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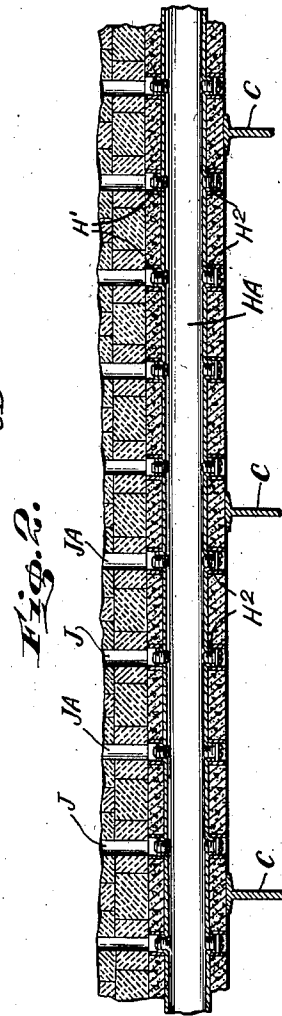
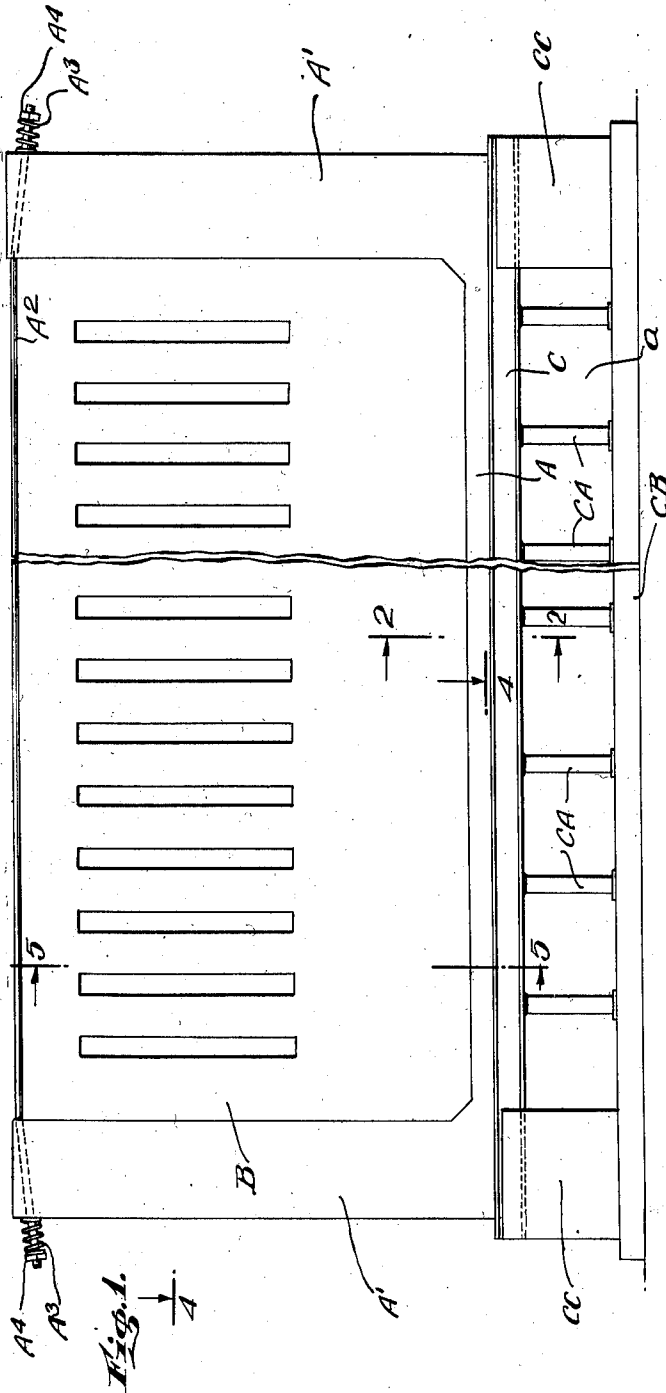
C. OTTO

2,376,718

REGENERATIVE COKE OVEN

Filed Nov. 9, 1942

4 Sheets-Sheet 1



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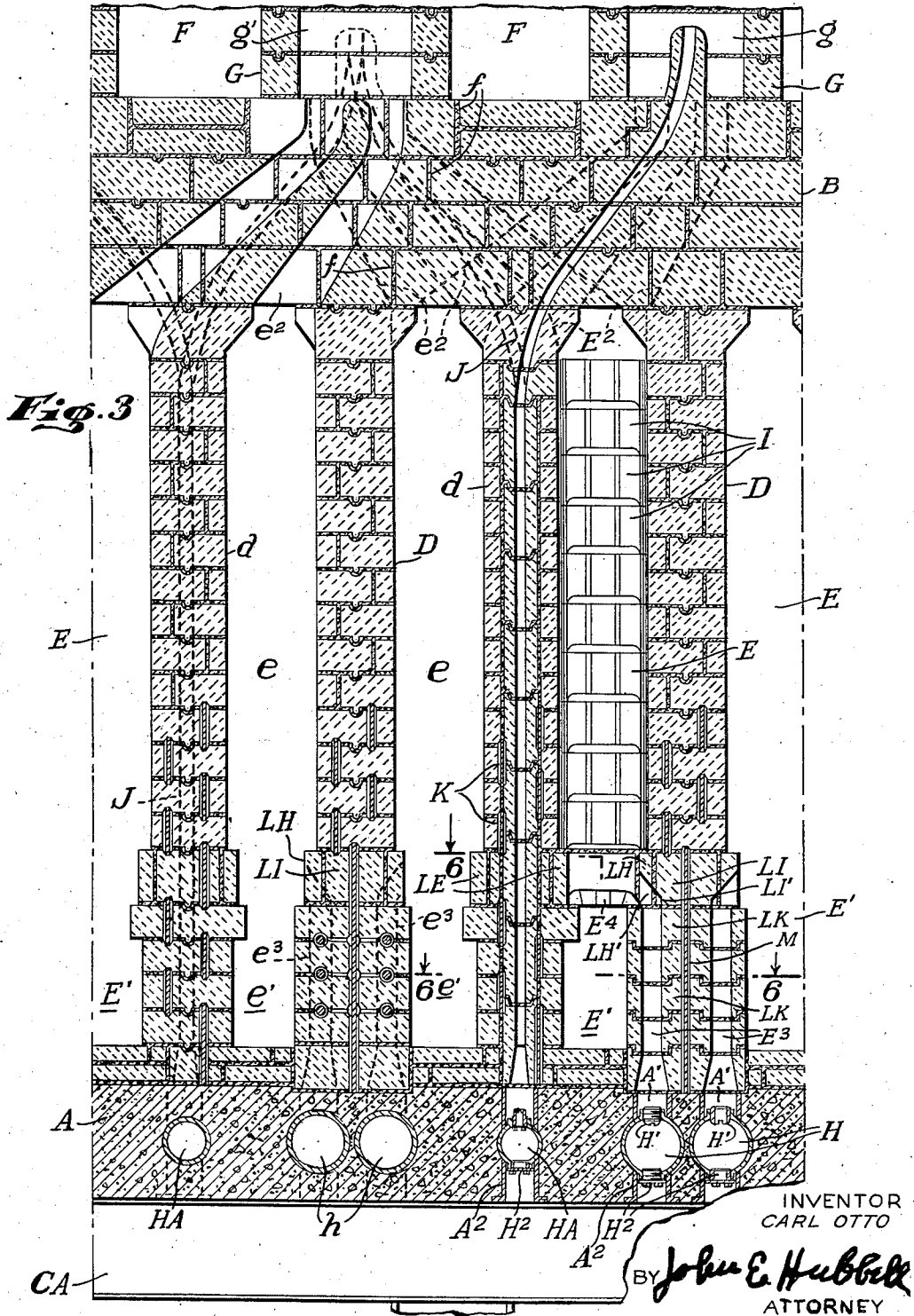
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REGENERATIVE COKE-OVEN

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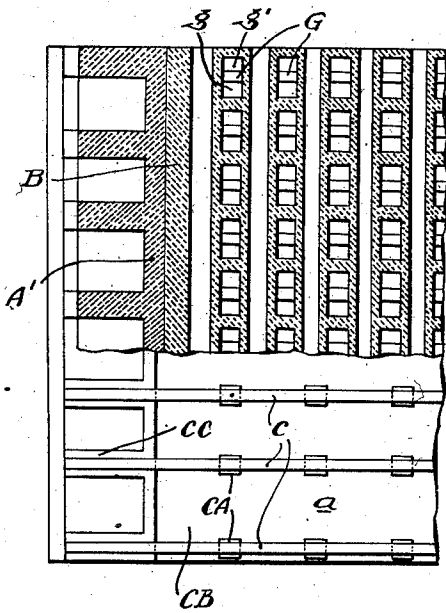


Fig. 4.

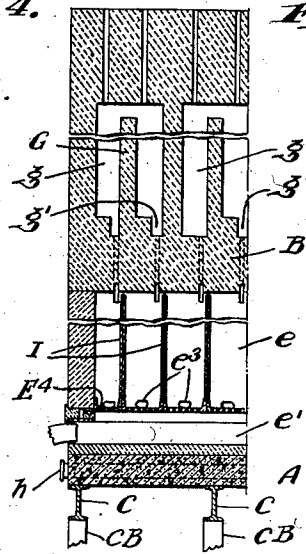


Fig. 5.

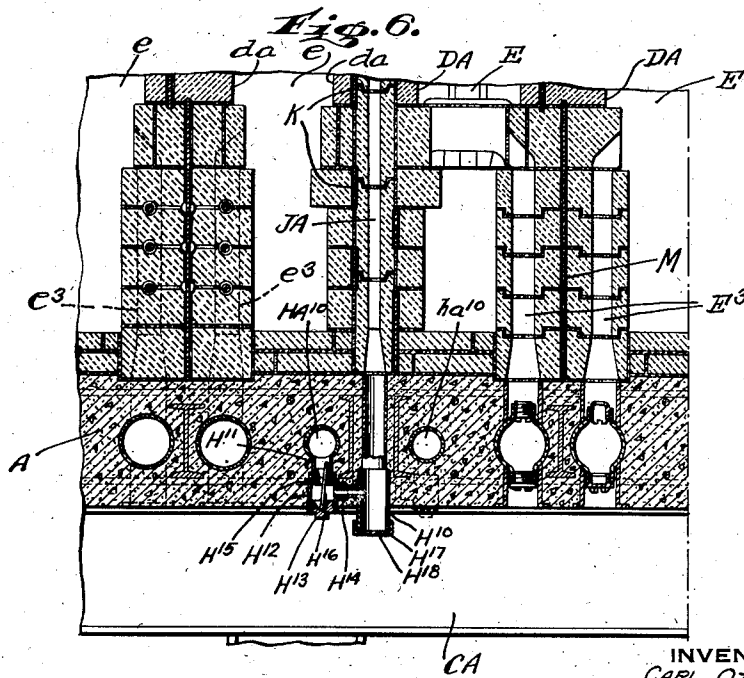


Fig. 6.

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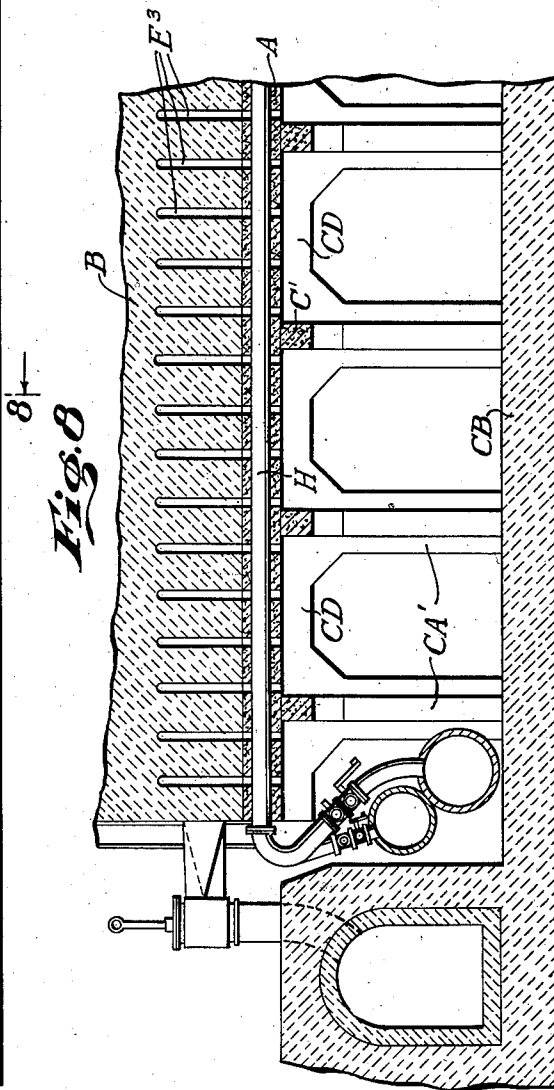
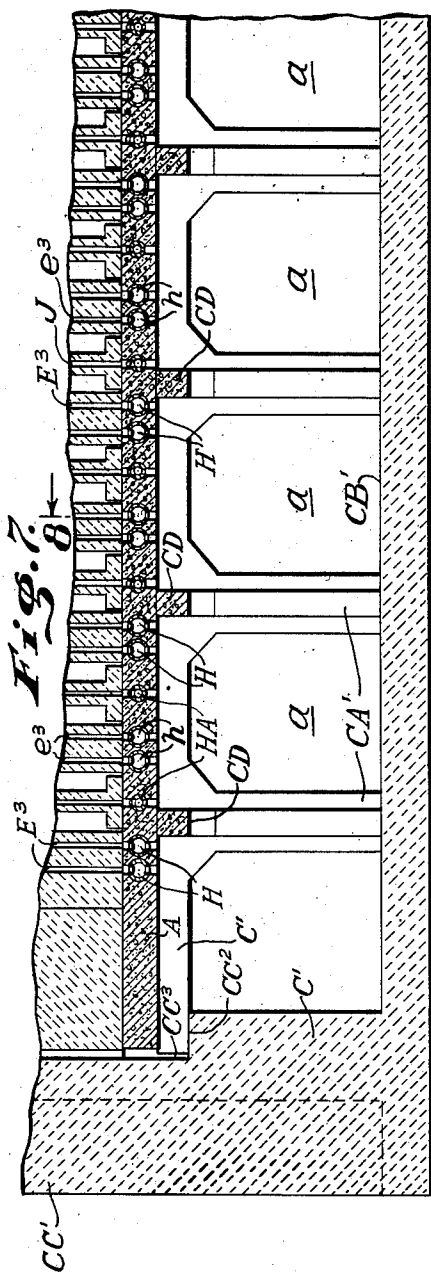
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REGENERATIVE COKE OVEN

Filed Nov. 9, 1942

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,376,718

REGENERATIVE COKE OVEN

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Application November 9, 1942, Serial No. 464,971

10 Claims. (Cl. 202—133)

The general object of the present invention is to provide structural improvements in underfired coke oven batteries of the type now extensively used in the manufacture of metallurgical coke in this country and abroad.

A coke oven battery of the above mentioned type includes as essential and characteristic elements, a brick work mass or block, a deck member underlying and directly supporting the brick work block, a foundation beneath the supporting deck and separated from the latter by the basement space required for underfired operation, distributed supports extending upward from the foundation through said space and supporting the deck and pinion walls at the end of the battery in abutting relation with the ends of the brick work block.

Said brick work block comprises an upper story formed with horizontal coking chambers extending transversely of the length of the battery and heating walls alongside the coking chambers, and a lower story including regenerative provisions for transmitting heat from the heating gases leaving the heating walls to the combustion air, and to the fuel gas, if lean, supplied to the heating walls. Said brick work mass is also formed with vertically disposed expansion joints which extend transversely to the battery length and divide the brick work block into a series of sections arranged end to end along the length of the battery.

A highly important specific object of the invention is to provide an underfired coke oven battery of the above mentioned type with novel deck and pinion wall structural characteristics and supporting provisions, adapted to avoid or substantially minimize difficulties which the relative thermal expansion of different portions of the battery tend to produce. Those difficulties are especially serious because of the large bulk and weight of underfired coke oven batteries.

In the numerous underfired coke oven batteries now in use and in process of construction in this country, the brick work blocks have an average length of about 250 feet, an average width of about 43 feet and an average height of about 29 feet, and in such batteries the average bearing load on the deck is of the order of 2500 pounds per square foot of horizontal deck area. In such batteries the heating flue temperatures in full load operation are of the order of 2600° F., and but for the expansion joints in the brick work block, the portion of the latter between the oven floor and roof levels would elongate more than 1% as a result of the thermal expansion of the bricks occurring when the battery is brought up to working tempera-

tures. The battery deck temperatures are much lower, the average deck temperature being of the order of 200° F. In consequence, the total longitudinal expansion of the deck of a battery having a brick work block length of 250 feet is about 4 inches whereas said brick-work block would elongate more than 30 inches if it included no expansion joints.

In all underfired coke oven batteries now in use in this country, and I believe in all such batteries now in process of construction in this country, the deck supporting members which extend upward through the basement space, are arranged in rows extending transversely to the battery length and the supports in each such transverse row are connected at their upper ends by a beam extending transversely of the battery and engaging the superposed portion of the deck directly above it.

The thermal expansion in the longitudinal direction of the battery of a monolithic deck which is 250 feet long and supported on the transverse beams just described, would inevitably increase the distance between the transverse beams supporting the opposite end portions of the deck, and would thereby subject the corresponding uprising supports to severe and highly objectionable bending stresses. Risk of such bending stresses have been avoided in every underfired coke oven battery in use in this country, the division of the deck into a multiplicity of end to end sections separated by expansion joints, and by the provision designed and operative to so take up the expansion joints in the deck and in the brick work block as to reduce the overall longitudinal expansion of the deck and the brick work block and make each small fraction of the deck elongation which would occur if the deck included no expansion joints.

To attain the above mentioned specific object of the present invention I depart from prior practice by separating the pinion walls from the foundation and rigidly connecting them to the adjacent end portions of the deck, to thereby form a brick work supporting structure which may be monolithic, and which is devised and adapted to spread the pinion walls apart as the deck is elongated by its thermal expansion, and I further depart from prior practice by providing a battery sub-structure including deck supporting beams which extend longitudinally of the battery for substantially the full length of the latter, and each of which connects the upper ends of uprising deck supports arranged in a row extending longitudinally of the battery, to thereby pro-

vide a support for the deck and pinion walls on which the deck and pinion walls move on and in accordance with the changes in the relative lengths of the deck and supporting beams resulting from changes in the temperatures.

In the ordinary use of the present invention, the deck and pinion walls are formed of reinforced concrete as has been the practice heretofore, but are integrally connected instead of being separate parts, as has been customary heretofore. In the preferred forms of the present invention, however, the deck reinforcing means differ from that heretofore customary, in that it consists in substantial part of horizontal pipes extending transversely to the battery length and embedded in the deck and serving as distribution pipes supplying combustion air and fuel gas to the regenerators and heating flues of the battery. The embedding of such metal pipes in the deck reduces the deck resistance to fracture along lines transverse to the battery length and increases the deck resistance to fracture along lines extending longitudinally of the battery; and a further specific object of the invention is to provide a battery deck including embedded transverse distribution pipes, with supporting means including longitudinal supporting beams which minimize the risk of deck fracture along lines transverse to the length of the battery.

It is to be noted, moreover, that the embedding of the distribution pipe in the concrete layer makes it entirely feasible and advantageous to support that layer on beams extending longitudinally of the battery, whereas with the fuel gas distribution pipe located in the basement space in accordance with prior practice, the use of longitudinal beams requires an undesirable lowering of the distribution piping.

Another specific object of the present invention is to provide a special relative arrangement of regenerator checker bricks and supporting provisions therefor, whereby the checker bricks may be made of clay, having a relatively small coefficient of thermal expansion, and may be supported on parts of regenerator walls which are formed of silica bricks or blocks having a relatively high coefficient of expansion, so that the expansion of the regenerator walls relative to the checker bricks will not interfere with the proper spacing of the checker bricks in the regenerator chambers, and so that the silica brick supporting parts are not exposed to the wide fluctuations in temperature to which the lower checker bricks are subjected as a result of the reversals of flow through the regenerators.

Still another specific object of the invention is to provide an improved arrangement of channels and conduit connections for supplying rich fuel gas to the combustion flues.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described embodiments of the invention.

Of the drawings:

Fig. 1 is a somewhat diagrammatic side elevation of a coke oven battery;

Fig. 2 is a partial vertical section on the line 2—2 of Fig. 1;

Fig. 3 is a partial vertical section taken longi-

tudinally of the battery shown in Fig. 1, through the lower portion of the coke oven battery;

Fig. 4 is a partial sectional plan on the broken line 4—4 of Fig. 1;

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

Fig. 6 is a partial section taken similarly to Fig. 7 through a portion of the deck of a battery differing somewhat from that shown in Figs. 1-4;

Fig. 7 is a partial longitudinal section of a battery differing somewhat from those shown in Figs. 1-5; and

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

In Figs. 1-5 of the drawings, I have illustrated the use of the present invention in a horizontal, underfired, regenerative coke oven battery comprising a concrete layer A which forms the supporting deck for the coke oven brick work block or mass B, and forms the roof or the basement space *a* of the battery. The brick work block B has its ends in abutting relation with so called pinion walls A' at the opposite ends of the battery which are rigidly connected at their lower ends to the corresponding ends of the deck A. The deck A and pinion walls A' thus collectively form a brick work supporting structure which underlies and supports the weight of the brick work block B and restricts the expansion of the brick work block in the direction of the length of the battery as hereinafter explained.

Ordinarily, and as shown, the deck A and pinion walls A' constitute a monolithic structure of reinforced concrete. The upper ends of the pinion walls are connected by tie bolts A² extending longitudinally of the battery and resting on the roof of the latter. As diagrammatically shown, each end of each tie bolt extends through the upper end of the corresponding pinion A' and acts on the latter through a cushion spring A³ and an abutment nut A⁴ threaded on the end of the tie rod. By suitable adjustment of the nuts A⁴, the tie bolts A² may be maintained under such tension as the battery heats up, that the upper ends of the pinion walls are spread apart by the thermal elongation of the deck member A.

The brick work supporting structure formed by the deck A and pinion walls A', is mounted on a sub-structure which as shown in Figs. 1-5, comprises a plurality of spaced apart steel beams C which extend longitudinally of the battery for the full length of the latter, and each of which is supported at distributed points along its length by steel columns CA which extend upward from the masonry battery foundation CB through the battery basement space *a*. The columns CA supporting each beam C are arranged in a row extending longitudinally of the battery and have their upper ends welded to said beam. As shown in Fig. 1 the ends of the beam C extend under the pinion walls A' and rest on masonry piers CC extending upward from the foundation CB at the end of the battery. In the particular battery design shown in Figs. 1-5 there are seven longitudinal beams C spaced apart as shown in Fig. 4.

The coke oven brick work comprises a lower story, or section, and an upper story, or section. In the lower section, regenerator division walls D and *d* alternate along the length of the battery, each extending from one side of the battery to the other, and between each adjacent pair of walls D and *d* is a regenerator E or *e*, extending from one side of the battery to the other. The different regenerators E and *e* are similar in construction, but the regenerators E are used only for preheating combustion air while the regen-

erators *e* are used to preheat either lean fuel gas or air, accordingly as the oven is heated by the combustion of lean gas which requires preheating, or by the combustion of rich gas which does not require preheating. There are a pair of regenerators *E*, or a pair of regenerators *e*, between each two adjacent walls *d*, the pairs of regenerators *E* alternating with pairs of regenerators *e* along the length of the battery.

The upper story or section of the coke oven brick work mass *B*, is shown as of well known type comprising horizontally elongated coking chambers *F*, alternating with heating walls *G*, each of said chambers and walls extending from one side of the battery to the other. Each heating wall *G* is formed with vertical flues *g* and *g'* alternating with one another in a row extending from one side of the battery to the other. Each flue *g* and an adjacent flue *g'* are connected at their upper ends and collectively form a so-called hairpin flue. Each heating wall *G* is directly above a corresponding regenerator division wall *D*, which may therefore be aptly called a pillar wall, and beneath each coking chamber *F* is a wall *d*, which may be called an intermediate regenerator division wall.

Beneath each of the regenerator chambers *E* and *e* is a corresponding sole channel *E'* or *e'*, respectively, through which the waste heating gases which flow down through the regenerator, when the latter is serving as an "off" regenerator, pass to one or both sides of the battery, and thence through the usual reversing valves to the waste heat flue system. The reversing valves and waste heat flue system form no part of the present invention and may be of the usual type, and hence need not be illustrated or further described. Each of the regenerators *E* and *e* is connected at its upper edge by channels *E²* or *e²* in the brick work to the lower end of one limb, *g* or *g'*, of each of the hairpin flues in each of the two heating walls *G* directly above the two immediately adjacent pillar walls *D* between which the regenerator is located, and each hairpin flue limb is connected by one channel *e²* to the regenerator *E* at one side of the subjacent pillar wall *D*, and is connected to the regenerator *e* at the other side of said pillar wall by a second channel *e²*.

Each of the regenerators *E* and *e* receives the combustible agent, air or lean fuel gas, which it preheats, through a corresponding one of distribution pipes *H* and *h*, respectively. Each of said pipes is imbedded in the concrete layer *A*, and is formed with a multiplicity of upper outlets distributed along its length. The flow through each of said outlets is regulated by the size of the measuring orifice or nozzle passage in a nozzle member *H'* threaded into, or otherwise replaceably mounted in, the outlet opening. Each nozzle *H'* discharges into a corresponding uprising passage *A'* formed in the layer *A*, and communicating at its upper end with the lower end of a corresponding brick work channel *E³* or *e³*, formed in the adjacent pillar wall *D*. Each of the channels *E³* and *e³* opens laterally at its upper end into the corresponding regenerator *E* or *e*, above the grid like refractory material parts *E⁴*, which separate the regenerator proper from its sole channel *E'* or *e'*. Advantageously, the regenerator checker bricks *I*, which are supported as hereinafter described, comprise end portions *I'* shaped and disposed to collectively form vertical partition walls dividing each regenerator into a row of regenerator cells which correspond

in number to the hairpin flues in a heating wall, and each of which is connected at its upper end by corresponding channels *E²* or *e²*, to one heating flue in each of the two adjacent heating walls.

The coke oven brick work block is formed with the usual expansion joints extending transversely to the length of the battery and dividing the block into a series of end to end sections.

In the customary expansion joint arrangement shown in part in Fig. 3, a vertical series of expansion joints *f* are formed in the portion of the brick work between the floor of an oven chamber *F*, and the ceiling of a subjacent regenerator chamber *e*. Each joint *f* extends vertically for the depth of a corresponding brick course, and the joints in adjacent superposed brick courses are staggered, and similarly staggered expansion joints *f* are formed in the floor of the sole channel *e'* at the bottom of the last mentioned regenerator chamber *e*, and in the roof of the last mentioned oven chamber, but the oven roof expansion joints are not shown in Fig. 4.

In accordance with the usual practice the expansion joints are initially filled with cardboard or analogous combustible material which will clear, or burn out when the battery is heated up, so that the opposed vertical joint sides extending transversely of the battery may approach one another as the end to end brick work block sections expand in the direction of the length of the battery and the bodily elongation of said block is restricted.

In heating the battery by the combustion of rich fuel gas, the latter is distributed by pipes *HA* embedded in the concrete layer *A*. Each pipe *HA* may be and is shown as similar in construction and arrangement to the pipes *H* and *h*, but ordinarily and as shown, each pipe *HA* may be somewhat smaller in diameter than the pipes *H* and *h*, and in the arrangement shown, each of the pipes *HA* has twice as many outlet openings, with nozzle members *H'* removably mounted therein, as does each of the pipes *H* and *h*. Each pipe *HA* is located beneath a corresponding intermediate regenerator division wall *d*, and has its alternate outlet openings connected to one limb *g* or *g'* of each hairpin flue in one adjacent heating wall by a set of brickwork channels *J*, and has its other outlet openings connected by a second set of brick work channels *JA* to the limbs *g* or *g'* of the different hairpin flues in the other adjacent heating wall. The lower portions of the channels *J* and *JA* associated with each pipe *HA* are vertical and centrally disposed in the corresponding division wall *d*, but upper portions of the channels *J* curve away from that wall toward one, and the upper portions of the channels *JA* curve away from that wall toward the other of the two adjacent heating walls.

As shown, each of the pipes *H*, *h* and *HA*, is formed with an opening in its bottom wall each normally closed by a screw plug or other removable closure *H²* and each located beneath a corresponding outlet opening and adapted when its closure *H²* is removed, to permit of the replacement of the nozzle member *H'* in the outlet opening above it. The concrete layer *A* is formed with openings *A²* extending from the underside of the layer *A*, through which a workman in the basement space may replace the corresponding closure part *H²* and nozzle part *H'*. In respect to the form of the distribution pipes, and their disposition in the concrete layer *A*, the construction illustrated in Figs. 1-5 is like that disclosed and claimed in Patent 2,273,885 of February 24,

1942, granted on my application filed October 9, 1939. Furthermore, in respect to the features of its construction and arrangement already described, the coke oven brick work does not differ from that disclosed in Reissue Patent 21,933, dated October 28, 1941. In the last mentioned patent, moreover, the combustible agents are distributed by distribution pipes corresponding generally to the above mentioned pipes H, h and HA.

In any regenerative coke oven comprising transverse regenerators arranged for side by side reversal, there are necessarily "on" regenerators each separated by a single regenerator division wall from an "off" regenerator. The difference between the pressures at the opposite sides of such a division wall, causes leakage through open joints or cracks in that wall from the "on" regenerator to the "off" regenerator. Such leakage from an "on" regenerator in which lean gas is being preheated, into an "off" regenerator is seriously objectionable when substantial in amount, as the lean gas leaking into the "off" regenerator will unite in combustion with unburned oxygen invariably contained in the waste heating gases.

Other things being equal, regenerator division walls including rich fuel gas supply channels have a greater leakage tendency and capacity, than regenerator division walls not including such channels, and leakage of rich fuel gas from supply channels in a wall, into an "off" regenerator alongside that wall is highly objectionable. However, as explained in the above mentioned Reissue Patent 21,933, risk of objectionable leakage through the walls including the rich gas supply channels J and JA may be avoided by arranging those channels, as shown, in the walls d, each of which separates regenerators which are both "on" regenerators during the reversal periods in which rich fuel gas is being passed through the supply channels.

In said Reissue Patent 21,933, I also disclose how significant leakage through regenerator division walls may be prevented by incorporating vertically disposed leakage barrier plates of heat resistant metal in the lower portions of the walls which are subjected to lower temperatures and to high leakage inducing pressure differentials than are the upper portions of the walls.

The construction shown in Fig. 3 includes an improved arrangement of metal leakage barrier plates, K and M, which need not be described herein, however, as that arrangement forms no part of the invention claimed herein, and is fully disclosed in Patent 2,273,886, granted February 24, 1942, on an application filed by me as a division of my application, Serial No. 314,760, filed January 20, 1940. The instant application is a continuation in part of said application, Serial No. 314,760.

The walls D and d may be similar in form and construction except as the inclusion of rich gas supply channels J and JA, only in the walls d and the inclusion of regenerator supply channels E³ and e³, only in the walls D, result in differences in the shape and disposition of the ceramic bricks or blocks forming said walls. Except for said channels, the walls D and d need differ from prior art regenerator division walls in no manner of consequence herein, other than that the ledge forming bricks LE and LH of the walls d and D, respectively, are made of clay, whereas the remaining bricks or blocks in the walls d and D, and all of the bricks or blocks used in form-

ing the regenerator division walls of prior unfired coke oven batteries, are made of silica.

Each row of bricks LE forms one supporting ledge of a wall d, and the adjacent row of bricks LH of the adjacent wall D forms the other supporting ledge for the stacks of checker brick I in the corresponding regenerator. The checker bricks are formed of clay which is not subject to the objectionable spalling which occurs when silica bricks are subjected to the wide temperature fluctuations to which the checker bricks and the bricks LE and LH are subjected by their contact with downflowing waste gases and upflowing air or lean gas to be preheated during alternating reversal periods. Furthermore, with the clay bricks LE and LH incorporated in silica brick walls as described, the great thermal expansion of the silica bricks relative to that of clay bricks, will not disturb the general arrangement of the stacks of checker brick distributed longitudinally of each regenerator and hence will have no tendency to open up large gaps between portions of the checker brick work displaced longitudinally of the regenerator, which exists when the checker bricks are supported on ledges formed by silica bricks.

While the elongation of each wall D or d due to the thermal expansion of the silica bricks in the wall, increases the distance between each two adjacent end to end ledge forming clay bricks LE or LH in the wall, the extent to which said two end to end bricks are thus separated is small. The separation of any two end to end ledge bricks normally results in a corresponding small and insignificant separation of the portions of the checker brick mass directly above and supported by said two end to end bricks, and normally does not result in any sliding movement of the checker bricks on the ledge bricks in the longitudinal direction of the walls D and d. Such sliding movements inevitably occur when the ledge bricks are formed of silica, which expand with the wall of which they form a part without relative movement of the adjacent ends of each two end to end ledge bricks. Such sliding movements are normally irregular and result in the irregular separation of the checker brick mass in each regenerator chamber into end to end sections. The number of checker brick sections so formed depends on fortuitous circumstances, but normally is a small fraction only of the number of end to end bricks in each supporting ledge. The thicknesses of the joint spaces opened between the adjacent sections may vary, but the average thickness necessarily increases as the number of sections formed is diminished.

The avoidance of large and irregularly positioned gaps in the checker brick mass is especially important when the regenerator checker bricks are shaped and disposed as previously described to divide each regenerator into a row of regenerator cells communicating individually with the different adjacent combustion flues.

In the construction shown in Figs. 1-5, the portion of each wall D, below the level of the bottoms of the checker brick masses, includes a central metallic plate barrier E, which may be formed by a single strip of sheet metal, or preferably by a series of overlapping sections of sheet metal. Between each row of bricks LH and the corresponding barrier M is a row of blocks LI. Suitably spaced notches LI' are formed in the blocks LI to unite with notches LH' in adjacent blocks LH in forming the upper portions of the corresponding channels E³ or e³. The portion of

each wall D at each side of its central barrier M and below the notched parts LH and LI, comprises vertical stacks of apertured bricks or blocks LK, each stack of blocks LK forming the wall of a vertical portion of a corresponding channel E³ or e³.

As shown in Figs. 1-5, the masonry above the basement space *a* is directly supported by metallic I beams C, which extend longitudinally of the battery. Those beams may be replaced by reinforced concrete beams C as shown in Figs. 7 and 8, however, since the use of the features of the invention previously described, does not depend upon the character of the beams supporting the layer A, except that for reasons already explained, it is practically important to have those beams extend longitudinally of the battery.

Where an especially strong foundation is required, as in the case of a coke oven battery in a locality subject to earthquake conditions, the concrete layer A may be directly supported by longitudinal beams C', which are associated, as shown in Figs. 7 and 8 with transverse beams CD. The latter need not come in direct engagement with the deck structure, but are advantageously combined with the beams C' and with the supporting pillars CA' in a monolithic structure of reinforced concrete.

The overall thermal elongation of the deck A depends upon the deck temperature and is decreased by decreasing said temperature. With the thickness of the deck A only fractionally greater than the diameter of the distribution pipe H and H' and with those pipes and the pipes HA embedded in the deck, the latter is subjected to a cooling action which makes the average temperature of the deck appreciably lower than it would be if the distribution pipes were incorporated therein.

However, the longitudinal expansion of the deck is small enough so that a substantial advantage is obtainable by the use of longitudinal deck supporting beams on which the deck is mounted with freedom to move as it expands, even though the deck is not subject to the cooling action of embedded distribution pipes, and even though the pinion walls are not connected to the ends of the deck as shown in Fig. 1, but have their lower ends anchored to the battery foundation as has been customary heretofore, and as is shown in Figs. 7 and 8.

At each end of the battery shown in Figs. 7 and 8, the corresponding ends of the deck A and of the longitudinal beams C' extend over a horizontal supporting shoulder or ledge portion CC² at the adjacent side of a member CC'. The latter forms the corresponding end of the battery structure. In effect, the member CC' is a retaining wall comprising a lower portion integrally connected to the battery foundation CB' and corresponding generally to one of the masonry piers CC of Fig. 1, and comprising an upper portion which is integrally connected to said upper portion and which corresponds to one of the pinion Walls A' shown in Fig. 1. As shown, the shoulder CC² is the bottom wall of a horizontal groove or recess formed in the corresponding side of the back wall CC³ of the recess deep enough to prevent the adjacent ends of the beams CB and deck A from impinging against a vertical portion of the wall CC¹, as a result of their thermal expansion when the battery is heated up. The arrangement permits the small required movement of the deck A relative to the beams C' and to the shoulder CC² in the longitudinal direction of the

battery. As shown in Figs 7 and 8, the pillars CA¹ as well as the battery end walls CC' are integrally connected with, and extend upwardly from the mat foundation CB' which may be made of reinforced concrete as usual.

The use of rich gas fuel distribution channels J and JA with their lower vertical portions in the same wall *d* and with the upper portions of the channels J running to one heating wall and with the bent upper portions of the channels JA running to an adjacent heating wall has the advantage that all of the said channels in each wall *d* may be supplied with rich gas from a single distribution pipe HA.

Notwithstanding the above advantage and others possessed by the rich gas supply arrangement shown in Fig. 3, I now consider it ordinarily desirable to locate all of the rich gas supply channels for each heating wall in the pillar wall directly beneath the heating wall. When this is done it becomes necessary to employ one distribution pipe to supply rich fuel gas to the channels JA, and another distribution pipe to supply rich fuel gas to the channels JA in the same pillar wall, as is made apparent in the above mentioned Reissue Patent 21,933, and as is illustrated in Fig. 6. In the arrangement illustrated in Fig. 6, the group of channels J and the group of alternating channels JA in the pillar wall DA beneath each heating wall, receive fuel gas during alternating reversal stages from distribution pipes ha¹⁰ and HA¹⁰, respectively, embedded in the deck member A.

As shown in Fig. 6, the regenerator supply channels E³ and e³ are formed in the sides of the pillar walls *da*. The regenerators with which the channels E³ and e³ are associated may well be connected to the heating flues in the manner disclosed in my Patent 2,293,074, dated August 18, 1942, though this is not essential.

In the rich fuel gas supply arrangement shown in Fig. 6, each rich fuel gas supply channel in a regenerator division wall DA, extends vertically downward to the subway space, and has its lower portion lined by a metal tube H¹⁰, incorporated in the lower portion of the deck layer A, and located at one side of the corresponding distribution pipe HA¹⁰. The latter, as shown, is formed with a tubular outlet H¹¹ extending downward from the underside of the pipe and connected at its lower end into a T H¹². The lower end of the latter extends below the bottom surface of the layer A and is internally threaded to receive a removable plug H¹³, normally closing the corresponding branch of the T. The transverse opening in the T receives the corresponding end of a short horizontal pipe section H¹⁴ embedded in the masonry and having its other end extending through a lateral opening in the corresponding vertical pipe H¹⁰. An orifice member H¹⁵ is mounted in the upper opening of the T and regulates the volume of gas flow from the pipe HA¹⁰ into the corresponding channel JA.

As shown, the plug H¹³ is formed with a conical recess in its upper side which receives and centers the lower end of a wire or rod H¹⁶. The latter extends up through the nozzle member H¹⁵ and correspondingly restricts the area of the flow path through the orifice. The replacement of one rod H¹⁶ by another of different diameter will vary the volume of flow through the nozzle member by a definite amount. The lower end of each vertical pipe H¹⁰, extends below the underside of the deck layer A, and is externally threaded to receive a removable closure part H¹⁷. When the latter is removed, the corresponding uprising fuel

gas supply channel may be entered by a flexible shaft or rod, employed to clean out the channel when necessary to eliminate mortar, or carbon deposit.

As shown, the closure part H¹⁷ is formed with a small opening H¹⁸ through which atmospheric air is constantly drawn into the corresponding uprising fuel gas supply channel. A small influx of air into that channel during the periods in which the latter is passing fuel gas from the corresponding distribution pipe H¹⁰ to the corresponding vertical combustion flue eliminates, or materially reduces, the tendency to the deposit of graphite on the hotter upper portion of the channel wall. The air passing through the port H¹⁸ during the periods in which the supply of gas through the corresponding distribution pipe HA¹⁰ is interrupted, serves the graphite removing purpose for which decarbonizing air is customarily supplied to the uprising rich gas supply channels. In the arrangement shown in Fig. 6, the rich gas supply channels J in each wall DA, are associated with and connected to a corresponding distribution pipe ha¹⁰, in the same manner in which the channels JA and distribution pipes HA¹⁰ are associated and connected.

As those skilled in the art will understand, the apparatus illustrated and described is well adapted to the attainment of the hereinbefore stated objects of the invention, and has numerous practically important characteristics and advantages. The wide difference between the oven brickwork temperature at the floor level of the ovens and adjacent the deck is mainly due to the regenerators, and would exist if the type of regenerator provisions shown were replaced by regenerator provisions of the kind specifically designated recuperators.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, those skilled in the art will recognize that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims, and will understand also that some features of my invention may sometimes be used with advantage without a corresponding use of other features.

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

1. A regenerative underfired coke oven battery comprising in combination an elongated brick work block formed with transverse horizontal coking chambers arranged side by side and with heating walls alongside the coking chambers and with regenerator chambers and walls beneath said coking chambers and heating walls, said block being formed in sections arranged end to end longitudinally of the battery and separated by transverse expansion joints, a brick work supporting structure comprising a deck member underlying said brick work block, pinion walls abutting against the ends of said brick work block and rigidly connected at their lower ends to the ends of said deck member, and a tie rod connection between the upper ends of said pinion walls including means adjustable to elongate said connection on and in accordance with the thermal elongation of said deck member as the battery is heated up, and a battery sub-structure comprising a foundation beneath said deck member and separated therefrom by a space forming an oven attendant passage way required for underfired

operation, distributed supports extending upwardly from said foundation through said space and beams carried by said supports and extending longitudinally of the battery and providing a support on which said supporting structure rests with freedom to move in accordance with changes in the relative lengths of said supporting structure and beams resulting from changes in their temperatures.

2. A coke oven battery as specified in claim 1 comprising metallic combustible agent distribution pipes extending transversely of the battery and imbedded in said deck.

3. A coke oven battery as specified in claim 1, in which said distributed supports are metal columns and said beams are formed of metal welded to the upper ends of the subjacent columns.

4. In an underfired coke oven battery comprising a basement space and a masonry structure above said space and including coking chambers, heating walls, regenerators, and regenerator division walls all extending transversely of the battery, metallic combustible agent distribution pipes extending transversely of the battery and incorporated in the lower portion of said structure, beams extending longitudinally of the battery and directly supporting said masonry structure with freedom for relative movement in accordance with changes in the relative lengths of said structure and beams, and pillars extending upward through the basement space of the battery and supporting said beams.

5. In an underfired coke oven battery, the combination with a masonry structure comprising coking chambers, heating walls, regenerators, and regenerator division walls all transverse to the length of the battery, of combustible agent distribution pipes extending transversely of the battery, a reenforced concrete layer beneath and directly supporting said brick work mass and in which said pipes are incorporated, and a supporting structure comprising beams extending longitudinally of the battery beneath and directly supporting said layer with freedom for relative movement in accordance with changes in the relative lengths of said layer and beams and pillars extending upward through the basement space of the battery and supporting said beams.

6. An underfired coke oven battery comprising a basement space and a masonry structure above said space and including heating walls, coking chambers, regenerator spaces, and regenerator division walls, all extending transversely of the battery, and supporting means for said structure, comprising beams extending longitudinally of the battery, pillars extending upward through the basement space of the battery and supporting said beams at different distances from the ends thereof, and a reenforced concrete deck member interposed between, said beams and said masonry with freedom for relative movement in accordance with changes in its length relative to the lengths of said beams and said masonry as a result of temperature changes occurring in heating up the battery.

7. In an underfired coke oven structure comprising a basement space and a masonry structure above said space and including coking chambers, heating walls, regenerators, and regenerator division walls all extending transversely of the battery, metallic combustible agent distribution pipes extending transversely of the battery and incorporated in the lower portion of said structure, said structure being formed with fuel gas supply channels extending upward from said

space to said heating walls through regenerator division walls, a removable closure for the lower end of each of said channels, and a conduit connection including a restricted portion and embedded in the lower portion of said structure between each of said channels and an adjacent distribution pipe, and means independent of said channel and accessible from said space for adjustment of said restricted portion to thereby regulate the flow through said conduit connection.

8. In an underfired coke oven structure comprising a basement space and a masonry structure above said space and including coking chambers, heating walls, regenerators, and regenerator division walls all extending transversely of the battery, metallic combustible agent distribution pipes extending transversely of the battery and incorporated in the lower portion of said structure, said structure being formed with fuel gas supply channels extending upward from said space to said heating walls through regenerator division walls, a removable closure for the lower end of each of said channels, and a conduit connection in the lower portion of said structure between each of said channels and an adjacent distribution pipe, and means independent of said channel and accessible from said space for adjustment to thereby regulate the flow through said conduit connection, each of said supply channels having a small constantly open inlet for the continuous inflow of atmospheric air into said channel.

9. An underfired coke oven structure comprising a basement space and a masonry structure above said space including coking chambers, heating walls and regenerator walls all extending transversely of the battery, a row of fuel gas supply channels extending upward from said space to each heating wall through a subjacent regenerator division wall, metallic combustible agent distribution pipes extending transversely of the battery and each displaced in the longitudinal directions of the battery from each adjacent row of upwardly extending channels, a conduit connection between each of said channels and an adjacent distribution pipe each of said conduit connections being embedded in said structure and including a restricted portion, and said structure being formed with passages each leading upward from said space into intersection with a corresponding connection, means adjustable through said passages to adjust the flow capacities of the restricted portions of said conduit connections, removable closures for the lower ends of said channels, and closures for the lower ends of said passages removable to permit access from said space for the adjustment of the flow restricted portions of said conduit connection.

10. An underfired coke oven battery as specified in claim 6, in which each of the beams extending longitudinally of the battery, extends from one end of the battery to the other.

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