Nov. 24, 1942. F. WETHLY 2,302,728

UNDERFIRED REGENERATIVE COKE OVENS

Filed March 14, 1941 2 Sheets-Sheet 1

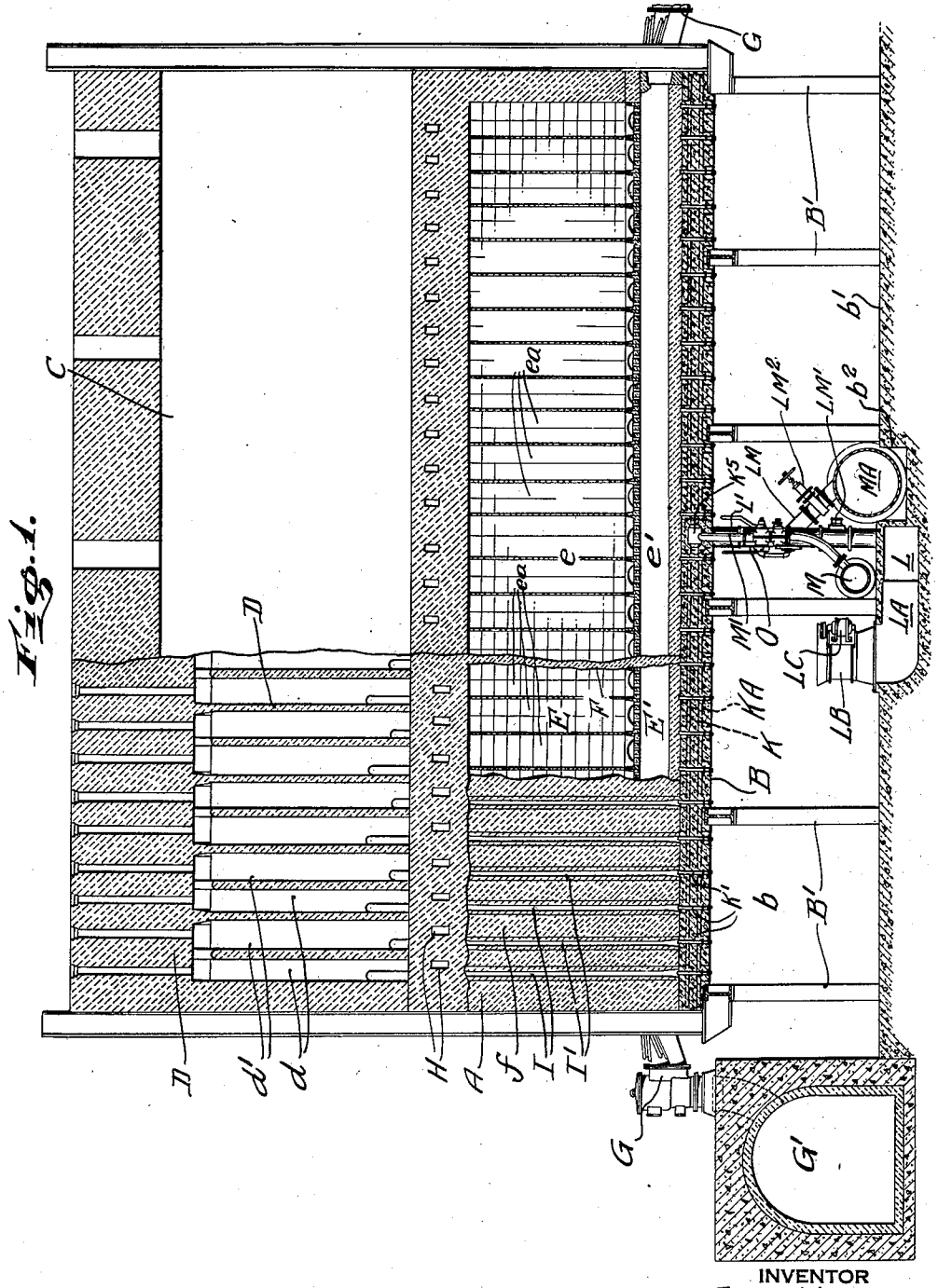


Fig. 1.

INVENTOR
FRANS WETHLY

BY
John E. Hubbell
ATTORNEY

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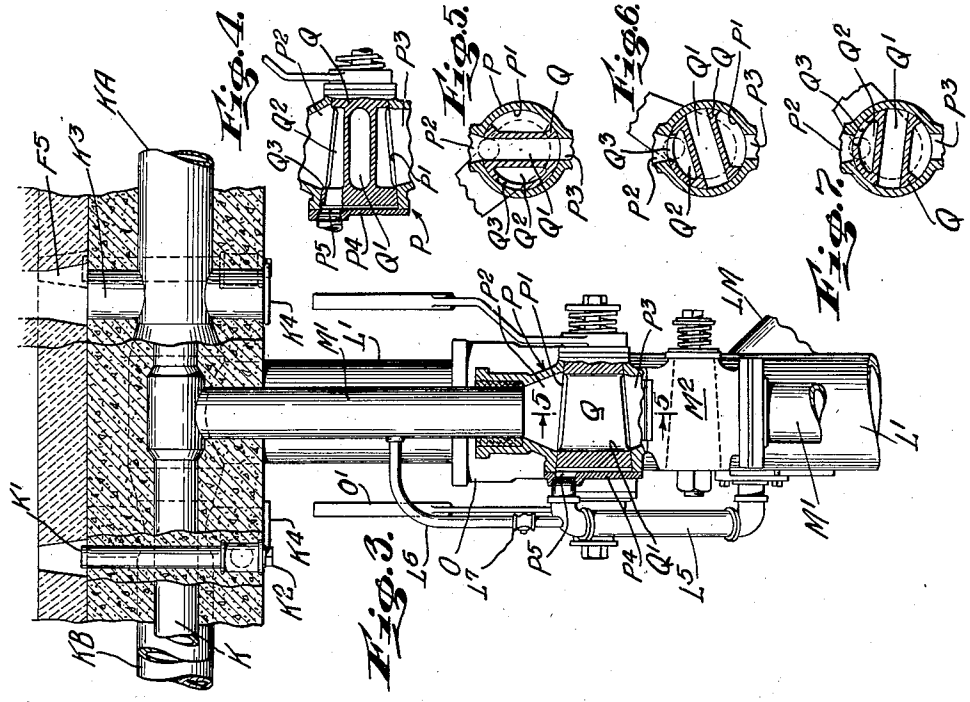


Fig. 3.

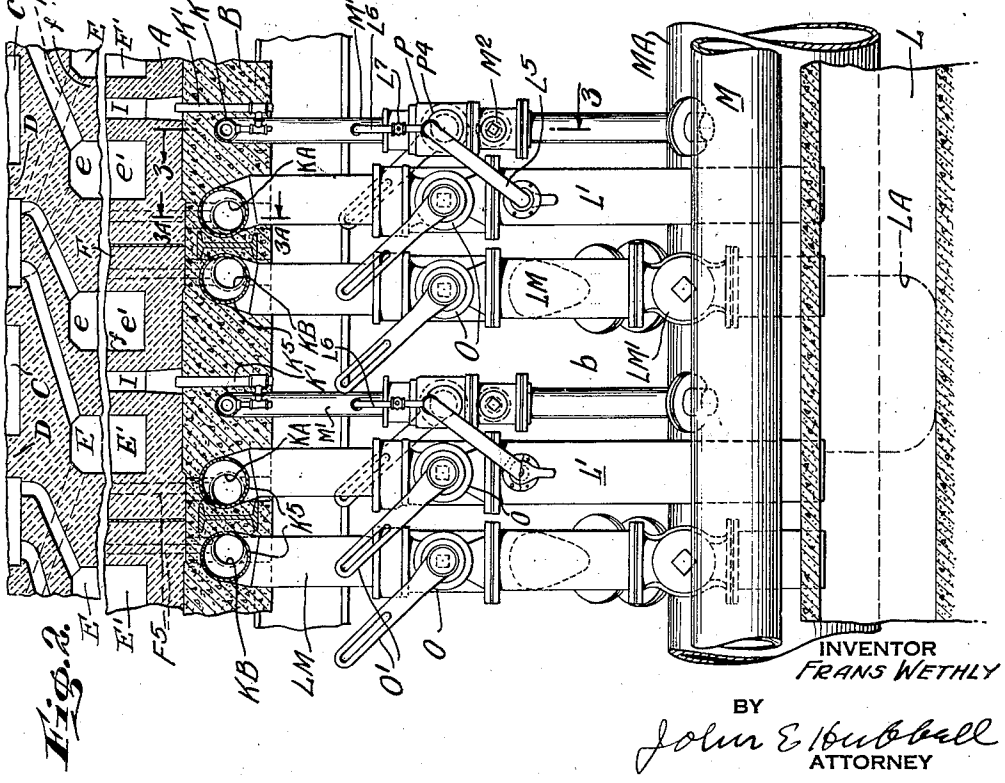


Fig. 2.

INVENTOR
FRANS WETHLY

BY
John E. Hubbell
ATTORNEY

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UNITED STATES PATENT OFFICE

2,302,728

UNDERFIRED REGENERATIVE COKE OVEN

Frans Wethly, New York, N. Y., assignor to The Fuel Refining Corporation, Dover, Del., a corporation of Delaware

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10 Claims. (Cl. 202—141)

The present invention relates to coke ovens and particularly to underfired horizontal regenerative coke ovens adapted for use in the manufacture of metallurgical coke. The general object of the present invention is to provide improved means for supplying and distributing to the coke oven regenerators and combustion flues, air and lean fuel gas preheated in the regenerators, and rich fuel gas passed to the combustion flues without regenerative preheating.

A specific object of the present invention is to equalize the lengths and flow resistances of heating system flow paths in which at any one time the flows are in parallel. Another specific object of the invention is to reduce the required diameters of the numerous distribution pipes extending transversely of the battery. Another specific object of the invention is to equalize the cooling effects on different portions of the battery of the combustible agents flowing through said portions. Another specific object of the invention is to provide an arrangement permitting of a desirable simplicity in the form and disposition of cutoff and reversing valves and reversing valve gear.

While not restricted to such use, the present improvements are of especial utility when used in underfired coke ovens in which the different combustible agents are distributed through horizontal distribution pipes embedded in the portion of the coke oven masonry beneath the regenerators and above the basement space of the battery, in the general manner disclosed in the Otto Patent 2,216,983, granted October 8, 1940. In the preferred form of the present invention means are associated with each of the horizontal distribution pipes for supplying to that pipe the combustible agent which it distributes through a connection to the pipe about midway of its length from a corresponding combustible agent supply main extending longitudinally of the battery in proximity to the central plane of the latter.

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 preferred embodiments of the invention.

Of the drawings:

Fig. 1 is a somewhat diagrammatic transverse sectional elevation of a coke oven battery with different portions of the section taken on different planes;

Fig. 2 is a partial section taken at right angles to Fig. 1;

Fig. 3 is a partial section, with a left-hand portion taken on the line 3—3 of Fig. 2, and a right-hand portion taken on the line 3A—3A of Fig. 2;

Fig. 4 is a partial section on the line 3—3 of Fig. 2; but with the valve in a position different from its position shown in Fig. 3.

Fig. 5 is a partial section on the line 5—5 of Fig. 3; and

Figs. 6 and 7 are sections taken similarly to Fig. 5 but showing the parts in different relative positions.

In the drawings I have illustrated an embodiment of the present invention in an underfired regenerative coke oven of the general type and design disclosed in said prior Patent 2,216,983, and comprising a coke oven brickwork mass A resting on a support, or deck, B of reinforced concrete, which is supported, as shown, by columns B' extending upward through the battery basement space *b*. The upper portion of the coke oven brickwork comprises horizontally elongated coking chambers C extending transversely of the battery and alternating along the length of the latter with heating walls D which, as shown are formed with hairpin flues, each comprising two vertical limbs *d* and *d'* which are connected to one another at their upper ends.

The lower portion of the coke oven brickwork mass is formed with alternately disposed regenerator chambers E and *e* extending transversely of the battery and shown as alternating with one another. As shown, each of the regenerators E and *e* is separated from the adjacent regenerator *e* or E at its left-hand side, as seen in Fig. 2, by a pillar wall F directly beneath a corresponding heating wall D, and is separated from the adjacent regenerator *e* at its right-hand side, as seen in Fig. 2, by a regenerator division wall *f*. The sole channel forming the bottom portion of each regenerator is connected at one side or preferably at each side of the battery through a corresponding reversing valve G to a waste heat tunnel or stack flue G' extending longitudinally of the battery.,

In the type of battery illustrated, each of the flue limbs *d* and *d'* has its lower end connected by one channel H to an adjacent regenerator E, and connected by a second channel H to an adjacent regenerator *e*. The two regenerators E

and *e*, to which a single flue limb *d* or *d'* has its lower end connected, are simultaneously "on" and simultaneously "off" regenerators. The regenerators E and *e* may be similar, or identical, in construction, but in the battery the regenerators E are intended for use solely in preheating the combustion air, and the regenerators *e* are intended for use in preheating lean gas when the battery is being heated by the combustion of lean gas and for use in preheating combustion air when the battery is being heated by the combustion of rich gas.

When rich fuel gas is being used, the gas is supplied to the different combustion flue limbs *d* and *d'* through vertical channels I extending upward from the bottom of the coke oven brickwork through the intermediate regenerator division wall *f*. Each of the flue limbs *d* and *d'* has its lower end connected to the upper end of a corresponding channel I, and as in the arrangement disclosed in said prior Patent 2,216,983, all of the flue limbs *d* in one heating wall may be connected to channels I having their lower portions extending upward through a regenerator division wall *f* at one side of said heating wall, and the channels I connected to the flue limbs *d'* in the same wall have their lower portions in the regenerator wall *f* adjacent, but at the other side of the heating wall.

The channels I in each regenerator division wall *f* are each connected by individual branch piping K' to a corresponding horizontal distribution channel K extending transversely of the battery and embedded in the concrete deck B adjacent the lower edge of said wall. Each of the regenerators E receives combustion air to be preheated through a horizontal distribution pipe KA extending transversely of the battery and shown as embedded in the deck B adjacent the lower edge of the corresponding side of the adjacent pillar wall. Similarly, each regenerator *e* receives the lean gas or combustion air which it is to preheat through a horizontal distribution pipe KB similar in construction and disposition to the distribution pipes KA.

Each of the branch pipe connections K' includes throttling provisions which may be adjusted from the basement space when a closure K^2 for the opening in the branch piping is removed. Each of the distribution pipes KA and KB is formed with outlets K^3 distributed along its length and each opening to the lower end of a corresponding channel F^5 formed in the adjacent pillar wall F and opening to the corresponding regenerator E or *e*, preferably at a level above the sole channel of the regenerator. Advantageously, each of the regenerators is divided into as many vertical regenerator cells *ea*, as disclosed in said Patent 2,216,983, as there are hairpin flues in a heating wall. In such case, as disclosed in said Patent 2,216,983, each cell is connected by two corresponding channels H to one hairpin flue in each of two adjacent heating walls, and such cell is connected at its lower end through a corresponding channel F^5 to a corresponding outlet K^3 of the corresponding distribution pipe KA or KB. As shown, each of the distribution pipes KA is formed at its under side with openings, one in alignment with each of its outlet openings K^3 and each normally closed by a plug K^4 accessible for removal from the basement space *b* and when removed permitting adjustment from said space of regulating provisions variably throttling the corresponding outlet K^3.

In respect to its features, already specifically described, the coke oven battery construction illustrated includes nothing now novel with me and is but one typical example of coke ovens of known type and design with which the improvements devised by me, and now to be described, may advantageously be used.

In the preferred form of the present invention illustrated in the accompanying drawings, each of the distribution pipes K receives rich fuel gas midway between its ends through a corresponding branch M' from a rich gas supply main M extending longitudinally of the battery and shown as resting on the floor of the battery adjacent, but at one side, of the central plane of the latter. Each distribution pipe KA receives air midway between its ends through an individual vertical branch L' from a combustion air supply main or duct L shown as embedded in the basement floor and extending longitudinally of the battery adjacent its central plane. As shown also, each distribution pipe KB receives the combustible agent which it is to distribute at its center through the upper end of a corresponding pipe connection LM having its lower end bifurcated with one branch including a cutoff valve LM' and connected to the air supply duct L, and with its second branch including a cutoff valve LM^2 and connected to a lean gas supply main MA extending longitudinally of the battery and shown as having its lower portion received in a groove b^2 formed in the floor of the basement space.

In the preferred construction illustrated, the main L receives combustion air under pressure through a lateral branch LA connecting the main at a point midway of the length of the battery to the outlet of a fan LB located in, and having its inlet open to the basement space and driven by a motor LC. The rich fuel gas and lean fuel gas may be supplied at suitable pressures to the mains M and MA respectively in any usual or suitable manner. As shown, the unbifurcated upper portion of each pipe connection LM includes a reversing valve O, and a similar reversing valve O is included in each of the branch pipe connections L'. The reversing valves O and the mechanism for periodically actuating them may be of any usual or suitable form. As shown, each of the reversing valves is of the rotatable cock type and is provided with an operating arm O' adapted for engagement with a cable or a length structure extending longitudinally of the battery and given to and fro movements at regular intervals.

Each of the branch pipes M' includes a cutoff valve M^2 and a reversing valve P. The latter may be of any usual or suitable type, but in the construction shown, the valve P is specially formed to serve as a decarbonizing valve as well as a reversing valve. In the construction shown, the valve P comprises a valve casing or body formed with a horizontally extending conical valve chamber P' at its upper and lower sides through corresponding ports P^2 and P^3 in the valve body, to upper and lower sections of the pipe branch M'. Mounted in the valve chamber P' is a correspondingly tapered cock Q formed with a through passage Q' which connects the ports P^2 and P^3 when the cock Q is turned into its fuel gas supply position shown in Fig. 5, and which is out of communication with each of the ports when the valve member Q is turned into its other end position.

For decarbonizing purposes the valve member Q is formed at one side with a channel Q^2 ex-

tending in the general direction of the axis of the valve member. The channel Q^2 is closed at its end adjacent the smaller diameter end of the valve member Q but extends to and is open at the opposite end of said member to receive decarbonizing air as hereinafter explained. An outlet port Q^3 is formed in the outer wall of the channel Q^2 but is closed by the wall of the valve chamber P' when the valve member Q is in its fuel gas supply position shown in Fig. 5. When the valve member Q is turned to cut off the passage of rich fuel gas through the port Q', the port Q^3 is brought into communication with the outlet port P^2.

In the preferred construction shown, the port Q^3 is so disposed as to be moved into full communication with the port P^2 by the movement of the valve member Q away from its gas supply position shown in Fig. 5 into a position shown in Fig. 6, which is intermediate of its gas supply position shown in Fig. 5 and the gas cut off position shown in Fig. 7, which it occupies during every alternate reversal period. When the valve member Q is in its end position shown in Fig. 7, the channel Q^2 is in restricted communication with the outlet port P^2 since a portion only of the port Q^3 is then in register with the port P^2. The purpose of the arrangement just described is to supply decarbonizing air at a rate rapid enough to force out all of the fuel gas residue in the corresponding distribution pipe K and its discharge passages, during the reversal operation initiating a decarbonizing period. For this gas purging operation, air is supplied at a rate appreciably greater than that at which decarbonizing air is advantageously supplied throughout the following decarbonizing period.

In the construction shown, air is supplied to the open end of the decarbonizing air passage Q^2 of each valve member Q through a corresponding branch L^5 from an adjacent regenerator air supply branch L'. As shown, the branch L^5 has one end suitably connected to the side of the corresponding air pipe L' and has its other end connected to a valve casing head P^4 normally secured to the body of the corresponding reversing valve P and closing the large end of the chamber P'. The head P^4 is formed with a chamber P^5 to which the branch pipe L^5 opens, and with which the open end of the valve member passage Q^2 may be in open communication in all positions of the valve member Q.

Advantageously and as shown, means are provided for supplying air continuously at a relatively low rate to the portion of each pipe M' at the outlet side of the corresponding reversing valve P. As shown, air is thus continuously supplied through a branch pipe L^6 of the branch pipe L^5 connecting the latter to the upper portion of the pipe M' at the outlet side of the corresponding valve P. Under all normal operating conditions, air is continuously supplied at a suitable rate through the branch L^5 and mixes with the rich fuel gas during periods in which rich fuel gas is being supplied to the corresponding distribution pipe K and then minimizes the tendency to the formation of objectionable carbon deposits on the upper portions of the channels I. When the valve member Q of each reversing valve is turned to cut off the supply of fuel gas through its port P' and to supply decarbonizing air through its port Q^2, the decarbonizing air then supplied through the corresponding branch pipe L^6 assists in burning out carbon previously deposited.

Advantageously and as shown, each branch pipe L^6 includes a check or non-return valve L^7 adapted to open automatically for the free passage of air from the pipe L^5 through the branch L^6 to the corresponding pipe L', and adapted to close in case of any accidental reduction in the air pressure in the corresponding air pipe L' which otherwise might produce backflow of rich fuel gas through the pipe L^6.

The introduction of the corresponding combustible agent to each of the various distribution pipes K, KA, and KB at a point approximately midway between the ends of the pipe permits of the use of a distribution pipe substantially smaller in diameter than would be required if the agent were supplied at one end of the pipe. This is of a substantial practical importance in the case of the pipes KA and KB because even with the use of the present invention, those pipes need to be several inches in diameter in consequence of the very considerable amount of combustion air or lean gas which each such pipe must distribute and which it desirably distributes without much variation in pressure along the length of the pipe. The reduction in the diameters of the distribution pipes KA and KB which my invention makes possible, is of especial importance when the pipes are embedded in the lower portion of the coke oven battery masonry.

The introduction of the combustible agents into the distribution pipes KA and KB adjacent their mid points, also has the effect of reducing the average length of gas travel longitudinally of the distribution pipe to its various branch outlets from the supply connections and thus directly minimizes the velocity head pressure variation occurring in a distribution pipe of given diameter and length. To minimize the pressure head loss in and adjacent the supply connections to the pipes KA and KB, each of the latter is shown as including a short, central section K^5, which is of appreciably larger diameter than the remainder of the pipe and to which the corresponding supply pipe L' or LM is directly connected.

With the preferred arrangement described in which waste heating gases are discharged into waste heat tunnels G' at each side of the battery by the regenerator sole channels, and in which the supply pipes L and LM are connected to the distribution pipes KA and KB, respectively, midway between their ends, the multiple flow paths between said supply pipes and waste heat tunnels which include the different hairpin heating flues, are of substantially uniform length. While the portion of each such flow path formed by a regenerator sole channel will be long or short accordingly as the corresponding hairpin flue is near the center or the side of the battery, the portion of the same flow path formed by a corresponding pipe KA or KB will be correspondingly short or long. Such uniformity in flow path length facilitates the desired uniformity in heating wall heat distribution.

The air or lean gas flowing through the distribution pipes KA and KB exert a cooling action on the adjacent portion of the battery which is desirably more uniform when the air and lean gas are supplied to the distribution pipes at their centers than when supplied to each pipe at one end under all conditions, or is supplied to the pipe at one end under one condition and at the other end under another condition, as is the case with arrangements disclosed in said prior Patent 2,216,983.

The arrangement of the supply mains LM and MA in the basement space approximately midway between the side edges of the latter is a convenient one, and permits of a desirably simple pipe and reversing valve arrangement. In particular it permits of the use of a single reversing supply valve for each of the distribution pipes KB which distributes air under one condition and lean gas under another condition of operation.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art 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 that in some cases certain features of my invention may be used to 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 horizontally elongated coking chambers, heating walls alternating with the coking chambers and formed with vertical flues and regenerators beneath said chambers and walls and all extending transversely of the battery, and in combination therewith, means for supplying to each regenerator a combustible agent to be preheated therein and comprising a horizontal distribution channel parallel to the regenerator and connected thereto at points distributed along its length and a supply conduit connected to said channel approximately midway between its ends.

2. A regenerative underfired coke oven battery comprising horizontally elongated coking chambers, heating walls alternating with the coking chambers and formed with vertical flues, regenerators beneath said chambers and walls and all extending transversely of the battery, and a basement space beneath said regenerator, and in combination therewith means for supplying to each regenerator a combustible agent to be preheated therein and comprising a horizontal distribution channel for each regenerator parallel to the latter and connected thereto at points distributed along its length and a separate supply conduit connected to said channel approximately midway between its ends, and a combustible agent supply main extending longitudinally of the battery in said basement space approximately midway between the side edges of the battery to which the lower ends of said conduits are connected.

3. A regenerative underfired coke oven battery comprising horizontally elongated coking chambers, heating walls alternating with the coking chambers and formed with vertical flues, regenerators beneath said chambers and walls and all extending transversely of the battery, and a basement space beneath said regenerators, and in combination therewith, means for supplying to said regenerators combustion air to be preheated therein and comprising a horizontal distribution channel parallel to each regenerator and connected thereto at points distributed along its length a combustion air supply main in said basement space extending longitudinally of the battery approximately midway between the side edges of the latter and a branch supply conduit connecting said channel approximately midway between its ends to said main.

4. A regenerative underfired coke oven battery comprising horizontally elongated coking chambers, heating walls alternating with the coking chambers and formed with vertical flues, and regenerators beneath said chambers and walls and all extending transversely of the battery, and in combination therewith, means for optionally supplying to each regenerator either combustion air or lean gas to be preheated therein and comprising a distribution channel parallel to the regenerator and connected thereto at points distributed along its length and a supply pipe having its upper end connected to said channel approximately midway between the ends of the latter and having separate air and lean gas receiving lower end portions, and a reversing valve in said pipe between its lower end portions and said channel.

5. A regenerative underfired coke oven battery comprising horizontally elongated coking chambers, heating walls alternating with the coking chambers and formed with vertical flues, and regenerators beneath chambers and walls and all extending transversely of the battery, and in combination therewith, means for optionally supplying to each regenerator either combustion air or lean gas to be preheated therein and comprising a distribution channel parallel to the regenerator and connected thereto at points distributed along its length and a supply pipe having its upper end connected to said channel approximately midway between the ends of the latter and having separate air and lean gas receiving lower end portions, a cut off valve in each of said lower end portions, and a reversing valve in said pipe between its lower end portions and said channel.

6. A regenerative underfired coke oven battery comprising horizontal elongated coking chambers extending transversely of the battery, heating walls alternating with the coking chambers and formed with vertical flues and regenerators and regenerator division walls beneath said chambers and heating walls parallel thereto and in combination therewith, separate horizontal distribution pipes for supplying air and lean gas to the regenerators for preheating therein and for supplying rich gas to said flues, and air, lean gas and rich gas supply pipes respectively connected to said air, lean gas and rich gas distribution pipes at points approximately midway between the ends of the latter and means for passing air into each rich gas supply pipe from an adjacent air supply pipe.

7. A regenerative underfired coke oven battery comprising horizontal elongated coking chambers extending transversely of the battery, heating walls alternating with the coking chambers and formed with vertical flues and regenerators and regenerator division walls beneath said chambers and heating walls parallel thereto and in combination therewith, separate horizontal distribution pipes for supplying air and lean gas to the regenerators for preheating therein and for supplying rich gas to said flues, and air, lean gas and rich gas supply pipes respectively connected to said air, lean gas and rich gas distribution pipes at points approximately midway between the ends of the latter and means for passing air into each rich gas supply pipe from an adjacent air supply pipe at one rate when rich gas is being supplied through said

supply pipes, and at a greater rate when the supply of rich gas is interrupted.

8. A regenerative underfired coke oven battery comprising horizontal elongated coking chambers extending transversely of the battery, heating walls alternating with the coking chambers and formed with vertical flues and regenerators and regenerator division walls beneath said chambers and heating walls parallel thereto and in combination therewith, separate horizontal distribution pipes for supplying air and lean gas to the regenerators for preheating therein and for supplying rich gas to said flues, and air, lean gas and rich gas supply pipes respectively connected to said air, lean gas and rich gas distribution pipes at points approximately midway between the ends of the latter and means for passing air into each rich gas supply pipe from an adjacent air supply pipe, comprising a reversing valve in each rich gas supply pipe having separate alternately open gas and air ports, and conduit connections from an adjacent air supply pipe to the air port in said valve and to the rich gas supply pipe at the outlet side of said reversing valve.

9. A regenerative underfired coke oven battery comprising horizontal elongated coking chambers extending transversely of the battery, heating walls alternating with the coking chambers and formed with vertical flues and regenerators and regenerator division walls beneath said chambers and heating walls parallel thereto and in combination therewith, separate horizontal distribution pipes for supplying air and lean gas to the regenerators for preheating therein and for supplying rich gas to said flues, and air, lean gas and rich gas supply pipes respectively connected to said air, lean gas and rich gas distribution pipes at points approximately midway between the ends of the latter and means for passing air into each rich gas supply pipe from an adjacent air supply pipe comprising a reversing valve in each rich gas supply pipe having separate gas and air ports, and conduit connections from an adjacent air supply pipe to the air port in said valve and to the rich gas supply pipe at the outlet side of said reversing valve, and a non-return valve in the last mentioned conduit connection.

10. A regenerative underfired coke oven battery comprising horizontally elongated coking chambers, heating walls alternating with the coking chambers and formed with vertical flues and regenerators beneath said chambers and walls and all extending transversely of the battery, and in combination therewith, means for supplying to each regenerator a combustible agent to be preheated therein and comprising a horizontal distribution channel parallel to the regenerator and connected thereto at points distributed along its length and a supply conduit connected to said channel approximately midway between its ends, and each of said regenerators including and communicating along its length with a sole channel extending between the opposite sides of the battery, and means for withdrawing waste heating gases from each sole channel at each end of the latter.

FRANS WETHLY.