REFRACTORY BRICK LINED FURNACE WALL

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This invention relates to boiler walls with particular reference to marine boiler walls. The operating temperatures in modern water tube boiler plants run up exceedingly high. To assure proper operations it has become a common practice to apply to the metal casing of the boiler a refractory brick section, an insulating brick lining being often interposed between the casing and the refractory brick.

In order to assemble boiler and furnace wall structures of this type and particularly to tie the refractory brick section to the metal casing iron bolts are frequently used, whereby the inner end of the bolt is anchored in the refractory brick section and the other end protrudes through the metal casing where it is secured in a suitable manner.

To increase the resistance of the bolts to the great stresses exerted upon them at the high operating temperatures of the boilers, the bolts are made of heat resistant high-grade alloy steel; this greatly increases the costs of the erection of the boiler walls.

In spite of this precaution it has been found that even the high grade steel bolts have a tendency to burn out and to break. This failure is apparently due to the fact that the bolts which reach into the refractory wall section are exposed in addition to the full attack of the heat to those high mechanical stresses which act upon the refractory brick section of the boiler wall.

But whatever the reason may be the quick burning out and breakage on only one of the anchoring bolts which tie the heavy refractory brick section to the metal casing involves grave dangers.

Due to breakage of a bolt the portion of the refractory wall section anchored to the casing loses its coherence therewith, the full weight of the thus loosened portion exerts great stresses and strains on the adjacent parts, as the tie-up of the refractory bricks with the metal casing only rests on the anchoring function of the bolts. Under the influence of these stresses also the adjacent bolts give way or break with the result that a large area of the refractory wall section bulges away from the metal casing. Not only the bulged part of the refractory section, but the entire refractory wall must be often torn out and rebuilt, which causes extensive work stoppages and excessive repair costs.

The danger that great areas of the boiler walls may be destroyed by the breakage of a single anchoring bolt is particularly apparent in marine boilers which undergo particularly unusual stresses and wear due to the continuous vibrations of the ship.

Therefore, it is an important object of the invention to so design a boiler wall and particularly a marine boiler wall that, if an anchoring bolt breaks, only that part of the wall requires tearing out and repair or replacement which is situated in the direct vicinity of the broken bolt.

It is another object of the invention to relieve the bolts from their function as direct anchoring means of the refractory wall section to the metal casing and to revert for this purpose to another element which in case of bolt breakage is affected to a lesser degree.

In connection therewith it is an object of the invention to reduce the danger of bolt breakage by relieving the same from a major part of the anchoring function.

At the same time it is an object of the invention to substantially prevent the stresses and strains which inevitably result from bolt breakages to act upon that part of the refractory brick section which is located in the direct vicinity of the broken bolt, as otherwise this portion will lose its coherence with the metal casing and force a large portion of the refractory wall section to bulge.

It is also an object of the invention to insulate the bolts by a new bolt mounting system, so that bolts may be used which are made of ordinary steel.

It is also an object of the invention to devise a bolt accommodating refractory block or brick assembly which in case of heat injury or damage of the bolts can be easily replaced during ordinary service without removing or tearing away greater areas of the refractory wall section. It is another object of the invention to provide special tie-in blocks for the anchoring bolts whereby except for these anchoring blocks ordinary fire bricks may be used for the erection of the boiler walls.

Another object of the invention is to so devise the tie-in blocks that they are of simple design and that a minor amount of warping and firing will not make the block unusable.

Yet another object of the invention is to devise an assembly of bolts and tie-in blocks in such a manner that the bolt does not project through the outside metal casing, whereby the hitherto created outside bolt holes are eliminated through which air leakages take place.

A further object of the invention is to devise an improved boiler wall construction having the
advantages of the present invention which can be installed in existing boiler furnaces without alterations of any sort.

Still another object of the invention is to design a boiler wall which can be quickly installed at moderate costs, repaired at a minimum of expenses, erected without skilled labor, which has low maintenance costs and, therefore, is particularly usable for marine boilers.

With these and other objects in view which will become apparent as this specification proceeds, the invention is based on the discovery that in a boiler wall where the inner refractory brick section is anchored by bolts to the metal casing the projection of the bolts into the refractory brick section and its direct tie-up to the casing by the bolts bears grave dangers and must be avoided. This phenomenon has hitherto not been recognized and not been considered in the construction of furnace and boiler walls.

In prior practice where direct bolt connections are employed to anchor the refractory bricks to the metal casing, the stresses caused by the weight of the refractory bricks loosened through breakage of a single bolt are imparted to a large area involving those fatal consequences which have been previously described.

The recognition that in furnaces and boiler walls of the instant type the main part of the anchoring functions must be entrusted to other elements than bolts led to the construction of special tie-in blocks which, though remaining an integral body, are composed of two portions. The one portion which may be called the outer or foot portion and accommodates a bolt, is connected to the casing and anchored and embedded in the insulating brick lining in case such one is provided, and the other inner portion of the tie-in block projects into the refractory brick or inner brick lining section and is firmly seated therein.

In order to obtain a firm and reliable seat of the tie-in block in the refractory brick section the inner or head portion of the block is dovetailed in that it is provided with oppositely directed laterally extending wing shaped shoulders or overhangs of a preferably triangular cross-section which extend into or between the bricks of the refractory section.

The refractory bricks which form the seat for the shoulders of the tie-in block are provided with oppositely sloping groove-shaped recesses complementary to the form of the shoulders, and they are herein termed the recessed refractory bricks. They have the double height of the normal bricks of the refractory section which have the usual shape and size.

By seating the shoulder carrying portion of the tie-in block between a pair of the accordingly shaped and symmetrically disposed refractory bricks, the one of which supports and the other one covers the inner portion of the tie-in block, the latter is firmly held in the refractory brick section. By means of this tie-in block the inner or refractory brick section is anchored to the metal casing.

This purpose is fulfilled by the outer or foot portion of the tie-in block; this outer portion has the shape of a longitudinal rib shown to be rectangular in cross-section which projects into the insulating lining of the boiler casing and is connected with the latter by a bolt which protrudes into and engages the rib or foot portion of the tie-in block.

The union of the tie-in block with the metal casing or the insulating layer if such one is provided is effected by the cooperation of the outer portion of the block which has the shape of a longitudinally extending preferably rectangular rib and of a bolt.

The mounting of the bolt at the inner face of the casing and its connection with the tie-in block will be described in detail in a later part of this specification; however, it should always be borne in mind that in the present boiler wall the bolt does not act as a direct connecting means for the inner or refractory brick section and the metal casing and that this function is imparted to the tie-in brick.

Moreover, particular stress is placed upon the fact that the means for fastening the bolt to the casing are located at the inside of the latter.

The use of especially shaped blocks for mounting cooling tubes by means of bolts in boiler walls is known; the bolts are anchored in the insulating layer of the wall and not connected with the metal casing of the boiler; the shape of these known tube holding blocks is entirely different from that of the tie-in blocks which are employed in connection with this invention, and so is their function and purpose.

After having explained the principles upon which this invention is based in general, the specific means for the materialisation of these principles will now be described in detail with reference to the accompanying drawings which illustrate a preferred embodiment of the invention.

In the drawings, Fig. 1 is a vertical sectional elevation of a part of the boiler wall forming the subject matter of this invention.

Fig. 2 shows an enlarged scale isometric views of the three brick or block combination forming the main element of this invention.

Fig. 3 shows an enlarged scale a vertical sectional elevation, a part of the boiler wall with the tie-in block attached thereto.

Fig. 4 shows on an enlarged scale partly in section and partly as a side view the three brick assembly and the part of the furnace wall to which it is applied.

Figs. 5 to 11 illustrate progressive stages in the building-up of a furnace wall of the component portions according to this invention.

Figs. 12 and 13 illustrate the sectional replacement of the furnace wall.

Referring to the drawings and particularly to Fig. 1, it will be seen that the boiler wall is made up of an outer casing A, an insulating lining B and a refractory brick section C.

The outer casing A is composed of two adjacent metal sheet structures 1, 2; the insulating lining consists of customary insulating bricks 3, and the refractory section C of usual refractory bricks 4. These parts of the boiler wall are known and are applied in the usual manner.

The unit intended to tie the refractory brick section C to the metal casing A is a specially designed tie-in block D. This block is an integral refractory body and has two portions.

Portion 15 which is to be seated in the refractory brick section C and will be termed "inner" block portion due to its location relative to casing A is provided with two oppositely directed outflaring laterally extending shoulders 12, 13.

The outer tie-in portion 15 has the shape of a longitudinally extending rectangular rib which has the same thickness as the insulating layer B, as clearly shown in Fig. 1; the rib is provided
with an L-shaped recess 16 for reasons which will be explained in a later part of the specification. To seat the tie-in block C refractory bricks 5, 6 are used having the double height of the usual refractory bricks 4; bricks 5, 6 are inserted above and beneath the tie-in blocks into the row of the usual refractory bricks 4. The brick 5 per se as an article of manufacture is identical to the brick 6, although both bricks are disposed symmetrically with respect to each other and relative to a tie-in block "D" with which they interlock. 

In Fig. 7 which is the brick situated above the tie-in block has a projection 17 with an upwardly sloping face 18 and lower brick 9 has a projection 8 with a complementary downwardly sloping face 20; in this manner complementary groove-shaped recesses 9 and 10 are created. These recesses form a reliable seat for the shoulder carrying inner portion 11 of the tie-in block D. The bricks 5 and 6 each have the general shape of a rectangular solid except for the respective recesses 9 and 10 provided therein.

It may here be stated that the use of over-lining bricks provided with triangular shoulders and recesses is generally known in the construction of furnace walls. Rib 15 of the tie-in blocks D is, as previously mentioned, provided with an L-shaped recess 16.

The metal casing A consists of two sheet structures 1 and 2. At the places where the tie-in blocks D are located in intervals in the boiler walls nuts 17 are welded to the outer sheets 1, the height of these nuts being such that their free face lies flush with the inner face of the sheets 2. L-shaped bolts 14 provided with threaded ends 18 are screwed into these nuts that the short shanks of the bolt extend vertically upward. The intervals at which the bolts are located signify the place at which the tie-in block assemblies are arranged in the finished walls.

As soon as the refractory section C and the insulating layer B are built up to the level of a bolt 14, the refractory bricks 6 are brought into their correct location on top of the refractory bricks 4. The tie-in block D is then seated over bolt 14 until it properly rests in recess 10 of bricks 6. Bolt 14 is locked in the recess 16 of the block. Hereupon the upper bricks 5 of the tie-in block assembly are located upon the block, the recess 9 covering the shoulder 12.

The erection of a further section of the wall is then continued from bricks 3 and 4 until the place for mounting the next tie-in block D is reached, whereupon the above described manipulations for mounting the block are repeated. The above described arrangement anchors tie-in blocks D and therewith the refractory section C firmly to casing A and in turn clamps the associated bricks 5, 6 in place.

Successive steps in the building-up of the furnace wall are illustrated in Figs. 8 to 11. That is, Fig. 8 shows a portion of a bare steel casing 24 having inwardly extending hook-shaped anchoring bolts for the tie-in blocks, for example a lower bolt 22 and a next higher bolt 23, such a shell portion confronting the workmen or bricklayers starting the construction of the furnace lining. In Fig. 9 the work has progressed to the point where a lower portion 24 of insulating lining has been applied to the casing and a lower tie-in block 25 has been positioned and engaged upon bolt 22, the underside of this tie-in block being sustained by portion 24 of insulating lining. In Fig. 7 the work is shown to have further progressed in so far as an additional portion 26 of insulating lining has been applied so that the outer or foot portion of tie-in block 25 has been embedded in the insulating lining, the bolt 22 thus being fully protected and occluded within the thickness of the insulating lining while only the dove-tailed inner or header portion of the highly-heat-resistant tie-in block projects from the face of the insulating lining. Similarly a next higher tie-in block 27 is shown to have been placed, anchored and embedded between the portion 26 of insulating lining and a next higher portion 28 of insulating lining.

In this way the first stage of this furnace lining comprising the combination of the insulating lining with the tie-in blocks may be completed, although at the same time the building-up of the inner brick lining may also proceed upwardly.

A start of this inner brick lining is shown in the Fig. 8. Here a recessed lower block 29 is shown to have been placed to interengage with a corresponding downwardly overhanging portion of tie-in block 25, this block 29 being shown to be sustained and locked in place by filler bricks 30.

In Fig. 9 the progress of the application of the inner brick lining has further advanced in that a companion recessed brick 31 has been added to the adjoining brick 28, both recessed bricks being identical although disposed in symmetry when inter-engaging with the tie-in block 25.

Fig. 10 shows a section of brick lining between two tie-in blocks in the process of being completed as a final filler brick 32 is being inserted for locking the final recessed brick 33 of this section in place. The height of this section is defined by the center-to-center distance between the tie-in blocks 25 and 27 and is designated as S. In this figure the important and relative heat insulating and heat resisting functions of the respective layers of this furnace lining have been emphasized by indicating an inner zone Z1, herein termed the high temperature zone, and a receiver zone Z2, herein termed a low temperature zone. Accordingly the high temperature zone Z1 is represented by the more expensive refractory bricks of high fire- and temperature resistance while the low temperature zone Z2 in which the anchoring bolts 22 and 23 are embedded may consist of a less expensive and less temperature resistant material.

Fig. 11 shows the section S of Fig. 10 completed and a next following recessed refractory brick 34 already placed on top of the companion brick 33 thereby starting a next following higher section of the brick lining.

Figs. 12 and 13 illustrate the manner of sectionwise replacement of the inner brick lining made possible by the construction according to this invention. That is in Fig. 12 in order to illustrate the replacement of an intermediate section S of the brick lining there are shown a pair of filler bricks 35 and 36 as being removed from their places in the lining structure. This allows the end bricks of this section S, viz., the bricks 25 and 33 to be disengaged from the tie-in blocks 25 and 27. The thus cleared section or gap in the brick lining is shown in Fig. 13 ready to receive replacement bricks which may be applied in substantially the manner indicated in Fig. 10. The invention avoids the drawbacks of hitherto customary bolt provided boiler and furnace walls, because the strain and stresses occurring in the walls during operation
of the boiler are mainly taken up by the tie-in blocks and not by the bolts. However, if a bolt should break, the bulging of the wall is prevented or at least confined to a small area.

The tearing-out and the repair of this small part of the refractory wall section and insulating lining bears no difficulty whatever whatever unless otherwise specified. The costs for this simple repair work are very moderate and as a main advantage may be carried out by unskilled laborers.

The invention has been described and illustrated in its application to boiler and particularly marine boiler walls. However, it is understood that it may well be applied to the walls of other furnaces, where similar operating conditions exist. Also the shape of the tie-in blocks and the mounting thereof in the boiler walls may be adapted to special requirements within the scope of the following claims.

I claim:

1. A furnace wall structure having an encasing wall, a refractory brick lining, an insulating lining between the encasing wall and the brick lining, and anchoring means for the brick lining, characterized by the fact that said anchoring means comprise a tie-in block having an outer end portion embedded in said insulating lining, and having an inner end portion protruding from said insulating lining and having a pair of flanges anchoring means comprising a first tie-in block having an outer end portion embedded in said insulating lining and having an inner end portion protruding inwardly from said insulating lining and having a pair of flaring shoulder portions symmetrically disposed with respect to one another, and an anchoring hook extending inwardly from said encasing wall and unitary therewith and inter-engaging with the inner end portion of said tie-in block to have anchoring relationship therewith; that said brick lining comprises a pair of identical bricks each of which has the general shape of a rectangular solid having a recess complementary to a shoulder portion of said tie-in block whereby said bricks interlock with said shoulder portions when symmetrically disposed with respect to each other and with respect to the tie-in block; and that refractory filler means are provided for locating each of said recessed bricks in place, said filler means being applied to the side of each brick opposite its recess and following the placement of said recessed bricks to interlock with said shoulders.

2. A furnace wall structure according to claim 3, in which the filler means comprise substantially rectangular bricks.

3. A furnace wall structure having an encasing wall, a refractory brick lining therefor, an insulating lining between the encasing wall and the brick lining, and anchoring means for the brick lining, characterized by the fact that said anchoring means comprise a first tie-in block having an outer end portion embedded in said insulating lining and having an inner end portion protruding inwardly from said insulating lining and having a pair of flaring shoulder portions symmetrically disposed with respect to one another, and an anchoring hook extending from said encasing wall and unitary therewith and inter-engaging with the inner end portion of said tie-in block to have anchoring relationship therewith, a second similar tie-in block spaced from and mounted and anchored similar to the first tie-in block; that said brick lining comprises a pair of identical recessed bricks each of which has the general shape of a rectangular solid having a recess complementary to a respective shoulder portion of said tie-in blocks, said pair of bricks being disposed so that the recess of one brick hugs and has interlocking relationship with a shoulder portion of the one tie-in block while the other brick hugs and has interlocking relationship with a shoulder of the other tie-in block in a manner whereby the recesses of the bricks face away from each other; and that refractory filler means are provided for locating each of said recessed bricks in place, said filler means being applied to the side of each brick opposite its recess and following the placing of said recessed bricks to interlock with said shoulders.

4. A furnace wall structure according to claim 3, in which the filler means comprise substantially rectangular bricks.

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