Feb. 2, 1943. G. P. REINTJES 2,309,789

FURNACE CHECKERWORK

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Fig. 1.

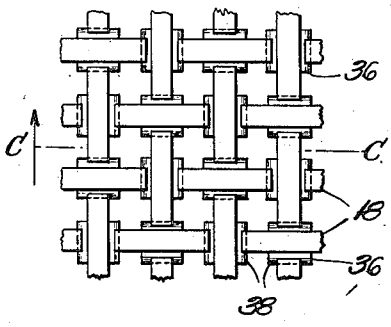


Fig. 2.

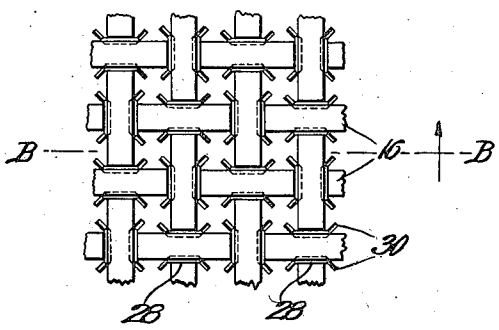


Fig. 3.

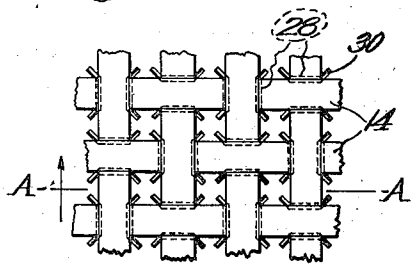


Fig. 6.

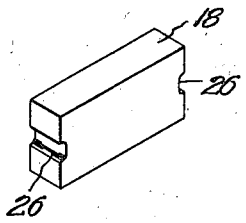


Fig. 5.

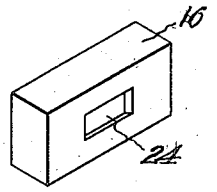


Fig. 7.

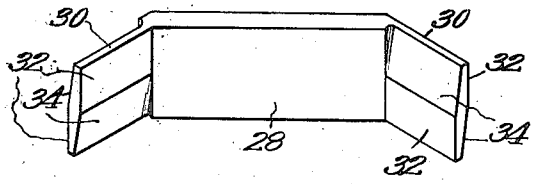
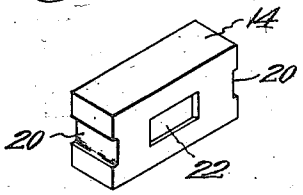


Fig. 4.



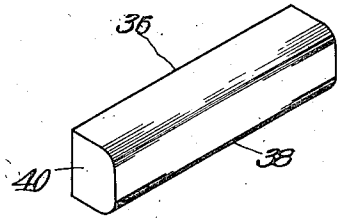


Fig. 8.

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FURNACE CHECKERWORK

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Fig. 9.

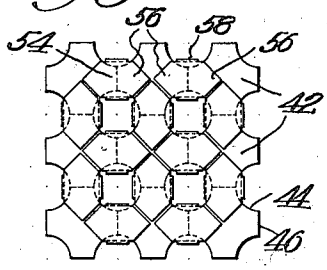


Fig. 10.

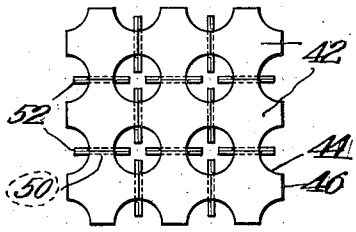
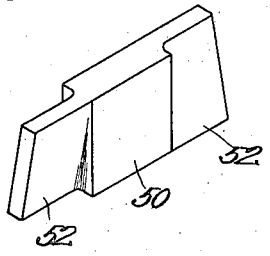


Fig. 12.



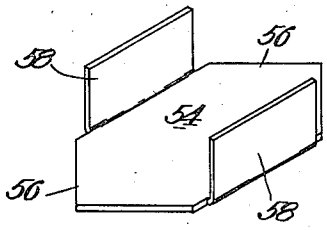


Fig. 11

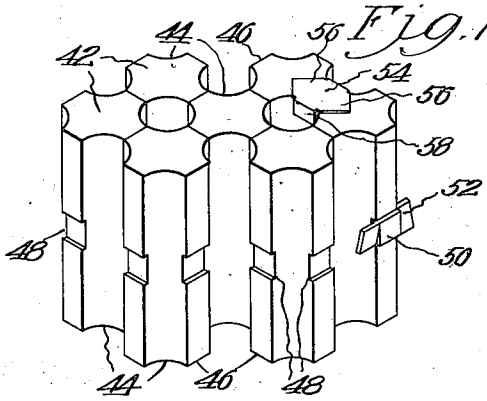
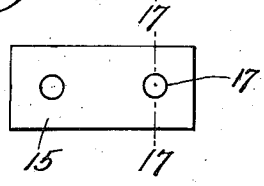


Fig. 13.

Fig. 15.



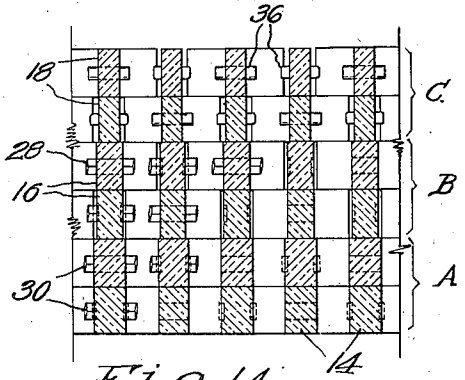
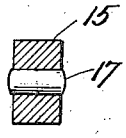


Fig. 14.

Fig. 16.



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UNITED STATES PATENT OFFICE

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FURNACE CHECKERWORK

George P. Reintjes, Kansas City, Mo.

Application August 31, 1940, Serial No. 355,039

3 Claims. (Cl. 263—51)

This invention relates to a new and improved checkerwork system for regenerative furnaces, stoves, hot blast furnaces and other constructions of similar heat absorbing and storing characteristics. It has been common practice to build checkerwork providing flues for the passage of hot gases and reverse flow or air or gases to be heated and various expedients have been adopted to vary the size or cross sectional area of these flues in accordance with the volume and velocity of the gases, such as, by means of refractory inserts of various kinds in an endeavor to increase furnace efficiency. It has also been common in furnaces of this general character to utilize different instrumentalities for causing turbulence of the flue gases as a means of increasing the absorption or transfer, but all of these methods, as far as I am aware, have in essence chiefly comprised the addition of further refractory material to the furnace, with the result that although greater heat absorbing capacity was supplied, it was gained by increasing the back pressure to the flow of gases. To overcome the consequent increase in back pressure, power means has been adopted to force the gases or air through the checkerwork, the cost of such power means practically nullifying the savings effected in the increased heat absorbing capability of the furnace.

It has also been found that where rectangular refractories are used, stacked up in columns of horizontal courses, there is always a relatively large area of each brick where it overlies an underlying brick, that is practically valueless as far as heat absorption and delivery is concerned, since the cycles of absorption and delivery are such that the centers of the bricks sometimes operate in reverse manner and tend to absorb heat from the brick surfaces when it is desired to transfer such heat to the air or gas passing through the furnace flues. In such constructions, therefore, it is clear that the protected centers or mid-portions of the refractories perform no function as far as efficiency of operation of a furnace is concerned. One of the chief objects of the present invention is to provide a checkerwork with means possessing relatively high ratio of heat transfer for absorbing heat from the flues and delivering it inwardly to the centers of the firebrick forming the flues, where it is available for flow to and from the areas which have heretofore been unavailable for this purpose. The invention contemplates the use of members projecting into or exposed in the flues, of such character and cross-sectional area as not to offer any material increase in resistance to the flow of gases or air, these members themselves having no particular value as heat storage agents, but being intended chiefly as heat transfer or conducting elements to feed to and from the centers of the fire-brick. For example, I contemplate making the checkerwork out of the usual fire brick and to provide said bricks with, say, suitably supported and contacting cast iron heat conducting elements which have from thirty-six to forty-five times the rate of heat transfer as the ordinary firebrick. Or plates, sheets, or molded or cast forms of suitable refractory material of high rate of heat transfer may be used, such as silicon carbide, fused alumina, and the like, having as much as 10 times the rate of heat transfer as the usual fire brick. In other words, I contemplate the use of any suitable material of heterogenous nature to the fire brick, and possessing a higher rate of heat transfer or conduction.

Another object of the invention is to produce a construction in which, in the preferred form, the heat conducting elements are not subjected to the load of the checkerwork or the load of overlying elements, in fact, if they have sufficient strength to resist breakage on cleaning of the checkerwork, they may even be of relatively friable material provided they will stand up under the scouring action of the gases or air passing through the flues.

A further object of the invention is to provide a heat transfer element which is supported by or imbedded in the joints, in sockets, recesses or the like, formed between abutting ends or intermediate the height of the bricks. It will be apparent that by utilizing the area of the brickwork that has heretofore been unavailable, the heat absorbing volume of the brickwork may be greatly increased without adding brickwork or interfering with the free circulation of air and gases therethrough.

Another object of the invention is to produce a checkerwork construction of such nature that the cross sectional areas of the flues may vary from end to end in accordance with the volume of air and gases, by a slight change in the thicknesses of the brick, their length and height remaining constant throughout the furnace.

In additional object of the invention is to provide a construction of the general character mentioned in which the heat conducting elements may be of such nature as to increase the turbulence of the gases or air flowing through the flues so that they come into better scouring contact with the flue walls and with said heat conducting elements. The spiral movement in adjacent flues

can be clockwise and counterclockwise if desired, depending upon the inclination of the directing vanes.

A still further object of the invention is to provide a construction of different sizes of bricks and heat conducting elements, so related that as the horizontal belts or zones of brick are built in superposed relation, the heat conducting elements are positioned, and the proportions of the various parts are so related that the medial vertical planes of successive zones will be maintained in determined relation to the corresponding planes of underlying zones, the flues however being of different cross sectional areas.

With the general objects named in view and others as will hereinafter appear, the invention consists in certain novel and useful features of construction and organization of parts as hereinafter described and claimed; and in order that it may be fully understood, reference is to be had to the accompanying drawings, in which:

Figure 1 is a top plan view of one form of checkerwork embodying the invention.

Figure 2 is a top plan view of another form of checkerwork, which may be used in a cooler zone than that shown in Figure 1, if both types are employed in the same furnace.

Figure 3 is a top plan view of still another modified form of checkerwork, which, if used with one or both of the preceding constructions, will be used in a cooler zone.

Figure 4 is a perspective view of the type of brick shown in Figure 3.

Figure 5 is a perspective view of a brick such as shown in Figure 2.

Figure 6 is a perspective view of the type of brick as used in the construction shown in Figure 1.

Figure 7 is a perspective view of the heat conducting elements shown in Figures 2 and 3.

Figure 8 is a perspective view of the heat conducting elements shown in Figure 1.

Figure 9 is a top plan view of a column of special bricks which form cylindrical flues, the horizontal joints between the bricks being provided with heat conducting elements projecting into the flues.

Figure 10 is a top plan view of a column of similar brick, in which the heat conducting elements are inserted at intermediate point in the height of each brick.

Figure 11 is a perspective view of the type of brick shown in Figures 9 and 10, and illustrates one of each form of heat conducting elements as shown in said figures.

Figure 12 is an enlarged perspective view of one type of heat conducting element shown in Figures 10 and 11.

Figure 13 is an enlarged perspective view of the other type of heat conducting element shown in Figures 9 and 11.

Figure 14 is a vertical section through horizontal zones A, B and C, composed of the three types of brick shown in Figures 4 through 6, as they will appear in superposed basket weave, said sections being on the lines A—A, B—B and C—C of Figures 3, 2 and 1 respectively.

Figure 15 is a face view of a brick having a modified form of heat conducting element.

Figure 16 is a section on the line 17—17 of Figure 15.

Figures 1 through 6, and Figure 14, of the drawings, show three forms of brick which may be used alone or in combination as a filler for a stove, regenerator, furnace or the like, said bricks, by preference, being of uniform length and height, but of different widths, as will hereinafter appear. Ordinarily the thicker brick will be used at the point of greatest load. In this connection, it will, of course, be understood that I do not limit myself to any particular flue formation, but contemplate horizontal as well as the vertical form of flues shown, or a combination of the two, nor do I intend to limit myself to the dimensions or proportions of bricks hereinafter set out by way of example. I prefer to use relative standard rectangular checkerbricks as shown in Figures 4, 5 and 6, which are, for convenience, identified respectively, as bricks **14**, **16** and **18**, suitable overall dimensions being, respectively, 9" x 4½" x 3", 9" x 4½" x 2½", and 9" x 4½" x 2". Each brick **14** is formed at its opposite ends with a pair of transverse grooves or recesses **20** providing slots or shelves stepped back from the vertical face of the brick, and in its opposite sides, said brick **14** is formed with a pair of recesses **22**, it being noted that said grooves and recesses are intermediate the height of the brick. The intermediate brick **16** is formed in its opposite sides with recesses **24**, corresponding to the recesses **22** of the brick **14**. The narrowest brick **18** is formed in its opposite ends with transverse grooves **26**, corresponding to the grooves **20** of the brick **14**, but this brick **18** does not have the recesses in its opposite sides. In making the preferred form of vertical flues, each brick may be laid up in courses in right angular relation as in a basket weave, the ends of each brick being in opposite or abutting the sides of adjacent brick. In the construction shown the vertical medial planes of adjacent courses are in vertical alignment, see Figure 14. When laid for horizontal flow the bricks may be laid in parallel courses.

For convenience of identification, the checkerwork belts or strata of similar bricks of the types **14**, **16** and **18**, will hereinafter be identified respectively, as zones A, B and C, Figure 14. Since the bricks of zone A are the thickest and are ordinarily exposed to the coolest temperature, they would require a greater time period to absorb and discharge heat, and in order to speed up or shorten the heat transfer period, I form said brick **14** at its ends and sides with the grooves and recesses previously described. By this means, it will be evident that I increase the surface area which might be exposed for heat absorption. However, since in laying up a basket weave filler, the ends and sides of the brick do not open into the flues, I insert in the registering grooves **20** and recesses **22** (see Figure 3), heat conducting elements of heterogenous character as compared to the brick, and having greater coefficient of heat conductivity per unit mass than that of the brick; said elements comprising plate or body portions **28** formed at their opposite ends with diverging vanes or fins **30**. The length of the body portion **28** preferably is substantially equal to the width of the brick **14** with which it is to be used, so that said vanes **30** project at right angles to each other, and at angles of 45° to the corners of the rectangular flues (see Figure 3). In the preferred construction, the vanes **30** are cast, ground, molded or otherwise formed in offset relation to provide parallel faces **32** for one-half the height of their opposite sides, and inclined planes **34** on their opposite sides for the other half of their height. With a construction of this character, it will be evident that the vanes **30** have their greatest thickness midway

their height and may have a more or less venturi effect as will be possessed by other of the heat conducting elements to be hereinafter described. Due to their inclined plane portions **34** the vanes will tend to increase the turbulence of the gases or air passing through the flues and thereby increase their scouring contact with the bricks and better the rate of heat transfer. When horizontal flues are laid the brick of Figures 15 and 16 are preferably employed. These brick **15** may be of any desired size and will have two or more transverse passages which are filled or plugged with any suitable plastic **17** having a higher rate of heat conductivity than that of the brick.

It will be apparent that when the brick **16** of the zone B are laid, as they are of less width than those of zone A, they will not need as much increased absorptive area as the brick of the latter zone. The parts, therefore, are so proportioned that when the brick **16** are laid, the heat conducting elements **28** fitted in the recesses **24** will contact the ungrooved ends of the abutting brick **16**, the thickness of the portion **28** being such as to act as an automatic spacer and insure the proper positioning of the vertical medial planes of the brick **16** of zone B in relation to the vertical medial planes of the brick of the zone A, see Figure 14.

When the brick **18** are laid to form the zone C, the hottest zone, heat conducting elements **36** as shown in Figure 8, may be employed, said spacers having a rounded base **38** to fit in the grooves **26** in the ends of the brick **18**. The flat faces **40** of said elements **36** are in abutment with the unrecessed sides of adjacent brick **18**, see Figure 1. The heat conducting elements **36** are so proportioned that they automatically position the brick **18** in the zone C, so that their vertical medial planes bear a proper relation to the vertical medial planes of the underlying brick of the other zone or zones, as shown in Figure 14.

When it is desired to have a stove or furnace equipped with cylindrical flues, brick **42** of more or less octagonal shape as shown in Figure 11, may be employed, the alternate faces of said brick being respectively arcuate as at **44** and plane as at **46**. When these brick **42** are laid up in courses, their plane faces **46** are brought into abutment, see Figure 11. To increase the heat transferring capabilities of brick of this character or of the brick previously described, their plane faces intermediate their height may be formed with transverse grooves **48** of such depth as to receive a flat bar member **50**, corresponding to the member **28** of the previous figures, the opposite ends of said bar **50** projecting into the cylindrical flues formed between the arcuate faces of adjacent brick. By preference, the projecting ends of the bar **50** are cast, molded or otherwise formed to provide oppositely inclined fins or vanes **52** of substantially one-half the thickness of the body of the bar **50**. Turbulence or spiral movement in the flues is thus increased to raise the overall efficiency of the system. As an alternative method of increasing the heat transferring capacity of any of the brick, the spaces between the horizontal joints may be filled by heat conducting elements heterogenous as compared to the brick, comprising flat plate-like members **54** having a pair of their opposite ends forming right-angular shaped extensions **56**, so that they may be laid in patterned relation, each end **56** covering one-fourth of a brick (see Figure 9). By preference, the side edges of the plates **54** project into the circular flues, and said edges may be provided with relatively vertical flanges **58** paralleling and within the flues, if desired.

From the above description it will be apparent that I have produced a construction embodying all of the features of advantage set forth as desirable, and while I have described and illustrated the preferred embodiments, it is to be understood that I reserve the right to all changes within the spirit and scope of the appended claims.

I claim:

1. A refractory checkerwork comprising a plurality of refractories forming a plurality of spaced vertical flues, and inserts having a higher coefficient of heat conductivity per unit mass than that of the refractories having their body portions embedded in openings leading to the interior of the refractories forming the flues, each of said inserts having at least one end exposed in a flue to conduct heat to and from the interior of the refractories.

2. A jointed refractory checkerwork construction comprising a plurality of refractories forming a plurality of spaced vertical flues, and inserts having a higher coefficient of heat conductivity per unit mass than that of the refractories positioned in said joints for conducting heat to and from the center mass of the refractories and having at least one end projecting into a flue, the body portion of said inserts being wholly confined between the joints.

3. A checkerwork comprising two sets of identical brick lying in coplanar relation, the brick of each set being in spaced parallel rows in right angular relation to the spaced parallel rows of the other set with the ends of each brick of each set abutting the body of a brick of the other set, to form a plurality of vertical flues, and inserts having a higher coefficient of heat conductivity per unit mass than that of the brick, said inserts extending through said end joints with their ends projecting into a pair of adjacent flues for conducting heat to and from the center mass of the brick.

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