July 18, 1933. A. McD. DUCKHAM 1,919,098

FURNACE, CARBONIZING CHAMBER AND RETORT, AND THE LIKE

Filed June 16, 1930 2 Sheets-Sheet 1

Fig. 1.

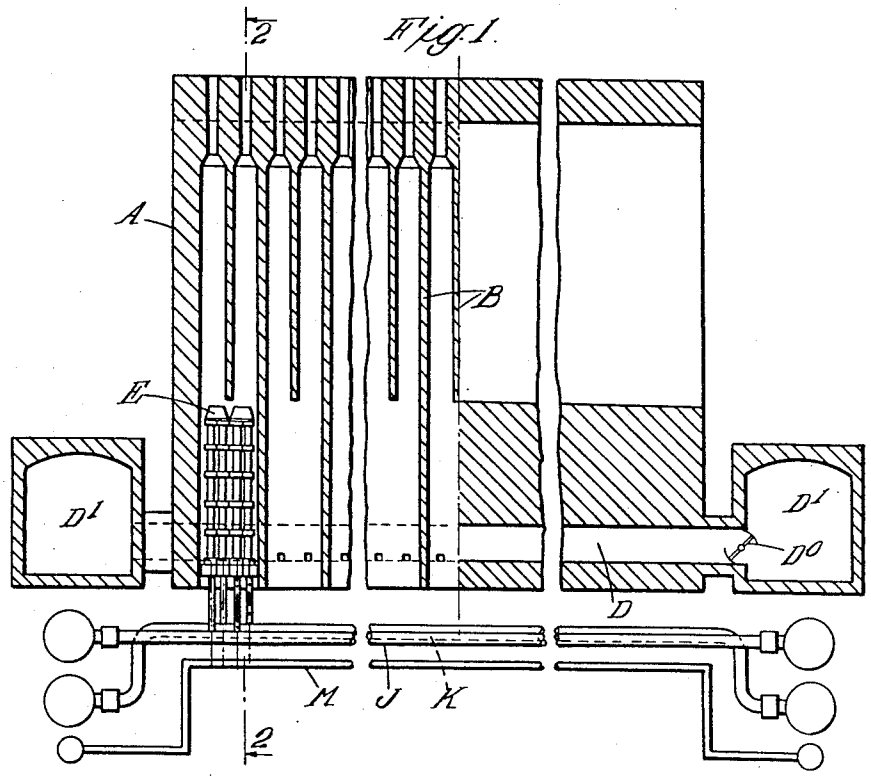
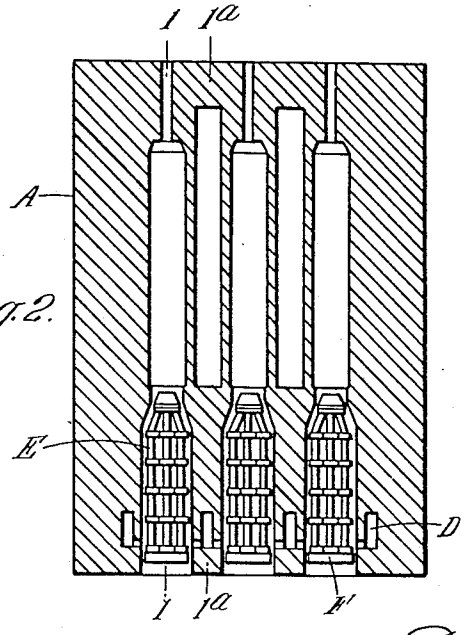


Fig. 2.



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Filed June 16, 1930 2 Sheets-Sheet 2

Fig. 3.

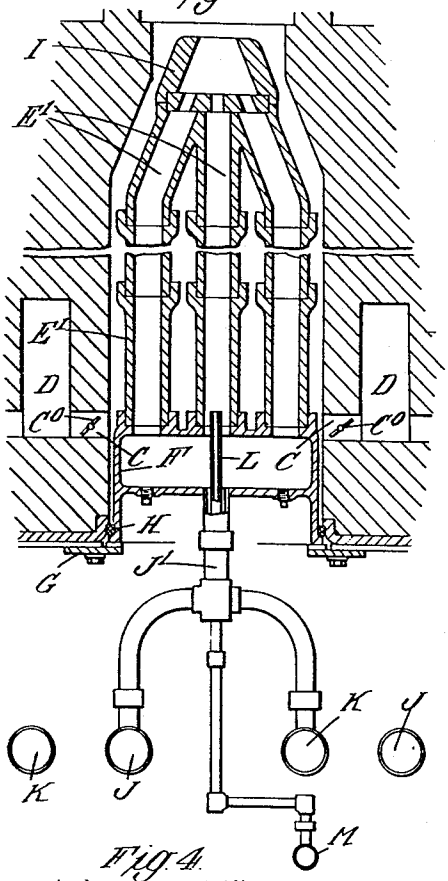


Fig. 4.

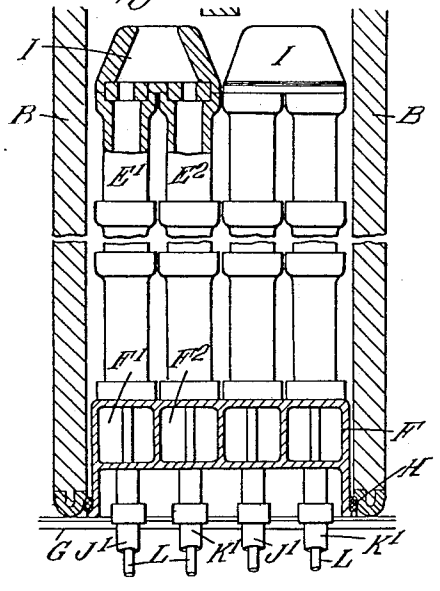


Fig. 5.

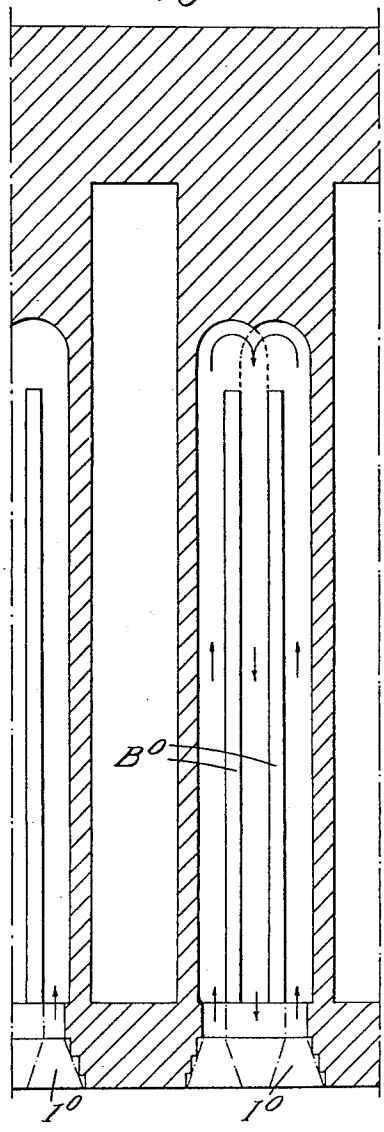
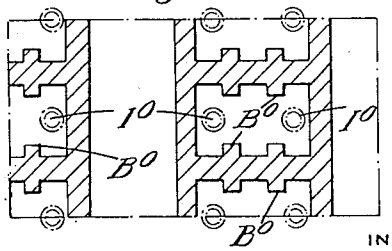


Fig. 6.



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UNITED STATES PATENT OFFICE

ARTHUR McDOUGALL DUCKHAM, OF LONDON, ENGLAND, ASSIGNOR OF ONE-HALF TO WOODALL-DUCKHAM (1920) LIMITED, OF LONDON, ENGLAND

FURNACE, CARBONIZING CHAMBER AND RETORT, AND THE LIKE

Application filed June 16, 1930, Serial No. 461,458, and in Great Britain August 6, 1929.

The heating of metallurgical and other furnaces, carbonizing chambers, retorts, kilns and the like is generally arranged either on the recuperative or regenerative principle. Of these two methods the regenerative principle entails a periodic reversal of the direction of firing which, apart from the necessity of providing means for the reversal of the travel of the gases, also necessitates expensive and complicated flue construction. The ordinary recuperative method does not involve periodic reversal of the stream of heating gases and combustion products, but usually requires long flues, which are expensive to construct and maintain, in order to ensure that the gases in traversing them will give up the bulk of their heat content, the gases in this system entering at one end of a flue and leaving at the other end. Moreover, the recuperator is normally built into the brickwork of the flue and is subject to stresses due to the expansion and contraction of the brickwork structure which are liable to cause leakage.

The object of the present invention is to provide a construction in which these drawbacks are overcome and in which the advantages associated with regenerative and recuperative heating are obtained without the necessity either of expensive and complicated flue construction or of costly reversal gear.

According to the invention I construct furnaces such as coke ovens with vertical heating walls divided into individual vertical flue units by cross walls in a generally known manner; into each of these individual units heating gases are admitted at the bottom end, burn in an upward direction, arrive at or towards the upper end, reverse their direction of travel, and return down the same flue which they leave at the bottom end.

The expression heating gases is herein used to denote the gases which traverse the unit heating flues and includes the gaseous elements of combustion which enter the flues and also the products of combustion which leave the flues.

The entering heating gases, or such of them as it is desired to preheat, are admitted, preferably under pressure, to the unit heating flues through recuperators comprising flues or ducts traversed by such gases and adjacent flues traversed by the combustion products.

According to the invention this flued recuperative structure is usually surrounded by and contained within the main structure supporting the coke oven, furnace, or the like, but the recuperative structure is not built into the furnace structure, and is not therefore affected by the expansion and contraction of the furnace structure. There is thus no possibility of the heat stresses of the furnace causing distortion of or leakage in the recuperator structure, or otherwise interfering with its successful operation.

The part of the recuperator formed of the flues or ducts referred to may be constructed so as to be capable of easy removal as an entity for purposes of examination, repair, or replacement of parts.

There may be one or more recuperators for each unit flue, or one recuperator may do duty for two or more adjacent unit heating flues.

A further feature of the invention is the provision of interchangeable nozzles at the outlet of the recuperator for the purpose of varying the type and shape of the flame within the unit heating flue.

If the furnace or oven is to be heated by means of rich gas, such as coke oven gas or oil gas, the gas may be introduced into the unit heating flue by a pipe or pipes leading approximately to the nozzle of the recuperative element, or it may be introduced into one of the air ducts of the recuperator at any point along its length, under such conditions as not to allow premature combustion.

If the furnace is heated by means of lean gas, such as producer or blast furnace gas, the recuperator is constructed so as to provide for the heating of both the lean gas and the combustion air or of either.

Whether rich or lean gas is used for heating, the combustion products, after passing through the flues or ducts of the recuperator and pre-heating the incoming streams of air and/or combustible gas passing through adjacent flues or ducts, are carried away by suitable flues or ducts and conducted to the

chimney or equivalent exhausting device, such as a fan.

The invention is illustrated in the accompanying drawings as applied to a coke oven, and these drawings show a suitable construction of recuperator for such apparatus, but it is to be understood that this construction may be varied in many respects according to the character and construction of the apparatus to which the invention is applied.

In these drawings Fig. 1 represents a vertical section through a coke oven forming one of a battery, the left half of the section being taken on line 1—1, and the right half on line 1^a—1^a of Fig. 2, which is a section on line 2—2 of Fig. 1; Fig. 3 is a section on an enlarged scale of a single recuperative element, the section being taken on line 2—2 of Fig. 1; Fig. 4 is an enlarged elevation, partly in section, of the recuperative element shown in Fig. 1; Fig. 5 is a vertical section showing certain modifications in the construction of the unit heating flue, and Fig. 6 is a sectional plan of same.

As shown in the drawings, the vertical flues in the heating walls of the coke oven A are divided into individual vertical unit flues by transverse walls B. Each of these vertical unit flues is provided with means for introducing the gaseous elements of combustion, usually under pressure, at the lower end of the unit flue, so that the flame is directed upwardly in the unit flue, and the heating gases, reversing their direction at or near the upper end of the unit heating flue, emerge at the lower end thereof and pass through the recuperator and thence by dampered ports C to flues D leading to the chimney. The spent combustion products on their exit, and the heating gases on their entrance, traverse in opposite directions the ducts of a recuperator indicated generally by E, with which each unit flue is provided at its lower end. As shown, this recuperator is of tubular construction and for convenience is built up in sections of tubes E′, E^2 of any suitable refractory material (metallic or otherwise) upon a hollow base F which is supported by means of plates G carried by the oven structure. A packing H makes a gas-tight joint around the base F. It will be seen that by removing the plates G, and disconnecting the heating gas circuits, the entire recuperator structure E can readily be withdrawn.

The tubular ducts in the recuperator lead to a nozzle I which is detachable from the recuperator element so as to be interchangeable for the purpose of varying the type or shape of the flame. The nozzles I may extend upwards into the unit flues farther than is shown in the drawings and they may be given any desired shape, as for example what is commonly called a Venturi shape, so as to give the issuing jet a cylindrical or a diverging or converging configuration at and beyond the point of issue.

As shown in Figs. 1 and 4 the recuperative element E is a double element, that is to say it does duty for two adjacent unit heating flues, this double element being carried by a single hollow base and being removable therewith as an entity. This, however, is only one particular arrangement of recuperative element, and may be modified in many ways, as for example by having a separate element or more than one such separate element for each unit heating flue, or a multiple element might do duty for more than two adjacent unit heating flues.

If the oven is to be heated by means of lean gas, such as producer or blast furnace gas, the recuperator element may be duplicated or subdivided, as shown for example in Fig. 4, the part E′ being used for preheating the combustion air which is supplied to the air box F′ through an air main J and branch J′, and the part E^2 for preheating the lean gas which is supplied to the gas box F^2 through a gas supply main K and branch K′. The air and lean gas combine in the nozzle I which directs the flame upwardly into the unit flue.

If the oven is to be heated by rich gas, such as coal gas, this may be introduced into a tubular element of the recuperator through a pipe L supplied from a gas supply main M.

As shown in Fig. 3, the gas pipe L is directed into the central air tube of a 3-tube recuperator element, the proportions of gas to air allowed to travel in the recuperator tube being adjusted to prevent premature combustion. The two outer tubes are supplied with air only from the air box F′, which air mixes with the air and gas mixture in the nozzle I to form an upwardly directed flame.

As previously stated, the hot gases of combustion reverse their direction at or near the top of the unit heating flue and pass downwardly along its walls to the recuperator unit E, traversing the outer surfaces of the tubular walls thereof, and, after giving up their heat, pass through flues D to main flues D′ leading to the stack. Means such as dampers C^0, D^0 may be provided in the ports C and flues D to control the draught.

It will be understood that coal gas, producer gas, vaporized oil and other forms of gaseous fuel may be used for heating purposes according to this invention, and are herein included under the term gas, and further it should be noted that by using suitable gas and air supply pressures and nozzles of appropriate character, the stream of gases issuing from a nozzle can be varied in form and given such a velocity as to impart a quasi-rigidity to the ascending gas stream and, consequently, when the direction of travel of the gases is reversed, the return gaseous stream will more or less envelop the

entering gaseous stream. This effect can be varied in many respects by modifications in the character of the nozzles. For example, a pair of mutually inclined nozzles or nozzle orifices may be used to convert the issuing gaseous streams into a flat sheet.

Further, the form and velocity of the flame can be regulated so as to entrain some of the descending combustion products and re-circulate them in the heating circuit.

Moreover, the walls of the heating unit flues may be modified so as to guide or control the flow and return of the heating gases. For example, the arrangement shown in Figs. 5 and 6 may be used. In this construction the heating gases are directed upwardly along opposite walls B of the unit flues by nozzles which are not shown but which would occupy the positions indicated at I°, I° in the base of the structure. The two streams or sheets of heating gases meet at the top of the flue, which may be shaped as indicated in Fig. 5 to guide the gas streams inwardly, reversing their direction and flowing downwards along the central part of the same flue to traverse the recuperator at the common inlet and outlet end of the flue.

To guide or control the upward and downward flowing streams of heating gases, the walls of the unit flue may be constructed to form more or less defined vertical channels for the several streams of gases. For example, as shown in the drawings opposite walls of the unit flues may have ribs B°, B° projecting more or less into the unit flue but not extending across it so as to subdivide it into separate passages. These ribs may be continuous or interrupted, and if continuous they may extend over substantially the whole vertical length of the unit flue as shown in Fig. 5 or over any desired portion of the length.

While it is preferred to arrange the recuperators vertically as shown in the drawings, it is to be understood that the recuperator elements may be laterally or horizontally disposed with suitable modification of the discharge nozzles to direct the heating gases into the unit flues.

Having thus described the nature of the said invention and the best means I know of carrying the same into practical effect, I claim:—

In gas-fired furnaces, retorts and other carbonizing chambers a heating system therefor comprising a heating wall divided into vertical combustion flues by transverse walls, said combustion flues having the inlet and also the outlet for the heating gases at the bottom end.

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