the surfaces 76 of plates 62 whereby to close off those portions of apertures 66 underlying flaps 74 and to open those portions of apertures 66 underlying flaps 78 so that gas will pass through said latter portions of the apertures 66. Of course, in order to provide such a valve action, the flaps 74 and 78 will be made of a light weight material which must have suitable refractory properties in order to withstand the relatively high temperatures of the gaseous fluid. Such a material may be for example stainless steel.

As was mentioned earlier in this specification, the gaseous fluid tends to concentrate at the end of the entrance sole channel remote from the associated valve 54 and to collect at the end of the exit sole channel adjacent the associated valve 54 whereby to cause non-uniform flow through the regenerator and, accordingly, non-uniform heating of the coke. The flaps 74 and 78 are proportioned to eliminate this undesirable effect. For instance, referring now to Fig. 1, assuming that the sole channel 44 is the entrance channel for the gaseous fluid and the sole channel 46 is the exit channel for the gaseous fluid, the flaps 74 will overlie portions of apertures 66 and the flaps 78 are so proportioned that the uncovered portion of aperture 66 associated with the orifice member 56' will be large and the uncovered portions of each valve plate aperture associated with each successive orifice member will be progressively smaller whereby to reduce the resistance to gaseous flow through regenerator passage 40' and to tend to progressively increase said resistance through each adjacent regenerator passage in regenerator section 36. On the exit half 38 of the regenerator, the flaps 78 will overlie portions of apertures 66 and the flaps are so proportioned that the uncovered portion of the aperture in the plate 62 associated with the orifice member 56'' will be relatively small and the uncovered portion of each other aperture 66 in the plates 62 associated with each other orifice member 56 on the right hand side of the regenerator will be successively and progressively larger whereby to tend to decrease the resistance of flow in said successive regenerator passages. In this manner, with the gaseous fluid entering through the sole channel 44 and leaving the regenerator through the sole channel 46, the flow can be rendered uniform.

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Assuming now that the reversing mechanism is operated so as to reverse the flow of gaseous fluid through the regenerator and through the heating flues whereby gaseous fluid enters through sole channel 46 and exits through sole channel 44. With regard to the valves on side 36 of the regenerator, upon reversal of the direction of flow, the gaseous fluid will cause the flaps 78 to move into surface-to-surface relationship with plate 62 whereby to close off those portions of the plurality of apertures 66 underlying flaps 78 and at the same time move flaps 74 away from plates 62 whereby to open those portions of aperture 66 not underlying flaps 78. On side 38 of the regenerator, the flaps 74 move into engagement with surfaces 72 of plates 62 and flaps 78 move out of overlying relationship with plates 62. With the direction of flow reversed and the valves having operated to their second condition as described above, the proportioning of the uncovered portions of apertures 66 will be the exact opposite of the proportioning of the uncovered portions of apertures 66 heretofore described. That is to say, the portion of aperture 66 which is uncovered at orifice member 56' will be relatively large and each successive uncovered portion of apertures 66 associated with successive orifice members 56 will be progressively smaller. Moreover, the portions of apertures 66 associated with orifice member 56' will be relatively small and each successive uncovered portion of apertures 66 associated with each successive orifice member 56 in the left hand portion 36 of regenerator 18 will be successively larger whereby to cause uniform flow in the reverse direction.

As has been suggested hereinbefore, the plates 62 or, in the alternative, the flaps 74 and 78 may be removable from their respective mountings. Accordingly, if it is found that the portion of the aperture 66 uncovered during flow in one direction is improperly proportioned so as to render the flow non-uniform, the valve means may be readily removed and rearranged so as to properly proportion the openings for flow in both directions.

The construction of the valve shown in Fig. 4 is one in which the flaps 74 and 78 operate independently of one another although, of course, they operate in substantial unison due to the fact that they are both responsive to the flow of the same gaseous fluid.

Referring now to Fig. 5, a modified form of valve is illustrated wherein the flaps 74 and 78 are connected by means of a link 80 whereby to cause the flaps to operate in unison. With this construction, the force of the gaseous fluid exerted against each flap 74 and 78 is transferred to the other flap by means of the link 80 whereby to insure a more positive movement of the flaps and a more positive holding of one flap against the plate 62 and a more positive holding of the other flap away from the plate 62.

Referring now to Fig. 6, still another form of valve means is illustrated. Due to the relatively high temperatures to which the valve means are subjected, it is possible that some material might act to cement one of the flaps to the plate 62 whereby to cause flow of gaseous fluid to be shut off in one direction. In order to obviate this possibility, the flaps 74 and 78 are proportioned with regard to the opening or aperture 66 in plate 62 so that portions of each flap overlies portions of the other flap. Each flap has a protruding kicker or striker member 82 secured to the portion of the flap which overlaps the other flap. Preferably, and as shown in Fig. 6, each kicker member 82 is provided with a curved or blunt end 84 for reasons which will become clear presently. Assuming that flap 74 is in surface-to-surface relationship with the plate 62 and flap 78 is out of said relationship and the flow of gas is reversed, flap 78 will pivot downwardly in order to bring it into surface-to-surface relationship with plate 62. Under normal operating conditions, flap 74 simultaneously moves away from said surface-to-surface relationship. However, in the event that flap 74 for any reason should adhere to plate 62, then as flap 78 ap-

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proaches the end of its swing wherein its member 82 is moving substantially horizontally, the member 82 will strike or kick flap 74 and this kicking or rapping will normally be enough to break the adhesion between flap 74 and plate 62 whereby to permit flap 74 to move away from the plate. It will be obvious that at the time the kicker 82 strikes flap 74, the striker 82 associated with flap 74 will be struck by flap 78 so that both strikers 82 will transmit force from flap 78 to flap 74. It will also be clear that the arrangement will work satisfactorily if only one kicker member is included. Moreover, the end 84 is turned or blunted in order to prevent undue surface wear on the portion of the flap struck by the end of the kicker member. Furthermore, by proportioning and disposing the kickers 82 so that they engage the flaps during a substantially horizontal movement, the component of movement or momentum transferred to the stationary flap is substantially the total momentum of the moving flap whereby to insure a maximum rapping or kicking effect.

Referring now to Figs. 7, 8 and 9, another modification of the present invention is illustrated. In this modification the sole channel 44' is sub-divided into a plurality of passages 86 by horizontal walls 87. The passages extend directly from the entrance-exit end 60' of the sole channel to one or more of the ports 48 in the wall 50' of the sole channel. This type of sole channel arrangement has been known hereinbefore and is normally employed to attempt to equalize the flow of gaseous fluid through the regenerator passages and the flues. However, this method of equalizing or uniformly distributing the flow is not entirely satisfactory and in accordance with this form of the invention I associate with each passage 86 a valve means 61 similar to any of the valve means shown in Figs. 4 to 6. The valve means 61 are associated with a plurality of openings 89 in plate 88; said openings 89 being in communication with the horizontal passages 86 which extend to one or more ports 48. Overlying each of the openings 89 is a valve means 61 which in all respects are similar to the valve means shown in Figs. 4 to 6. The opening 89 in communication with the passage going to the nearest set of ports 48 will have associated therewith a valve means 61 which will permit minimum opening when gases are flowing out of the regenerator through said opening 89 and maximum opening when gases are flowing into the regenerator through said openings 89. The opening 89 associated with passage 86 in communication with the ports most remote from plate 88 has associated therewith a valve means 61 which may be similar to any of the valve means shown in Figs. 4 to 6, which valve means is arranged to provide for a minimum opening when gases are flowing into the regenerator through said plate opening 89 and to provide for a maximum opening when gases are flowing out of the regenerator through said plate opening 89. The various other openings 89 have associated therewith valve means arranged in intermediate steps between the two extremes described above. With such an arrangement it will be seen that the flow of gas through the regenerator and coke oven heating walls will be equalized regardless of the direction of flow in precisely the same manner as is achieved where a single non-partitioned sole channel is employed and as has been described hereinbefore.

It will be apparent to those skilled in the art that the valve means 61 associated with walls 88 are subjected to substantially lower temperatures than the valve means 61 disposed within the sole channel as shown, for instance, in Fig. 2. Accordingly, the valve means 61 shown in Figs. 7, 8 and 9 may be made of less refractory material than the valve means 61 shown in Fig. 2. Furthermore, with the valve means 61 associated with walls 88 disposed outside of the passages 86, these valve means 61 are accessible for adjusting the openings for passage of gas in either direction and for removal should said

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valve means become inoperative for any reason. Such adjustment or removal and replacement may be readily effected since the valve means 61 in Figs. 7, 8 and 9 are accessible as shown.

Although there has been shown herein a number of forms of the present invention, it will be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of this invention.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, and valve means operatively associated with said ports and selectively responsive to pressure exerted in the direction of gaseous fluid flow through the regenerator for subjecting some of said ports to a throttling effect when gaseous fluid flow is in one direction and for subjecting said some ports to a different throttling effect when gaseous fluid flow is in the opposite direction.

2. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, said ports all being of substantially the same size, and valve means operatively associated with said ports and selectively responsive to pressure exerted in the direction of gaseous fluid flow through the regenerator for subjecting some of said ports to a throttling effect when gaseous fluid flow is in one direction and for subjecting said some ports to a different throttling effect when gaseous fluid flow is in the opposite direction.

3. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, and removable valve means operatively associated with said ports and selectively responsive to pressure exerted in the direction of gaseous fluid flow through the regenerator for subjecting some of said ports to a throttling effect when gaseous fluid flow is in one direction and for subjecting said some ports to a different throttling effect when gaseous fluid flow is in the opposite direction.

4. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, said ports all being of substantially the same size, and removable valve means operatively associated with said ports and selectively responsive to pressure exerted in the direction of gaseous fluid flow through the regenerator for subjecting some of said ports to a throttling effect when gaseous fluid flow is in one direction and for subjecting said some ports to a different throttling effect when gaseous fluid flow is in the opposite direction.

5. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, and valve means operatively associated with at least some of said ports for controlling the flow of gaseous fluid in two directions, said valve means comprising a plate provided with an aperture for the passage of said gaseous fluid therethrough toward and away from said ports, and a pair of flaps movable relative to said plate, said flaps being arranged so that when said gaseous fluid flows through said regenerator in one direction one of said flaps overlies a portion of said plate aperture to throttle said flow between said regenerator and sole channel and the other of said flaps is out of overlying relation with said plate, and when said gaseous fluid flows in the opposite direction through said regenerator the said other flap overlies a portion of said plate aperture to throttle

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said flow between said regenerator and said sole channel and said one flap is out of overlying relation with said plate.

6. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, and valve means associated with at least some of said ports for controlling the flow of gaseous fluid in two directions, said valve means comprising a plate provided with an aperture for the passage of said gaseous fluid therethrough toward and away from said ports, and a pair of flaps pivotally mounted on opposite surfaces of said plate for movement to and from positions in which said flaps are in operative surface-to-surface engagement with said plate, said flaps being movable by the flow of said gaseous fluid so that when said gaseous fluid flows through said regenerator in one direction one of said flaps overlies a portion of said plate aperture to throttle said flow between said regenerator and sole channel and when said gaseous fluid flows in the opposite direction through said regenerator the other flap overlies a portion of said plate aperture to throttle said flow between said regenerator and said sole channel.

7. Valve means in accordance with claim 6, further comprising means operatively connecting said flaps to one another for movement in unison whereby the force exerted by flowing gaseous fluid on each of said flaps is transmitted to the other of said flaps.

8. Valve means in accordance with claim 6, further comprising a member operatively fixed to one of said flaps and disposed in the path of movement of the other of said flaps whereby if either flap should fail to move from one to the other of its positions in response to a change in direction of flow of said gaseous fluid, movement of the other flap will be transmitted to said non-moving flap through said member whereby to impart movement to said non-moving flap.

9. In a regenerator having a wall defining a pair of horizontal longitudinally extending isolated sole channels, a plurality of passages for the flow of gaseous fluid extending upwardly from said sole channels and being spaced horizontally from one another, said wall having a plurality of horizontally spaced openings providing means for communication between said sole channels and their associated passages, means for introducing gaseous fluid into a first of said sole channels and for permitting the withdrawal of gaseous fluid through a second of said sole channels whereby said first channel is an entrance channel and the second channel is an exit channel and gaseous fluid flows upwardly through the passages associated with said entrance channel and downwardly through said passages associated with said exit channel, means for introducing gaseous fluid into the second of said channels and for permitting the withdrawal of gaseous fluid through said first channel whereby said second channel is the entrance channel and said first channel is the exit channel, and reversing means for alternately actuating said last two mentioned means for reversing the flow of gaseous fluid through said regenerator; means for rendering substantially uniform the flow through said passages regardless of the direction of flow therethrough, comprising valve means associated with each of said openings in said wall of said sole channels for controlling the flow of gaseous fluid through said openings, each of said valve means comprising a plate having an aperture through which gaseous fluid can flow toward and away from said associated wall opening, and a pair of flaps operatively associated with said plate and alternately movable into and out of overlying relation with said plate aperture in response to the direction of flow of gaseous fluid through said regenerator, said flaps being proportioned so that regardless of the direction of flow of gaseous fluid through said regenerator the uncovered portions of said plate apertures are progressively smaller as

they are disposed farther away from the area of introduction of gaseous liquid into the entrance channel and are progressively larger as they are disposed away from the rear of withdrawal of gaseous fluid from said exit channel.

10. In a regenerator having a wall defining a pair of horizontal longitudinally extending isolated sole channels, a plurality of passages for the flow of gaseous fluid extending upwardly from said sole channels and being spaced horizontally from one another, said wall having a plurality of horizontally spaced openings providing means for communication between said sole channels and their associated passages, means for introducing gaseous fluid into a first of said sole channels and for permitting the withdrawal of gaseous fluid through a second of said sole channels whereby said first channel is an entrance channel and the second channel is an exit channel and gaseous fluid flows upwardly through the passages associated with said entrance channel and downwardly through said passages associated with said exit channel, means for introducing gaseous fluid into the second of said channels and for permitting the withdrawal of gaseous fluid through said first channel whereby said second channel is the entrance channel and said first channel is the exit channel, and reversing means for alternately actuating said last two mentioned means for reversing the flow of gaseous fluid through said regenerator; means for rendering substantially uniform the flow through said passages regardless of the direction of flow therethrough, comprising valve means associated with each of said openings in said wall of said sole channels for controlling the flow of gaseous fluid through said openings, each of said valve means comprising a plate having an aperture through which gaseous fluid can flow toward and away from said associated wall opening, and a pair of flaps pivotally mounted on opposite surfaces of said plate for movement to and from positions in which said flaps are in operative surface-to-surface engagement with said plate, said flaps being movable by the flow of said gaseous fluid so that when said gaseous fluid flows through said regenerator in one direction one of said flaps overlies a portion of said plate aperture to throttle said flow between said regenerator and sole channel and when said gaseous fluid flows in the opposite direction through said regenerator the other flap overlies a portion of said plate aperture to throttle said flow between said regenerator and said sole channel, said flaps being proportioned so that regardless of the direction of flow of gaseous fluid through said regenerator the uncovered portions of said plate aperture are progressively smaller as they are disposed farther away from the area of introduction of gaseous liquid into the entrance channel and are progressively larger as they are disposed away from the area of withdrawal of gaseous fluid from said exit channel.

11. Valve means in accordance with claim 10, further comprising means operatively connecting said flaps to one another for movement in unison whereby the force exerted by flowing gaseous fluid on each of said flaps is transmitted to the other of said flaps.

12. Valve means in accordance with claim 10, further comprising a member operatively fixed to one of said flaps and disposed in the path of movement of the other of said flaps whereby if either flap should fail to move

from one to the other of its positions in response to a change in direction of flow of said gaseous fluid, movement of the other flap will be transmitted to said non-moving flap through said member whereby to impart movement to said non-moving flap.

13. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, said sole channel being sub-divided into a plurality of channel sections, each channel section extending from the entrance-exit end of said sole channel to at least one of said ports for conducting gaseous fluid to and from said ports from and to said entrance-exit end of said sole channel, respectively, and valve means associated with at least some of said channel sections for controlling the flow of gaseous fluid therein, said valve means comprising a plate having an aperture in registry with its associated channel section to permit flow of gaseous fluid therethrough, and a pair of flaps operatively associated with said plate and movable relative thereto, said flaps being arranged so that when said gaseous fluid flows through said regenerator in one direction one of said flaps overlies a portion of said plate aperture to throttle said flow between said regenerator and sole channel and when said gaseous fluid flows in the opposite direction through said regenerator the other flap overlies a portion of said plate aperture to throttle said flow between said regenerator and said sole channel.

14. In combination with a regenerator having an elongated edge and a sole channel alongside said edge, a wall interposed between said edge and said sole channel and having a plurality of ports distributed along the length thereof, said sole channel being sub-divided into a plurality of channel sections, each channel section extending from the entrance-exit end of said sole channel to at least one of said ports for conducting gaseous fluid to and from said ports from and to said entrance-exit end of said sole channel, respectively, and valve means associated with at least some of said channel sections for controlling the flow of gaseous fluid therein, said valve means comprising a plate having an aperture in registry with its associated channel section to permit flow of gaseous fluid therethrough, and a pair of flaps operatively associated with said plate and movable relative thereto, said flaps being arranged so that when said gaseous fluid flows through said regenerator in one direction one of said flaps overlies a portion of said plate aperture to throttle said flow between said regenerator and sole channel and when said gaseous fluid flows in the opposite direction through said regenerator the other flap overlies a portion of said plate aperture to throttle said flow between said regenerator and sole channel, said valve means being removably positionable adjacent the entrance-exit end of said sole channel.

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