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F. J. TONE

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FURNACE WALL STRUCTURE

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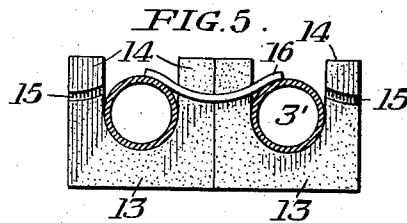
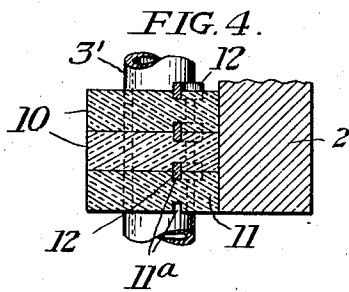
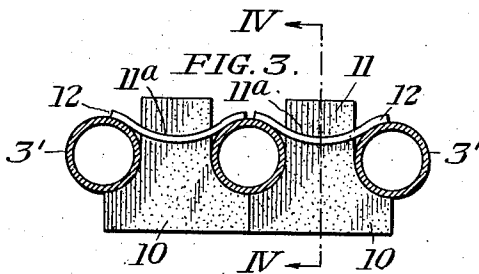
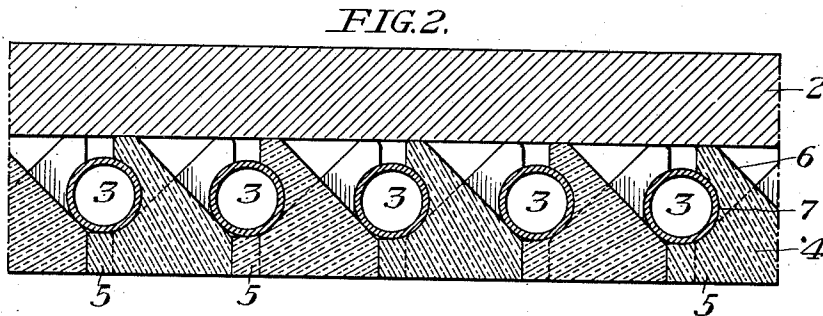
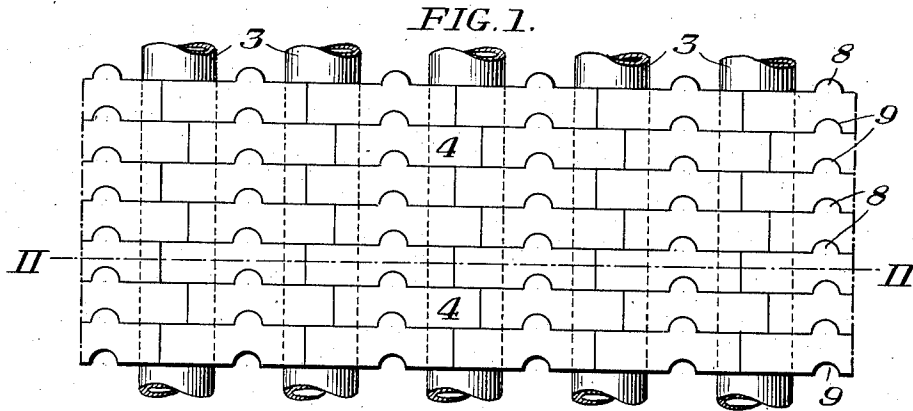
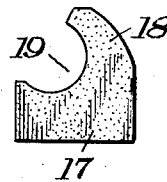


FIG. 6.



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## UNITED STATES PATENT OFFICE

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## FURNACE-WALL STRUCTURE

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This invention relates to furnace wall structures such as are used in boiler furnaces, and the like, where the side walls are subjected to severe temperature conditions. The invention refers particularly to a composite type of wall consisting of refractory material, in which are installed water tubes to absorb a portion of the heat and prolong the life of the structure.

It is the practice in certain types of construction to replace the ordinary fire-brick wall with a water tube construction which is either exposed directly to the flame in the furnace, or is partially protected from the flames by means of metal or refractory facings. In many cases the water tubes are entirely embedded in the refractory wall.

The present invention refers particularly to the use of silicon carbide and similar material of high thermal conductivity as a facing for the tubes, or as a protection for the tubes against the flames.

A further important feature of the invention is the shape of the refractory block which is so built that the blocks have an interlocking engagement with the tubes by means of which they are prevented from being removed under normal conditions.

The invention may be readily understood by reference to the accompanying drawings, which illustrate a preferred embodiment of my invention, but to the details of construction of which my invention is not limited.

In the drawings:

Figure 1 is a side elevation of a portion of a furnace wall embodying my invention;

Figure 2 is a section in the plane of line II—II of Figure 1;

Figure 3 is a detail view similar to Figure 2, showing a slightly modified construction of block;

Figure 4 is a section taken on the line IV—IV of Figure 3, showing in addition the outer wall of the furnace;

Figure 5 is a view similar to Figure 3, showing another modification and

Figure 6 is a detail view of another form of block.

In the drawings, 2 represents a portion of a furnace structure within which are vertical

tubes 3 through which fluid may be circulated to absorb some of the heat from the fire-box of the furnace. The tubes 3 are protected by means of a refractory facing which is preferably formed of silicon carbide or other refractory material of relatively high thermal conductivity. This facing is composed of a plurality of blocks 4, each of which has a body portion 5 and a lug portion 6. The lug portion 6 is adapted to project between parallel tubes 3, and is diagonally or angularly arranged with respect to the body of the block in such way that the outer end of the lug may extend behind one of the tubes, as clearly shown in Figure 2, while the lug itself has a recess 7 into which a portion of the tube may fit.

The thickness of the block may be varied as conditions may arise, but I have found that in the ordinary construction an overall thickness of approximately four inches is very satisfactory. In such a block the body portion is substantially two inches thick. The blocks are laid in courses or rows, with the angular lug or projection 6 in alternate courses being reversed, as shown in Figure 2. When arranged in this manner, the friction of one row of blocks on the contiguous rows makes it difficult for any row of blocks to be moved out diagonally from its proper position.

For the purpose of further securing the wall, the tops of the blocks may be provided with one or more lugs 8 adapted to project into correspondingly formed grooves 9 in the next adjacent block above, thereby providing an interlocking connection between joints. This prevents any movement of any single row of blocks in a direction parallel with the face of the wall. The result of this is that it is impossible for any block to move outwardly in a direction normal to the face of the wall and all of the blocks are locked securely in place by the tubes.

In the construction shown in Figure 3, the block is made with a lug of a different shape, whereby it may be inserted into the wall structure in a direction normal to the face of the wall. In this construction, 10 represents the body of the block and 11 is a lug

provided thereon which is sufficiently wide to fill the space between two parallel tubes 3'. The lug extends rearwardly as far as the inside edge of the tube and is provided in one face with a groove 11<sup>a</sup> into which a metal key or strap 12 may be set, this strap engaging the two parallel tubes to lock the block in position. By making the straps 12 of sufficient widths, it is possible to have a single strap hold two adjacent blocks in place. This can be done by forming the groove 11<sup>a</sup> in one of the blocks on the top face of the block and having the groove correspondingly located in the bottom of the block which would be superimposed thereon. The two grooves would then be opposite each other and would be aligned so that the single strap 12 could serve to hold two blocks in place, as shown in Figure 4.

The construction shown in Figure 5 is generally similar to that described in connection with Figure 3, but in this particular form of block the body 13 of each block has two legs or lugs 14 which are spaced apart a distance sufficient to enable the block to straddle the pipe 3'. The width of the lugs or legs 14 is equal to substantially half of the distance between adjacent tubes, so that the lugs of two adjacent blocks will serve to fill the gap between two adjacent tubes. The lugs 14 are provided with grooves 15 arranged in the same manner as the grooves 11<sup>a</sup> described in connection with Figure 3. A strap 16 may be inserted in the grooves 15 of the legs of two adjacent blocks, to lock the blocks to the tubes.

The block shown in Figure 6 has a body portion 17 and a curved lug 18 within which is a semi-circular recess 19. The shape of the lug 18 and the recess 19 is such that the block may be placed in the wall structure by turning it about the tube with the tube as a center. When in position, the curved lug 18 will be fitted around the pipe to such an extent that the block will be prevented from moving straight out away from the tube.

While the blocks as described in any of the various forms may be made of any suitable refractory material, I prefer to use a material for the blocks having an especially high refractibility and a high coefficient of thermal conductivity or heat permeability, as compared with fire-clay. This is because I find that these properties enable a sufficient amount of heat to be withdrawn from the exposed portion of the block to keep it below the temperature at which it would react with the products of combustion. This arrangement gives a block which will withstand excessive temperature conditions and excessive corrosive conditions. When the heat which is conducted away from the exposed portion of the block reaches the back of the block, it is absorbed by fluid passing through the tubes in a useful man-

ner. There is, therefore, a very definite advantage obtained by the use of blocks of high heat permeability in combination with cooling tubes, whereby a more highly refractory furnace is secured and a more effective cooling of the lining obtained.

As a specific example, silicon carbide has been found to be from around six to nine times more thermally conductive than fire clay. The thermal conductivity as compared with fire clay varies according to the density of the refractory blocks, the manner in which they are formed, and the percentage of bonding material and filler relative to the amount of silicon carbide contained in the block. Silicon carbide is also very much stronger at the high operating temperatures of a boiler than is fire clay. The thermal conductivity of silicon carbide is well above .006 cal./cm<sup>3</sup>/°C./sec., whereas fire clay has a thermal conductivity well below this.

Considering that fire clay is a much poorer conductor of heat than silicon carbide, it will be evident that in order to dissipate heat through a fire clay refractory the wall will have to be so thin, in order to transmit any appreciable amount of heat, as to be mechanically impractical. Considering that silicon carbide is from six to nine times more thermally conductive than fire clay, a silicon carbide wall from six to nine inches thick will dissipate the same amount of heat as a fire clay wall only one inch thick.

With the present invention the refractory wall can be thick enough to be mechanically sound and yet heat can be dissipated through the wall at a rate sufficient to maintain the inner surface of the wall at a temperature below the flame temperature in the furnace. In other words, heat can be dissipated through the wall at a rate sufficient to cause the congealing of slag on the inner surface of the wall and thereby form a protective coating over the refractory. In order to do this with a fire clay wall, the wall would be so thin as to be entirely impractical. The invention possesses an advantage over a metal wall, as is sometimes provided where water cooling is resorted to, for the reason that the temperature of the exposed face of the refractory can be kept much higher than the surface of the water cooled metal wall. This is of definite advantage because in the burning of fuels, particularly suspended fuels such as oil or powdered coal, it is desirable to keep the temperature of the refractory walls above the kindling temperature of the fuel, but below the slagging temperature. As above pointed out, the present invention permits the furnace to be operated with the exposed face of the refractory at a temperature where the slag will congeal to form a protective coating. At the same time the temperature of the wall can be kept well above the kindling temperature of the fuel.

The invention therefore secures a high degree of efficiency. The heat which is dissipated through the walls is utilized to heat the water in the tubes. The invention secures the advantage of the usual metal water leg in a boiler, but in an arrangement wherein the temperature of the refractory can be maintained at a point most favorable to efficient combustion. By reason of the fact that the blocks are interlocked with the tubes, the wall is supported throughout its entire area and is made secure against slippage or movement in any direction.

I claim:—

1. In a furnace wall, a water circulating conduit, and a protective non-metallic refractory coating thereover, said refractory coating comprising silicon carbide having a thermal conductivity in excess of .006 cal./cm<sup>3</sup>/°C./sec.

2. In a furnace wall, a water circulating passage, and a non-metallic refractory facing over the passage and in intimate contact therewith, said facing being comprised of a silicon carbide refractory which is at least six times as conductive as fire clay.

3. In a furnace wall, the combination with a series of spaced apart tubes with a refractory facing thereover comprised of a plurality of silicon carbide refractory blocks, said blocks being in intimate contact with and being mechanically interlocked with the tubes, the blocks having a thermal conductivity at least six times that of fire clay.

4. In a furnace wall, the combination with a series of spaced-apart water tubes, of a silicon carbide refractory facing thereover and in intimate contact therewith, said facing having a thermal conductivity many times that of fire clay but less than the thermal conductivity of cast iron.

5. In a furnace wall structure, spaced-apart boiler tubes and a facing over said tubes of heat-conducting refractory blocks having substantially rectangular flat front faces, the width of which is substantially equal to the distance between the tube centers, the blocks having an extension on the rear thereof projecting between the tubes, one side of the extension having a semi-circular recess therein adapted to fit around the tubes, the other side of the extension being tapered, said blocks being laid in horizontal courses with the ends thereof in abutting relation, the blocks in each course being reversed with respect to those of adjacent courses.

6. In a furnace structure having spaced-apart boiler tubes in the wall thereof, a heat-conducting nonmetallic refractory facing therefor comprised of substantially rectangular blocks with flat faces and squared ends, the width of the face being substantially equal to the distance between

the tube centers, said blocks having an extension on the rear face thereof projecting between the tubes, said extensions having a semi-circular recess in one side thereof to fit around the boiler tubes, said blocks having one end thereof projecting beyond the center of one tube and having the other end abutting against the end of the next adjacent block, said blocks being laid in horizontal courses, with the blocks of one course reversed with respect to the blocks of the adjacent courses whereby a breaking of joints is secured.

7. In a furnace structure having spaced-apart boiler tubes in the wall thereof, a heat-conducting nonmetallic refractory facing therefor comprised of substantially rectangular blocks with flat faces and squared ends, the width of the face being substantially equal to the distance between the tube centers, said blocks having an extension on the rear face thereof projecting between the tubes, said extensions having a semi-circular recess in one side thereof to fit around the boiler tubes, said blocks having one end thereof projecting beyond the center of one tube and having the other end abutting against the end of the next adjacent block, said blocks being laid in horizontal courses, with the blocks of one course reversed with respect to the blocks of the adjacent courses whereby a breaking of joints is secured, the top face of each block being provided with a projection, the bottom faces of the blocks being provided with a recess adapted to receive the projection of an adjacent block.

In testimony whereof I have hereunto set my hand.

FRANK J. TONE.