Oct. 11, 1938. C. OTTO 2,132,641

REGENERATIVE COKE OVEN

Filed Oct. 11, 1934 2 Sheets-Sheet 1

Fig. 1

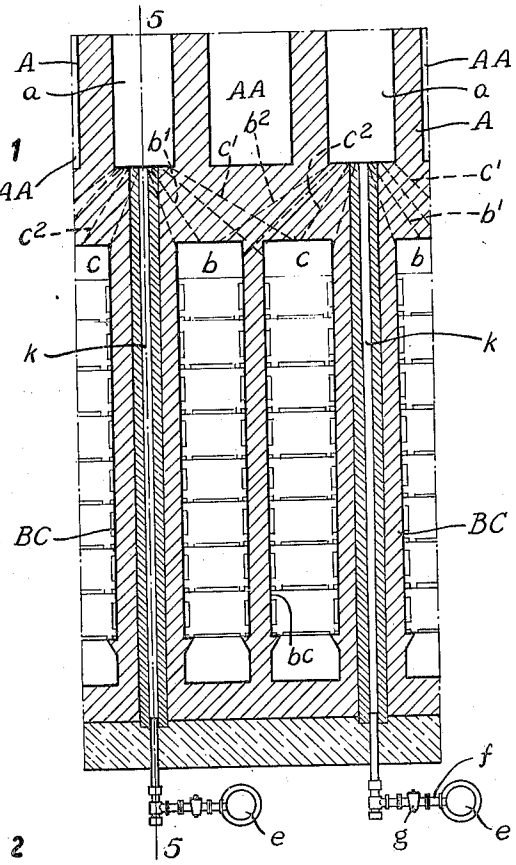


Fig. 2

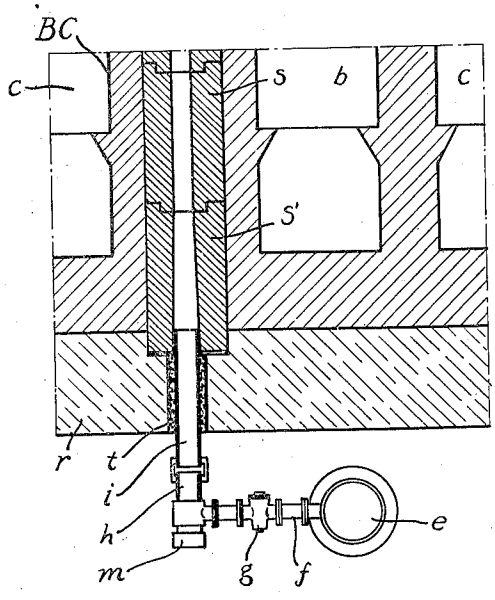


Fig. 3

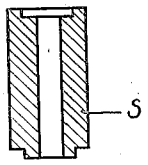
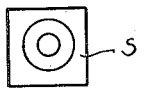


Fig. 4



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REGENERATIVE COKE OVEN

Filed Oct. 11, 1933 2 Sheets-Sheet 2

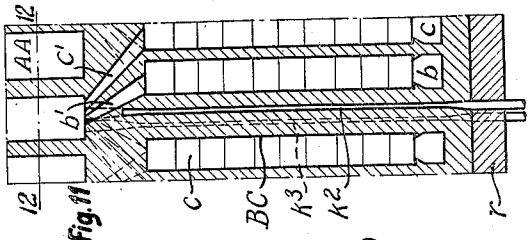


Fig. 11

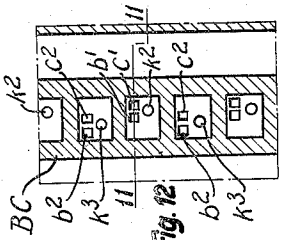


Fig. 12

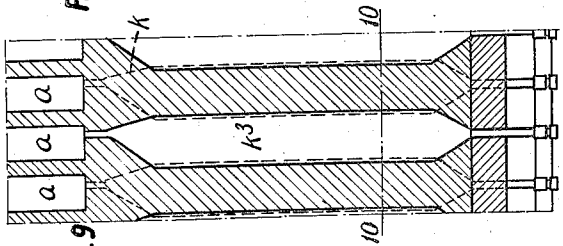


Fig. 9

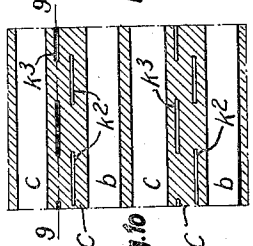


Fig. 10

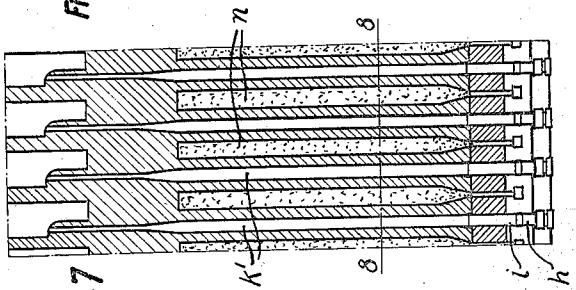


Fig. 7

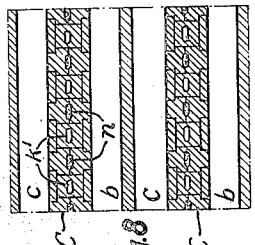


Fig. 8

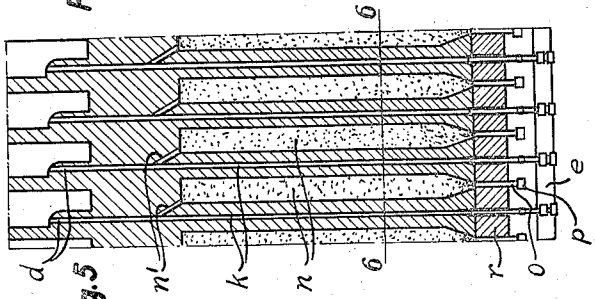


Fig. 5

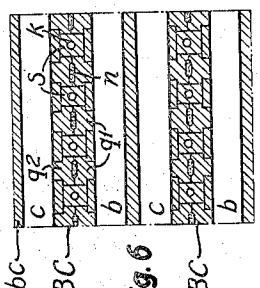


Fig. 6

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UNITED STATES PATENT OFFICE

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REGENERATIVE COKE OVEN

Carl Otto, Essen, Germany

Application October 11, 1933, Serial No. 693,085

12 Claims. (Cl. 202—269)

My invention relates to coke ovens of the type comprising regenerators, some of which may be used in preheating air and others in preheating gas when the latter is a low grade gas advantageously preheated prior to its admission to the combustion flues of the oven, and all of which may be used in preheating air for combustion when the fuel gas supplied to the flues is a rich gas; and relates particularly to a so-called underfired oven in which the regenerators are below the coking chambers and heating walls and in which rich fuel may be supplied to the heating wall flues through vertical ducts extending upward to the flues through regenerator partition walls from an underground space beneath the regenerators and containing the distribution piping and valves for regulating the supply of rich fuel gas to said ducts and thereby to said flues.

My invention is concerned particularly with the construction of regenerator partition walls, each of which in any normal operating condition of the oven, separates an "on" regenerator in which air or gas is being preheated, from an "off" regenerator through which products of combustion are being drawn away from heating wall flues, the particular regenerators which are "on" and "off" regenerators with one direction of heating gas flow being "off" and "on" regenerators, respectively, when the heating gas flow is reversed. The invention has for its object to prevent gas leakage in the regenerator partition walls separating adjacent "on" and "off" regenerators, and a further object of the invention is to provide for the repair of such a partition wall, when leakage therein occurs, quickly, and without significant interference with the operation of the oven.

Further my invention comprises an arrangement of the above mentioned vertical rich gas ducts which will minimize decomposition of the rich gas constituents passing through the ducts by the heat absorbed from the regenerators at the opposite sides of said partition walls, and thereby prevent the choking of the ducts by decomposition products.

My invention also comprises an arrangement of said ducts making the latter easily accessible from the underground space beneath the regenerators so as to facilitate the cleaning of the ducts during the operation of the ovens, and so as to facilitate the use of the ducts in tightening up the corresponding partition walls, by closing the joints or cracks developing therein, in the manner disclosed in Patent No. 1,990,089 granted on my prior application, filed December 15, 1932, without material interference with the normal operation of the oven.

In order that my invention may be easily understood and readily carried into effect, reference may be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred forms of embodiment of my invention.

Of the drawings:

Fig. 1 is a partial vertical longitudinal section of a coke oven battery;

Fig. 2 is a section taken similarly to Fig. 1, but on a larger scale and showing a portion only of the structure shown in Fig. 1;

Fig. 3 is a sectional elevation, and Fig. 4 a plan view of one of the duct forming bricks shown in Fig. 2;

Fig. 5 is a vertical section on the line 5—5 of Fig. 1;

Fig. 6 is a horizontal section on the line 6—6 of Fig. 5;

Fig. 7 is a vertical section taken similarly to Fig. 5, and illustrating a modification of the construction shown in Fig. 5;

Fig. 8 is a horizontal section on the line 8—8 of Fig. 7;

Fig. 9 is a vertical section generally similar to Fig. 5 and taken on the line 9—9 of Fig. 10 and illustrating a second modification;

Fig. 10 is a horizontal section on the line 11—11 of Fig. 9;

Fig. 11 is a section taken similarly to Fig. 1 illustrating another modification; and

Fig. 12 is a horizontal section on the line 12—12 of Fig. 11.

The coke oven battery construction illustrated in Figs. 1–6, comprises horizontal coking chambers AA alternating with heating walls A arranged side by side in a row extending longitudinally of the battery, each heating wall being formed with vertical heating flues *a*. Beneath each heating wall A and extending longitudinally thereof is a regenerator division wall BC separating a regenerator *b* at one side of the wall from a regenerator *c* at the opposite side of the wall, there being one regenerator *b* and one regenerator *c* separated from one another by a division wall *bc* between and extending longitudinally of each two adjacent walls BC. Each regenerator comprises a chamber and checker bricks *x* therein. The regenerators *b* and *c* may be used in preheating air and low grade gas, respectively, when the latter is the oven heating fuel gas, or all of the regenerators *b* and *c* may

be used in preheating air when rich fuel gas is used in heating the oven.

The rich fuel gas, when used, is supplied to the flues *a* in which combustion is initiated through nozzles *d* opening into the lower end of the flues and receiving gas through vertically disposed ducts *k* in the walls *bc*, the gas being supplied to the lower ends of the ducts *k* by distribution mains *e* provided with branch pipes *f* fitted with regulating and throttle valves *g*, each pipe *f* opening through a pipe *h* and an extension pipe *i* into the corresponding vertical duct. In the construction shown in Figs. 1–6, each duct *k* is circular in cross section and has its wall formed by a lower brick *s'* and superposed bricks *s* incorporated in the corresponding wall BC. Each of the bricks *s* is in the form of a perforated block rectangular in cross section and formed at its upper end with a circular recess, and at its other end with a tubular extension entering the circular recess of the adjacent brick, so that the joint between the adjacent bricks in end to end relation are bell and spigot joints. As shown, the brick *s'* differs from the bricks *s* above it in that its perforation forming a part of the duct *k* is conical and has its lower end enlarged to telescopically receive the upper end of the corresponding pipe *i*. The pipes *i* and *h* may have the same internal diameter as the portion of the duct *k* formed by the perforations in the bricks *s*. Any dust or other particles separating from the gas within a duct *k* and falling to the bottom of the corresponding pipe *h* can easily be removed by unscrewing the lower closure *m* with which said pipe *h* is provided. On the removal of the closure *m*, a poker or cleaning tool may be introduced into the corresponding duct *k* to remove material which has deposited from the gas onto the walls of the duct. The ducts *k* can also be used during the operation of the oven, and after the closure of the respective valves *g*, for the introduction under pressure of a mobile mortar which is left in the ducts until it has entered any cracks or joints issuing from the ducts, in accordance with the method of tightening regenerator partition walls described in my above mentioned Patent No. 1,990,089.

The coke oven described is adapted for operation with reversal of the direction of heating flow between successive periods of operation in such manner that the group of regenerators comprising a regenerator *b* and a regenerator *a* adjacent and at one side of each partition wall BC are on and off regenerators during each period of operation in which the similar group of regenerators *b* and *c* at the opposite side of and adjacent said partition wall are off and on regenerators, respectively. In consequence the gas pressures at the opposite side of each partition wall BC are normally different, and if said wall is not tight, the said difference in pressure may give rise to a transition of gas or air from the on regenerator immediately adjacent the wall into the waste gas or off regenerator to the opposite side of, and immediately adjacent said wall. To further the maintenance of the tightness of the partition walls BC, vertical spaces or chambers *n* are formed in, and distributed along the length of each wall BC, each such chamber being accessible from the previously mentioned underground space through a pipe *o* provided with a removable closure *p*. As shown, each chamber *n* is flattened or elongated in horizontal cross section in the direction of the length of the walls BC.

Each member *n* is advantageously filled with a mass of refractory material introduced into the space in a liquid or fluid mortar like condition and adapted to quickly solidify, but not to an extent, with the partition wall temperatures normally prevailing, to make the mass stone hard, or to prevent the mass from being broken up and removed by means of a poker introduced through the corresponding pipe *o*. When leakage develops in a partition wall, the chambers *n* therein, if previously empty are filled, and if not previously empty, are cleaned out and refilled with said refractory material which is introduced into the chambers *n* through the corresponding pipes *o* under pressure and is held therein until it sets or solidifies. The cleaning out and refilling operations may be repeated as often as the development of leakage conditions make desirable.

The above mentioned quick setting refractory material introduced in the chambers *n* in liquid form may consist, for example, of a mortar composed of small quartzite particles and a binder consisting of a small quantity of clay. Such a mortar quickly sets into a gas tight coherent mass, but does not sinter at the temperatures normally prevailing at the regenerator partitions.

Alternatively the spaces *n* may also be filled, as described in Patent No. 2,008,658 granted on my co-pending application, filed April 24, 1933, with a fine grained mass of granular refractory material such as fine ground silver sand.

The walls of the spaces *n* may be formed by superposed pairs of bricks q^1 and q^2, with the joints between the two bricks of each pair extending in the longitudinal direction of the partition walls in which they are incorporated as shown in Fig. 6. The above mentioned joints extend between vertical joints in the partition wall alongside the adjacent bricks *s* or *s'* which extend transversely to but terminate short of the sides of the partition walls, so that the silver-sand or other material working out through the first mentioned joints tends to choke up the transversely extending joints, and does not work out into the regenerator spaces.

In the modification illustrated in Figs. 7 and 8, the circular rich gas ducts *k* of the construction first described, are replaced by ducts *k'* which in their body and lower end portions are flattened or elongated in horizontal cross section in the direction of the lengths of the partition walls BC. In the upper portions of the ducts *k'*, the cross sections of the latter become circular. The iron pipes *i* and *h'*, which in Figs. 7 and 8 replace the previously mentioned pipes *i* and *h*, have the same flattened cross section as the body portions of the ducts *k'*. The flattened cross section of the ducts *k'* are particularly well suited for the repair of the partition walls to eliminate leakage by the introduction of liquid mortar into the ducts as described in my above mentioned Patent No. 1,990,089.

The cross sectional area of each of the ducts *k* and *k'* is advantageously made more than 1/100 of the cross sectional area of the flue *a* supplied with heating gas by the duct. With the cross sectional areas of the ducts and flues so related, a laminary flow of the heating gas is maintained in each duct, so that a quiescent gas layer is formed on the rough brick surfaces forming the inner wall of the duct and constitutes a heat insulating layer between the bricks and the gas

current passing through the duct and thereby prevents the gas passing through the duct from attaining the temperature required for the decomposition of its constituents before reaching the entrance to the flue *a* fed with gas by the duct. With the smaller cross sectional area of the rich gas fuel ducts relative to the cross sectional areas of the flues heretofore customary, the resultant higher gas velocity in the ducts produces a turbulent flow therein and the attainment of a gas temperature in the ducts high enough to result in decomposition of gas constituents therein notwithstanding the shorter period required for the movement of each gas molecule or particle through the duct.

In erecting ovens as hereinbefore described, a concrete layer *r* is formed on the supporting pillars (not shown) of the foundation masonry, which layer is called the nozzle plate and in which holes *t* for the insertion of the iron pipes *i* are provided. When the nozzle plate *r* has set, the pipes *i* are fixed therein and the bricks s' and s^2 are mounted in place. Finally the pipes *h* are screwed on the lower ends of the pipes *i*. To facilitate the use of the rich gas supply ducts in tightening up the regenerator partition walls BC during the operation of the oven, those ducts, provided they are flattened or horizontally elongated in cross section as previously described, may be arranged in two rows with the ducts in each row staggered relatively to the ducts in the other row, as shown in Figs. 9 and 10, wherein k^2 represents the rich gas ducts in one row and k^3 the rich gas ducts in the other row in the same wall BC. With this arrangement, the cross sections of the ducts are preferably horizontally elongated and arranged as shown in Figs. 9 and 10, so that each duct in one row overlaps the two adjacent ducts in the other row. In consequence any transverse crack developing across a partition wall BC necessarily extends through one at least of the ducts k^2 and k^3 in the adjacent portion of the wall which can thus be effectually tightened in the manner previously described.

As shown each heating wall has some of its flues *a* connected by channels b' and c' to the group of regenerators *b* and *c* at one side of the subjacent partition wall BC, and has its other flues *a* connected by ducts b^2 and c^2 to the group of regenerators *b* and *c* at the opposite sides of said subjacent wall. If, as when the flues *a* in each heating wall are connected at the upper ends in pairs to form hairpin or twin flues with one flue of each pair connected by ducts b' and c' to the regenerators *b* and *c* of one group and the other flue of each pair connected by ducts b^2 and c^2 to regenerators of another group, up burning flues alternate with down burning flues along the length of each heating wall. With the regenerators and flues so connected, rich fuel gas may be supplied to the up burning flues in each heating wall wholly through the ducts k^2 in one row with one direction of heating gas flow, and when the flow is reversed, rich fuel gas may be supplied wholly through the ducts k^3 in the other row in the subjacent wall BC. In such case it is advantageous to arrange the ducts so that with either direction of gas flow, the rich gas ducts in each wall BC which are in use, are the ducts in the row relatively near to the regenerators alongside that wall which are then employed as on regenerators heating air for combustion, and no use is then made of the ducts which are relatively near to regenerators then serving as off or waste heat regenerators. Such an arrangement is illustrated in Figs. 11 and 12, wherein the flues *a* of each heating wall receiving air for combustion through ducts b' and c' from regenerators at one side of the subjacent wall BC, receive rich fuel gas through the ducts k^2 in the portion of said wall relatively close to said regenerators, and the alternating flues which receive air for combustion through ducts b^2 and c^2 from regenerators *b* and *c* at the opposite side of said partition wall, receive rich gas through the ducts k^3 in the portion of the partition wall relatively near to the last mentioned regenerators.

To facilitate the introduction of refractory material in the form of a liquid mortar into the partition wall spaces *n*, the upper ends of those spaces may be connected in some suitable manner to neighboring hollow spaces in the oven masonry to permit the ready escape from the spaces of the gaseous medium replaced by the mortar when the latter is introduced. In a preferred form of the invention, the spaces *n* are thus connected by ducts n' to the adjacent rich gas supply ducts *k* as illustrated in Fig. 5.

What I claim and desire to secure by Letters Patent is:—

1. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical chambers, and an unsintered solid mass in each of said chambers of refractory material which is adapted to be inserted therein while in a wet mortar like condition and to quickly set into said mass and which will not sinter under the temperatures to which said wall is normally subjected in the high temperature carbonization of coal in said oven, and is substantially impervious to gas flow.

2. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical chambers, and an unsintered solid mass in each of said chambers of refractory material which is adapted to be inserted therein while in a wet mortar like condition and to quickly set into said mass and which will not sinter under the temperatures to which said wall is normally subjected in the high temperature carbonization of coal in said oven, and is substantially impervious to gas flow, each of said chambers having a flat horizontal cross section elongated in the direction of said wall.

3. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical chambers, and an unsintered solid mass in each of said chambers of refractory material which is adapted to be inserted therein while in a wet mortar like condition and to quickly set into said mass and which will not sinter under the temperatures to which said wall is normally subjected in the high temperature carbonization of coal in said oven, and is substantially impervious to gas flow, each of said chambers having a flat horizontal cross section elongated in the direction of said wall, the latter including bricks surrounding and forming the wall of each channel and arranged in two vertical rows with the joints between the two rows

extending longitudinally of said wall, and with joints between said bricks and adjacent portions of said wall extending transversely to the wall across the ends of the first mentioned joint but terminating short of the sides of said wall.

4. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical fuel gas supply channels at intervals along its length and with vertical chambers alternating with said channels along the length of said wall, and an unsintered solid mass in each of said chambers of refractory material which is adapted to be inserted therein while in a wet mortar like condition and to quickly set into said mass and which will not sinter under the temperatures to which said wall is normally subjected in the high temperature carbonization of coal in said oven, and is substantially impervious to gas flow, each of said channels and chambers having a flat horizontal cross section elongated in the direction of the length of said wall.

5. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical fuel gas supply channels at intervals along its length, and with vertical chambers disposed alternately with said channels along the length of said walls, and a readily frangible refractory mass comprising fine grained granular material and a binder and adapted to be inserted in the chamber in a wet mortar-like condition and to quickly set into said mass and which will not sinter under the temperatures to which said wall is normally subjected in the high temperature carbonization of coal in said oven and which is substantially impervious to gas flow.

6. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical fuel gas supply channels at intervals along its length, and with vertical chambers disposed alternately with said channels along the length of said walls, and a readily frangible refractory mass comprising fine grained granular material and a binder and adapted to be inserted in the chamber in a wet mortar-like condition and to quickly set into said mass and which will not sinter under the temperatures to which said wall is normally subjected in the high temperature carbonization of coal in said oven and which is substantially impervious to gas flow.

7. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical fuel gas supply channels arranged in two rows extending longitudinally of said wall, with the channels in each row staggered with respect to the channels in the other row, and with each of said channels having a flat horizontal cross section elongated in the direction of the length of said wall.

8. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators in which the gas pressures are normally different, a horizontally elongated wall between said regenerators and formed with vertical fuel gas supply channels arranged in two rows extending longitudinally of said wall, with the channels in each row staggered with respect to the channels in the other row, and with each of said channels having a flat horizontal cross section elongated in the direction of the length of said wall, and the adjacent portions of each two adjacent channels in each row overlapping the opposite edges of a channel in the other row.

9. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators each adapted for use alternately as an on and off regenerator during periods in which the other is used as an off and on regenerator, respectively, a horizontally elongated partition wall separating said regenerators and having two sets of vertically disposed channels arranged in two side by side rows extending longitudinally of said wall with the channels of each row nearer to one and more remote from the other of the two sides of said wall than are the channels of the other row, the channels in each row being adapted for use as fuel gas supply channels alternately with the channels in the other row and the channels in each row being adapted for use as fuel gas supply channels alternately with the channels in the other row and during the periods in which the regenerator immediately adjacent the side of said wall nearer the last mentioned row of channels is adapted for use as an off regenerator.

10. A regenerative coke oven of the kind described comprising two side by side horizontally elongated regenerators each adapted for use alternately as an on and off regenerator during periods in which the other is used as an off and on regenerator respectively, a horizontally elongated partition wall separating said regenerators and having two sets of vertically disposed channels arranged in two side by side rows extending longitudinally of said wall with the channels of each row nearer to one and more remote from the other of the two sides of said wall than are the channels of the other row, the channels in each row being adapted for use as fuel gas supply channels alternately with the channels in the other row and the channels in each row being adapted for use as fuel gas supply channels alternately with the channels in the other row and during the periods in which the regenerator immediately adjacent the side of said wall nearer the last mentioned row of channels is adapted for use as an off regenerator, the channels in each row being staggered with respect to the channels in each row and each having a flat horizontal cross section elongated in the direction of the length of said wall.

11. A regenerative coke oven comprising a horizontally elongated heating wall with vertical flues therein in a row extending longitudinally of said wall, a horizontally elongated regenerator division wall beneath and parallel to said heating wall with separate fuel gas supply channels therein one beneath and extending upward into communication with each of said flues from the lower edge of said division wall, and each of a cross sectional area sufficiently large for a laminary flow therethrough of the fuel gas supplied through said channel to the flue with which said channel is in communication.

12. A regenerative coke oven comprising a

horizontally elongated heating wall with vertical flues therein in a row extending longitudinally of said wall, a horizontally elongated regenerator division wall beneath and parallel to said heating wall with separate fuel gas supply channels therein, one beneath and extending upward into communication with each of said flues from the lower edge of said division wall, and each of a cross sectional area which is more than one percent of the cross sectional area of the flue with which said channel is in communication.

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