Sept. 30, 1941. E. E. MILNER 2,257,392

REGENERATIVE FURNACE

Filed Oct. 21, 1940 2 Sheets-Sheet 1

FIG. 1

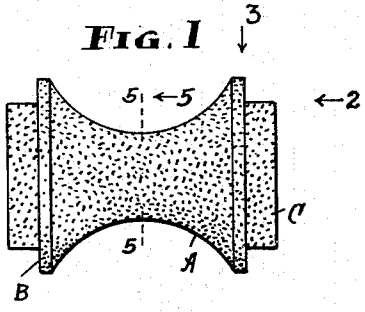


FIG. 2

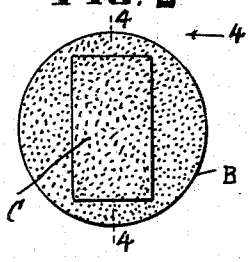


FIG. 4

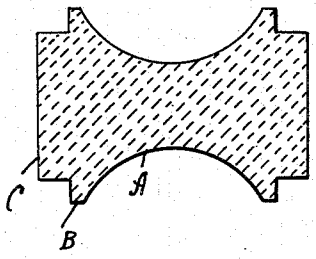


FIG. 3

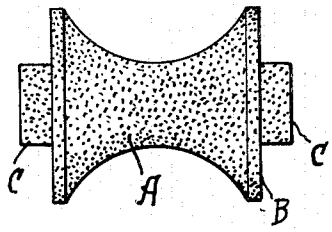


FIG. 5

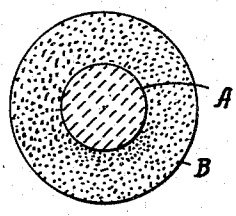


FIG. 6

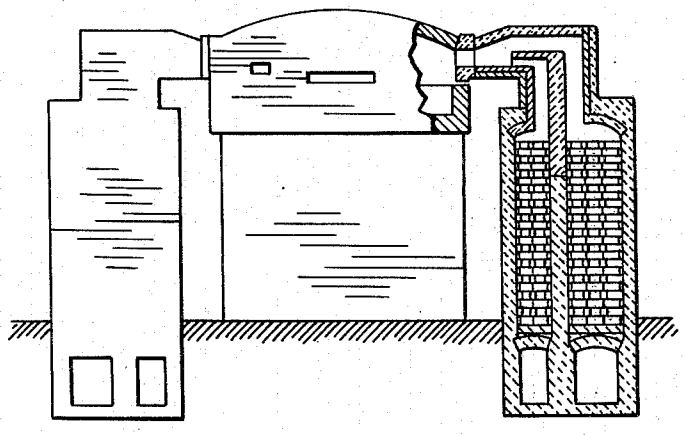


FIG. 7

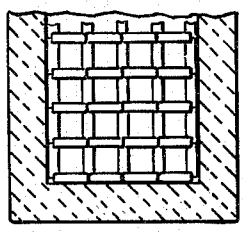
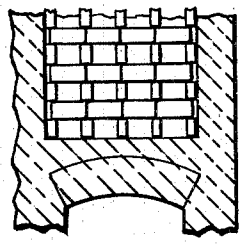


FIG. 8



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Sept. 30, 1941. E. E. MILNER 2,257,392

REGENERATIVE FURNACE

Filed Oct. 21, 1940 2 Sheets-Sheet 2

FIG. 9

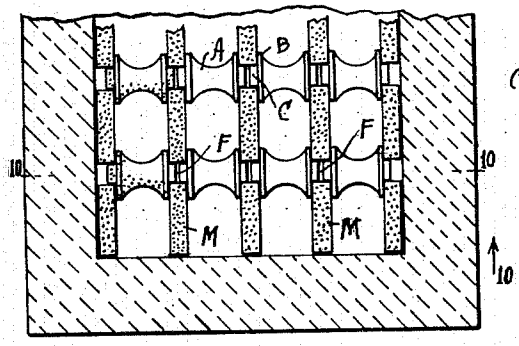


FIG. 10

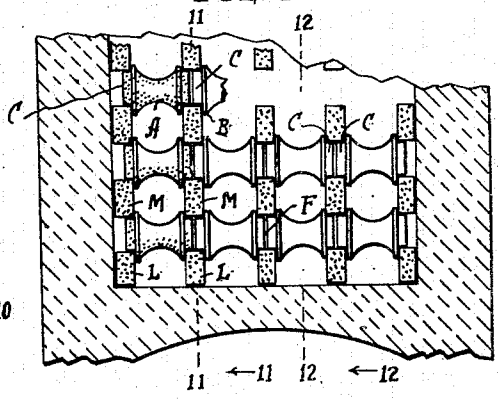


FIG. 11

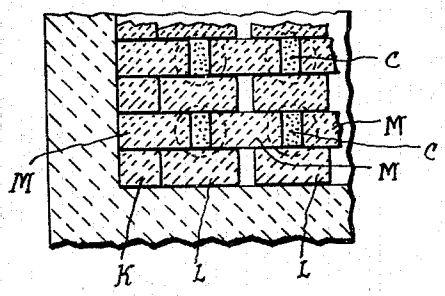


FIG. 12

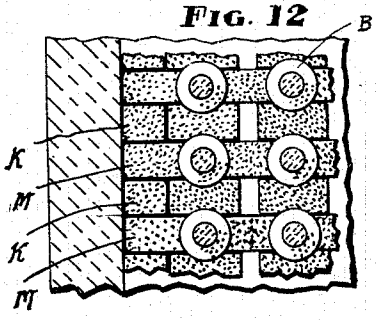


FIG. 13

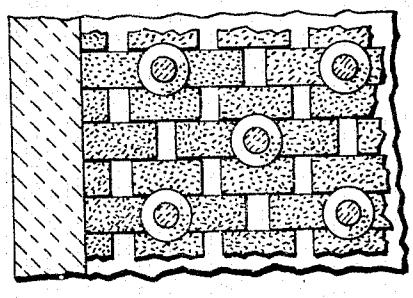
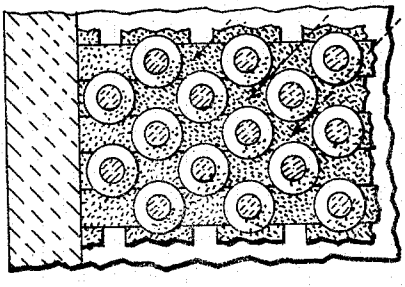


FIG. 14



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UNITED STATES PATENT OFFICE

2,257,392

REGENERATIVE FURNACE

Edwin E. Milner, Muncie, Ind.

Application October 21, 1940, Serial No. 362,022

2 Claims. (Cl. 263—51)

This invention relates to improvements in furnaces of the gas burning type, in connection with which is used a regenerator in which the incoming air or gas is heated by contact with masses of brick or the like previously heated by the outgoing hot air or waste gases. The invention has especial reference to regenerator construction intended to be used in connection with a furnace or melting chamber of the general form as used in the industry of glass making. A favored type of regenerator as applied to a furnace of the above description, and which is known as the checker brick system or setting, includes a chamber whose walls and crown are constructed of refractory units, said chamber being directly coordinated with the melting chamber. In the interior of such chamber, checker bricks such as of the rectangular form as shown in the drawings, are arranged in spaced order, and in such alignment, that there is provided a system of longitudinal, transverse, and vertical passageways. By this arrangement there is permitted the free passing of the waste gases to the chimney, and at the same time there is such absorption of heat units from said waste gases, that there is preheating of the air entering the regenerator chamber, results being more dependable furnace ignition temperatures and higher furnace efficiency.

It is recognized that the arrangement, form, and quality of the checker bricks used in the regenerator chamber, determines the degree of efficiency of the furnace installation as a whole. Also it may be kept in mind that any brick setting which interferes with the normal predetermined flow of gases, creates excessive resistance. The ill effects of such excessive resistance must be overcome, either by providing increased chimney draft, or by reducing velocities. Recourse to either of these subterfuges of course affects the entire furnace operation adversely. Other accepted facts are, that the volume of air and gas (combustibles) introduced into the combustion chamber is determined in accordance with the volume of waste gases which the regenerator has the capacity to handle; and that while the checker setting should so function as to permit passing of the waste gases in proper volume and at proper velocity, it should also so function as to retain the heat units contained in said passing gases.

Due to the fact that most waste gases contain particles in suspension, and also condensible vapors, a serious difficulty experienced in the use of regenerator settings as hitherto devised is, that the exposed surfaces of the bricks become so coated, and the coating takes such form, that their surfaces are rendered rough and irregular, and they are so distorted in form that the areas of the passageways are decreased and distorted within a relatively short period of time. As a result, the circulation of currents through the chamber is so impeded, that maintenance of ignition temperatures in the combustion chamber is adversely and seriously affected. Augmenting of the chimney draft to increase velocities; cleaning the bricks; and replacing those too deformed for re-use; results in delay and in such interruption of operation, that the campaign of the furnace is definitely arrested.

Many improvements have been made in the melting chamber structure, such as improved refractories, insulation, automatic control, and artificial cooling, the fact remains however, that the regenerative chambers, for lack of uniform efficiency, cause the entire furnace apparatus to become inefficient. Although means of divers kinds have been resorted to in efforts to remove from the checker bricks, the coatings and deposits above referred to, such means have been of doubtful value for the reason that by the very nature of the checker brick system, the exposed surfaces are only partly accessible to lancing and blasting operations; and moreover, vigorous efforts in attacking the surfaces of the bricks are not permissible, by reason of the danger of fracture, and of the dislodging of the bricks.

To make possible the full enjoyment of advantages which are incident to the improvements generally that have been developed in the manufacture of refractories used in the construction and adaptation of the combustion chamber comprised in regenerator furnace installations of the type herein described, my invention has proceeded upon the broad concept of providing regenerator chamber construction embodying features whereby improved current movement and circulation may be assured, tendency to clogging may be minimized if not eliminated, and whereby maximum absorption of heat units from the passing gases may be obtained. Further aims of my invention are to afford regenerator chamber construction which will lend itself to facility in cleaning, and which at the same time will be strong and durable, economical of manufacture, and capable of being installed by the exercise of only ordinary skill.

My invention consists of a regenerator installation comprising bricks of conventional rectangular formation spaced, and arranged in align-

ment one row above another, each brick of one row being in offset relation to each brick of the adjacent row, and transverse tie bricks each being of spool shaped formation, the walls thereof being concave provided at each of its ends with an integral stud that is adapted to reside in the space between the facing ends of the line bricks. My invention further consists in my newly designed tie brick by which said installation is made possible, said tie brick consisting of a refractory unit of spool shaped construction, the walls thereof being concave, and each embodying a stud, the ends and the studs of said tie brick being adapted to engage the proximate sides and the facing ends respectively of conventional bricks aligned for a checker setting.

Figure 1 is a side view of my improved tie brick for checker settings of regenerator chambers of the class described.

Figure 2 is an end view, in the direction of arrow 2 in Figure 1.

Figure 3 is a view taken in the direction of arrow 3 in Figure 1.

Figure 4 is a central longitudinal sectional view taken on line 4—4 in Figure 2, in the direction of arrow 4.

Figure 5 is a cross section view taken on the line 5—5 in the direction of arrow 5 in Figure 1.

Figure 6 is a diagrammatic view, partly in cross section, showing a typical regenerative furnace installation, and which is illustrative of the general structure and relative positions of the regenerative chambers.

Figure 7 is a horizontal sectional plan view of a conventional checker brick setting, and in a regenerative chamber of the form shown in Figure 6.

Figure 8 is a vertical cross section view of a checker brick setting, as in a regenerative chamber of the form shown in Figure 6.

Figure 9 is a horizontal sectional plan view showing the appearance of a checker brick setting wherein my invention is embodied.

Figure 10 is a vertical cross section view, on the broken line 10—10, in the direction of arrow 10 in Figure 9.

Figure 11 is a vertical longitudinal cross section view, on broken line 11—11, in the direction of arrow 11 in Figure 10.

Figure 12 is a vertical longitudinal section view, on the broken line 12—12, in the direction of arrow 12 in Figure 10.

Figure 13 is a modified form of installation.

Figure 14 is a modified form of installation.

My improved tie brick is shown herein, in the form and contour preferred for installations therein the line bricks used are of the conventional rectangular type, and which are about nine inches in length, four and one half inches high, and two and one half inches thick. It will be understood of course that references herein to dimensions are merely for the purpose of easily making clear the facility with which my improved tie brick is coordinated with the conventional bricks in constructing the checker setting.

For a setting in which the rectangular bricks of the above dimensions are used, my new tie brick unit A is six and one half inches in length, out to out, of flanges B. It is circular in cross section, and consists of refractory material molded into spool shaped formation, the sides thereof being concave. Each end of said unit embodies a stud C which in the present instance is four and one-half inches in length, two and one-half inches in width, and one inch in depth. My improved tie brick is capable of being formed by the practice of molding, such practice being common in the making of structural units composed of refractory material. The nature and quality of the material of which the brick is composed is determined by the duty which is to be imposed upon it. For the duty imposed wherein it is used in the installation of a setting for a regenerator chamber used in connection with a glass melting furnace, a composition of high alumina content is recommended same being preferred for high temperature operation. Obviously, the material of which the brick is composed should be suitable to constitute a brick especially adapted to the requirements it is intended to meet.

In observing the views in Figures 9, 10, 11 and 12, which are illustrative of regenerative chamber installations wherein my invention is embodied, and my improved tie bricks are employed, the business of installing the checker setting will readily be understood. Line bricks K, L and L are disposed on the floor of the chamber, and in the positions spaced as shown. On top of these line bricks L and L, are now disposed line bricks M and M, spaced as shown, and each being in offset relation to the adjacent underlying brick. My improved tie bricks A are now disposed in position, each with its stud C in the space between the ends of the bricks M and M, this business continuing until the floor area and interior of the chamber will have been filled.

The manner in which the flanges B of the tie bricks engage the side faces of the ends of the line bricks, and the manner in which the studs C are received in the space between the facing ends of the line bricks; and the manner in which the intermediate portions of the top and bottom faces of the line bricks engage the top and bottom edges of the said studs C, will be clearly understood by referring to the said views Figure 9, Figure 10, Figure 11 and Figure 12.

My new tie brick so lends itself to the purposes described, that various selections, as to which of the spaces in which the studs C are to be placed and retained may be had, thereby rendering possible the varying of the number of passageways or flues. This variation may cover more or less wide range, in conformity with the volume, temperature, and character of the gases entering and leaving the regenerative chamber.

Recommendations are that in instances where the waste gases are free from particles in suspension, the setting of the tie bricks is for smaller passageway areas. In instances where the gases are highly contaminated, the setting of the tie bricks is for larger passageway or flue areas.

Whereas in all instances, my new tie brick is the same in character and form, its selection as to size is governed by the size of the line brick being used, the height of the stud of the tie brick in all instances being the same as the height of the line brick in combination with which it is used.

In Figure 13 is illustrated a modification wherein the tie bricks are arranged in staggered order.

It will be observed that in the typical setting illustrated in Figures 9, 10, 11 and 12, vertical flues 6½ by 9 inches, and horizontal flues 6½ by 6½ inches are formed, thereby ample area being provided and without sacrificing the exposed heating surfaces.

Resultant of the concavo-concave formation of my improved tie brick, is a heating surface that is exposed to both exhaust and incoming gases, and a greater turbulence in the gas stream

in either or in both directions, both of these accomplishments contributing to the efficiency of the setting.

In the modification as in Figure 13 wherein the tie bricks are disposed in staggered order, there is relatively increased surface exposure, and relatively slightly decreased flue area. Figure 14 shows another modification of setting wherein the tie bricks are in more closely staggered order, to afford increased exposed surfaces, minimum flue area, and a greater mass. In all instances wherein my invention is used, since all exposed surfaces are curvate, extremely slight resistance, if any, is offered to the particles in suspension being carried by the gases.

A further advantage of my new tie brick is that it is self locking. There is suitable clearance F between the facing portions of the studs C. The flanges B which overlap the proximate side faces of the line bricks, effectively hold the latter against dislodgement or shifting, whereby vigorous cleaning of the exposed surfaces, as by a suitable blow pipe or lance, is practicable, and without liability of dislodging the brick.

Since the larger part of the complete setting in which my improved tie bricks are embodied, is composed of the conventional rectangular checker bricks, the slight increase of cost over the use of conventional bricks throughout is inconsiderable, whereas all other forms of special checker bricks are incapable of being used in combination with bricks of conventional form and cost.

A regenerator chamber embodying a checker brick installation in accordance with my invention is of efficiency to measure up to the increased present day efficiency of the melting and refining chamber structure, thus contributing to uninterrupted furnace operation, and maintenance of ignition temperatures at all times.

My improved spool shaped tie brick may be positioned to provide ample vertical flues six and one half by nine inches where excessive batch carry-over is encountered; or it may be positioned in staggered order forming flues six and one half inches in diameter suitable when waste gases are comparatively free from particles in suspension. A setting embodying my improved tie blocks provides horizontal flues of six and one half inches in diameter on nine inch centers both directions, thus assuring ample space for the use of a cleaning lance. In the use of my tie brick, the spacing of the line bricks to allow for communicating passageways at locations intermediate the tie bricks is practicable. This arrangement is desirable in instances where the regenerative chamber is accessible for cleaning under the ports or down takes.

In an installation comprising my improved tie bricks, the area of the exposed surfaces is somewhat greater than the area of exposed surfaces of transverse conventional bricks, for a given flue area, and is also considerably greater in mass.

My improved tie bricks may be composed of first quality or of super quality fire clay, or of silica. They require no engineering service, and they can be set by the exercise of only ordinary skill. Whereas they do not constitute a rigidly locked mass, they cannot easily be dislodged, and may be lanced as often as may be desired without injury. By virtue of their contour they facilitate the business of lancing by constituting a cradle upon which the lance may be more expeditiously manipulated.

Whereas I have described my invention as being especially applicable to furnaces intended for use in the industry of glass making, it will be understood that it is applicable as well to furnaces or ovens of the regenerative type as used in baking and annealing processes, and in other industries such as steel making and the like. Also it will be understood that my improved installation and tie brick is subject to minor modifications and changes which might be suggested by those skilled in the art to which my invention appertains, without departing from the principle of my invention or sacrificing any of its advantages.

What I claim as my invention is:

1. A regenerator installation comprising line bricks arranged in alignment one row above another, the bricks of one or more rows being spaced, and spool shaped concavo-concave tie bricks each embodying at each of its ends a stud rectangular in cross section and that is reposed between the edges of the facing ends of the spaced line bricks.

2. A checker brick consisting of a refractory unit of spool shaped concavo-concave formation, each end thereof embodying a stud rectangular in cross section.

EDWIN E. MILNER.