

Feb. 7, 1933.

M. FRISCH ET AL
FURNACE FLOOR STRUCTURE

1,896,669

Filed Aug. 16, 1930

2 Sheets-Sheet 1

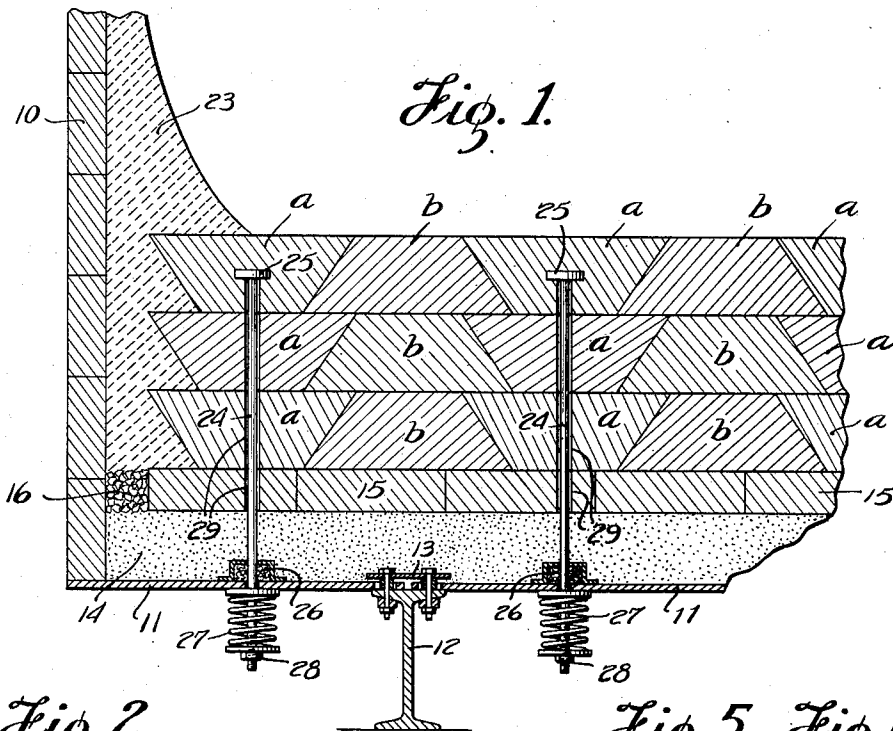


Fig. 2.

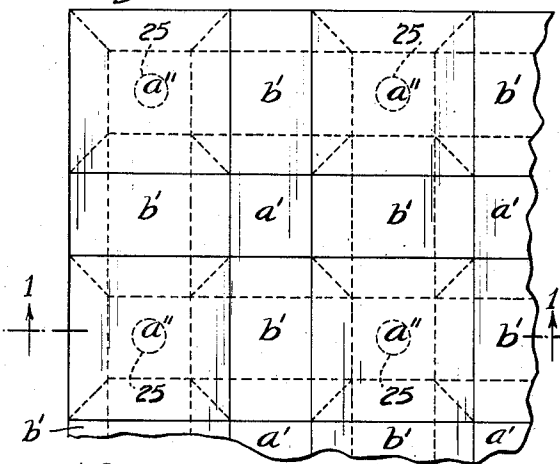


Fig. 3.

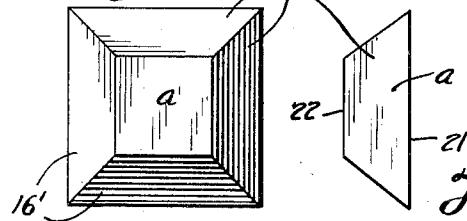


Fig. 4.

Fig. 5. Fig. 6.

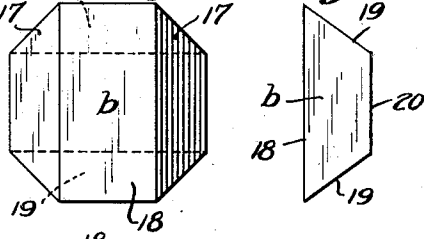


Fig. 7.

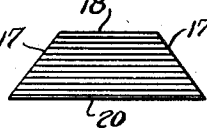
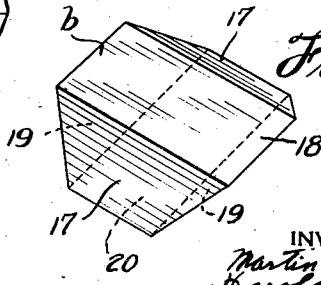


Fig. 8.



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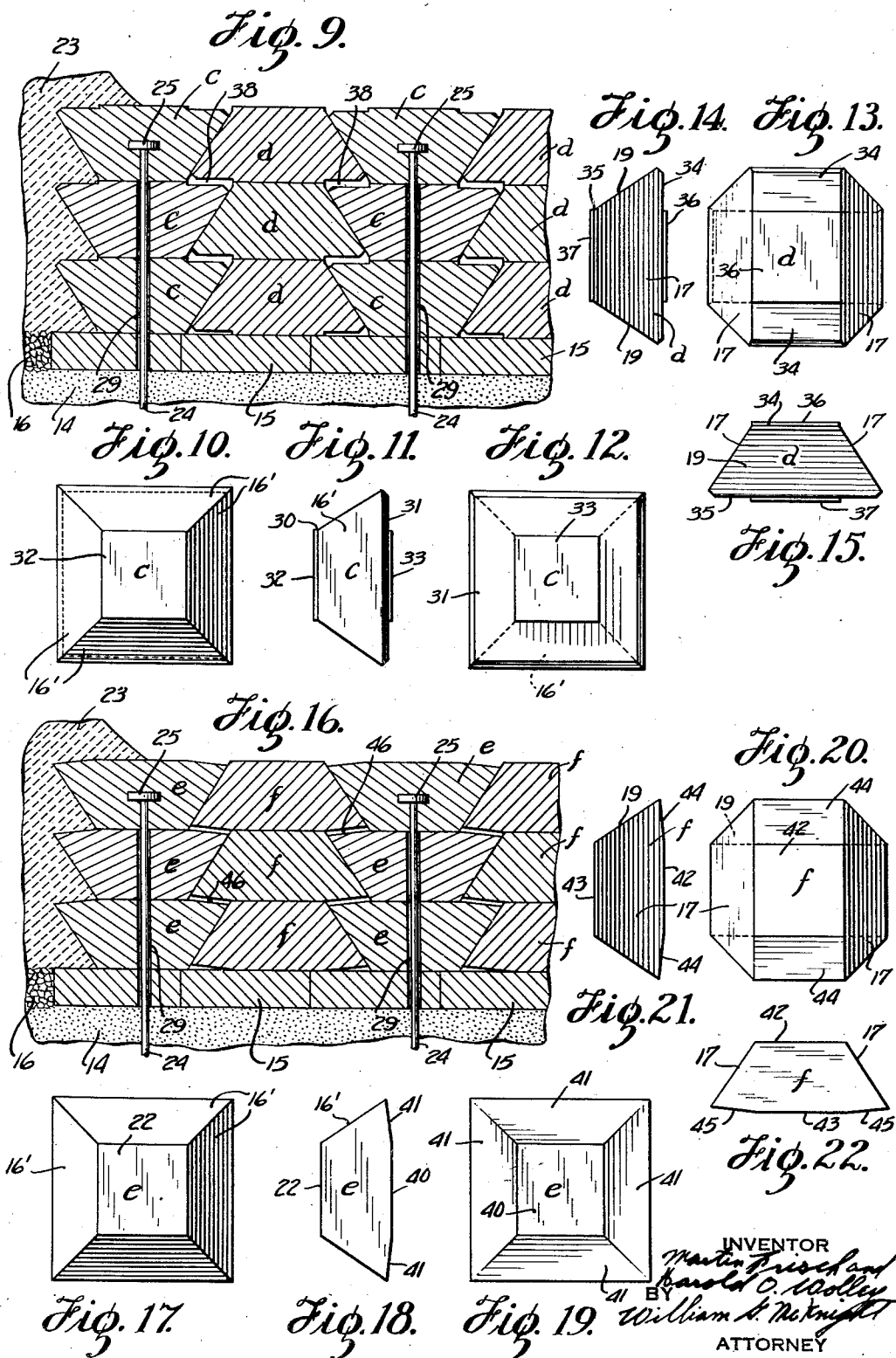
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FURNACE FLOOR STRUCTURE

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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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FURNACE FLOOR STRUCTURE

Application filed August 16, 1930. Serial No. 475,744.

This invention relates to wall structure of furnaces and more particularly to floor structure of furnaces in which slagging is likely to occur.

5 Heretofore the floors of such furnaces have ordinarily been constructed of layers of refractory material, each layer consisting of a plurality of tile blocks having their sides perpendicular to the top and bottom surfaces
10 of the blocks. It has been the practice to space the blocks in each layer to make the necessary provision for expansion. On repeated heating and cooling of the furnace structure, slag has run into the spaces between the blocks and the expansion of the
15 blocks together with the expansion of the slag in the joints has caused the floors to intermittently grow or work sideways. This growth or cumulative expansion of the floors
20 has usually resulted in the pushing outwards of the furnace retaining walls, which, in the case of boiler furnaces, usually include water tubes, which are thus distorted. In an effort to obtain a slag tight floor and thus avoid
25 the damaging effects or cumulative expansion of the floors, insufficient clearance between the blocks has sometimes been provided. But such inadequate clearances cause the floors to buckle and break up and on re-
30 heating, slag runs into the resultant fissures with the result that the floor expands cumulatively as it does when ample clearances are provided between the blocks as above mentioned.

35 The present invention overcomes the difficulties of cumulative expansion inherent in prior furnace wall or floor structures by providing a structure in which the expansion effect thereof is translated into lines of force
40 normal or perpendicular to the surface of the wall or floor instead of parallel therewith so that, for example, horizontally arranged floor units move in a vertical direction relative to one another instead of in a horizontal
45 direction as in prior practice. This arrangement takes care of localized expansions, or the expansion of individual sections of a floor, rather than conveying such expansion to the entire floor structure cumulatively, and
50 also provides a structure in which relative

movement of the floor units will be such as to maintain an essentially slag tight contact between the units.

The objects and characteristics of the invention will be apparent from the following
55 description taken in connection with the accompanying drawings, forming a part thereof, in which:

Fig. 1 is a vertical sectional view through a portion of a slagging furnace floor taken substantially on line 1—1 of Fig. 2;

Fig. 2 is a plan view of a portion of the floor, showing the manner in which the floor blocks are assembled;

Fig. 3 is a plan view of one of the floor
65 blocks or units;

Fig. 4 is a side view of the block shown in Fig. 3;

Fig. 5 is a plan view of another form of floor block or unit;

Fig. 6 is a side view of the block shown in Fig. 5;

Fig. 7 is an end view thereof;

Fig. 8 is a view in perspective of the floor
75 block shown in Fig. 5;

Fig. 9 is a vertical sectional view through a portion of a furnace floor assembled from modified forms of blocks;

Figs. 10, 11 and 12 are top plan, side elevation and bottom plan views respectively
80 of a modified form of the block shown in Figs. 3 and 4;

Figs. 13, 14 and 15 are top plan, side elevation and end elevation views respectively
85 of a modified form of the block shown in Figs. 5 to 8 inclusive;

Fig. 16 is a vertical sectional view through a portion of a furnace floor assembled from other modified forms of blocks;

Figs. 17, 18 and 19 are top plan, side elevation and bottom plan views respectively
90 of another modified form of the block shown in Figs. 3 and 4, and

Figs. 20, 21 and 22 are top plan, side elevation and end elevation views of another
95 modified form of the block shown in Figs. 5 to 8 inclusive.

Like reference characters indicate like parts throughout the several views.

Referring to the drawings, Fig. 1 shows
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a portion of a furnace having a side wall 10 which may or may not include boiler tubes and a floor supported by steel plates 11. Plates 11 are in turn supported by suitable
 5 frame work indicated at 12, tie members 13 being provided to hold the plates in position while permitting freedom of expansion and contraction of the plates under the influence of the heat of the furnace. The structure comprising plates 11 and their supporting members forms what may be termed the foundation of the furnace structure. A layer of sand 14 is preferably placed on the steel plates 11 and on the sand a layer of
 10 bricks 15 of suitable insulating material is laid. The space between the layer of bricks 15 and the side wall 10 of the furnace may be conveniently filled with cement, gravel or other suitable packing material 16.

15 Above the layer of insulating bricks 15, one or more layers of suitable refractory material are placed, each of which layers consists of a plurality of floors blocks or units which are constructed in accordance with the present invention. This refractory material comprises the furnace lining. Each layer consists of a plurality of blocks or units of tile or other suitable refractory material of two separate forms or shapes, both
 20 of which are provided with parallel top and bottom surfaces and bevelled sides. By the expression "bevelled side" as used herein is meant a side lying in a plane which is disposed at an angle to the planes of the top and bottom surfaces of the floor block. Due to the fact that the structure chosen for illustration purposes, and which is herein described, is a furnace floor, we have used the terms "top" and "bottom" as descriptive of
 25 the parallel surfaces of the blocks, but it is to be understood that the terms "top" and "bottom" are employed in their relative sense only and not in their absolute sense. Obviously if structure embodying the invention is applied to the vertical side wall the surfaces herein described as "top" and "bottom" become "inner" or "outer" surfaces with respect to the furnace.

One form of block of the preferred configurations, indicated *a* and shown in Figs. 3 and 4, is preferably of frusto-pyramidal configuration having a top surface 22 which is flat and square, a bottom surface 21 which is also flat and square and the edges of which
 30 are twice the length of the edges of surface 22, and bevelled flat sides 16' extending at an angle of 45° to the planes of the top and bottom surfaces, as shown.

Another form of block of the preferred configurations, indicated *b* and shown in Figs. 5 to 8 inclusive, is provided with similar rectangular top and bottom surfaces 18 and 20, the longer extent of one surface being at right angles to the longer extent of the other
 35 surface, the long edge being of the same

length as the edge of surface 21 of block *a* and the short edge of the same length as the edge of surface 22 of block *a*, and bevelled sides, the opposite sides 17 of which lie in planes which converge above the top surface 18, and the opposite sides 19 of which lie in planes converging below the bottom surface 20 thereof.

The two forms of blocks *a* and *b* are assembled to form a furnace floor structure in the manner shown in Fig. 2 of the drawings. Block *a* is laid on its bottom surface 21 in the position indicated *a'* in Fig. 2, after which blocks *b* are laid either on their top or bottom surfaces 18 or 20 in the positions indicated at *b'* in Fig. 2, with the bevelled sides of the blocks *a* and *b* in contact. Blocks *a* are then laid on their top surfaces 22 in the positions indicated *a''* in Fig. 2, with their bevelled sides in contact with the bevelled sides of blocks *b*. In this manner the entire furnace floor structure is assembled with the blocks *a* and *b*. The floor may consist of one layer of these blocks or a plurality thereof as shown in Fig. 1.

The spaces between the edges of the floor structure and the side walls 10 of the furnace are preferably filled with suitable plastic refractory material 23.

In order to keep the bevelled sides of the blocks in contact with each other during expansions and contractions of the floor, and thus prevent the entrance of slag in between the blocks, suitable ties or retaining members 24 are provided, each of which has one end 25 anchored to a block *a*, Fig. 1, the other end of each retaining member preferably passing through a sealing ring 26 secured to steel plate 11 and through a suitable compression spring 27 retained in position between the end thereof and plate 11 by a nut 28. The blocks and insulating bricks 15, positioned below the blocks *a* to which are anchored the ends 25 of retaining members 24 are provided with suitable apertures 29 to permit the retaining member 24 to move freely there-through.

With this arrangement it will be apparent that regardless of the temperature variations in the furnace, the floor units or blocks will remain in contact and will thus prevent the entrance of slag in between the blocks with the consequent objectionable results due to cumulative expansion heretofore pointed out. By reason of the bevelled contacts between the floor blocks, expansions in a horizontal direction will result in movement of the blocks in a vertical direction; but this movement is resisted and limited by the forces imposed by the ties heretofore described. It may be said that the contacting sides of adjacent blocks are reciprocally bevelled. In any layer, as seen in Fig. 1, upon the arising of horizontal compression forces, the blocks

a, will creep up on the blocks *b*. Thus, although the floor layers may separate, the surfaces of contact between each block and the blocks adjacent thereto will always be maintained and prevent the entrance of slag between the blocks.

Localized expansions may be taken care of in horizontal floor structures so as to permit the vertical displacement of some of the blocks with respect to the blocks adjacent thereto in the same layer without a separation of the layers of the floor structure, or with a delayed separation thereof, by assembling the floor structure from blocks of the configurations indicated *c* and *d* or *e* and *f*.

Block *c* is of substantially frusto-pyramidal configuration and is identical with block *a*, with the exception that the top and bottom surfaces 30 and 31 of block *c* are each provided with a central rectangular projection 32 and 33, and with the further exception that the peripheral edges of the bottom surface 31 are slightly bevelled as shown. The projection 32 on the top of block *c* is co-extensive with the top surface thereof and extends from the top surface of the block a distance equal to half the distance it is desired the block be displaced with respect to the blocks with which it is in contact in the same layer before any separation of the layers takes place. The rectangular projection 33 which extends from the bottom surface 31 of block *c* is centrally located with respect thereto and is in area equal to the area of projection 32 and extends from the bottom of the block the same distance the projection 32 extends from the top of the block, that is, a distance equal to half the distance the block is designed to be displaced with respect to the blocks with which it is in contact in the same layer before any separation of the layers takes place.

Block *d* is identical in form with block *b* with the exception that the top and bottom surfaces 34 and 35 of the block *d* are each provided with central rectangular projections 36 and 37 which are equal in area to the projections 32 and 33 on block *c* and extend from the top and bottom surfaces of the block *d*, a distance equal to the distance the projections 32 and 33 extend from the block *c*, and with the further exception that the end edges of the top and bottom surfaces 34 and 35 are slightly bevelled, as shown, to provide for movement of the blocks relative to each other when they are assembled into a floor structure.

The blocks *c* and *d* are assembled into a furnace floor structure in the same manner the blocks *a* and *b* are assembled, it being merely necessary to substitute block *c* for block *a* and block *d* for block *b* in the arrangement shown in Fig. 2. As thus assembled, as clearly shown in Fig. 9, the bevelled sides of each of the blocks *c* and *d* are in contact with the bevelled sides of adjacent blocks in the

same layer, but because of the projections on the top and bottom surfaces of each of the blocks, each block is in contact only with the blocks in other layers which are immediately above or immediately below it. Thus, when the blocks are subjected to the heat of the furnace and expand, the blocks *c*, for example, will expand laterally and will creep up on, or be displaced in a vertical direction with respect to, the blocks *d* as in the case with the floor structure assembled from the blocks *a* and *b*, but by reason of the spaces 38 between overhanging portions of the blocks *c* and *d*, the layers will not be separated until the blocks *c* have been displaced with respect to the blocks *d*, a distance equal to the extent of the space between the said overhanging portions of the blocks *c* and *d*. With this arrangement it will be seen that the layers of blocks are not separated at all due to the expansion of the blocks, or will only be separated after a period of time which depends on the extent of the relief space between the overhanging portions of the blocks and which in turn is determined by thermal conditions and the extent to which the projections 32, 33, 36 and 37 extend from the top and bottom surfaces of the blocks *c* and *d*.

Vertical displacement of the blocks in one of the layers of a horizontal floor structure with respect to the blocks with which it is in contact in the same layer without a separation of the layers or with a delayed separation thereof, may also be obtained by utilizing blocks of the configurations indicated *e* and *f* for the floor structure.

Block *e* is of substantially frusto-pyramidal configuration and is identical with block *a* with the exception that the bottom surface 40 of block *e* is bevelled in its perimetrical zone as indicated at 41. The bottom surface 40 of the block *e* has a central rectangular plane portion which is co-extensive with the top surface 22 of the block and the perimetrical zone which is bevelled extends from the perimeter of this central rectangular plane portion to the edges of the bottom of the block.

The block *f* is identical with block *b*, with the exception that the top and bottom surfaces 42 and 43 of the block *f* have their end portions bevelled as indicated at 44 and 45. The top and bottom surfaces 42 and 43 of block *f* each has a central rectangular plane portion which is co-extensive with the top surface 22 of block *e* and the end portions of these surfaces which are bevelled, lie in the zone between the perimeters of these central rectangular plane portions and the edges of the top and bottom surfaces of the block.

The blocks *e* and *f* are assembled into a furnace floor structure in the same manner the blocks *a* and *b* are assembled with blocks *e* substituted for blocks *a* and blocks *f* substituted for blocks *b* in the arrangement shown

in Fig. 2. As thus assembled, the bevelled surfaces of each block are in contact with the bevelled surfaces of the adjacent blocks in the same layer and each block is in contact only with the blocks in other layers which are immediately above or immediately below it. It will be apparent that because of the beveling of the top and bottom surfaces of the blocks *e* and *f* which provides the spaces 46 between the blocks *e* and *f* when assembled into a floor structure (these spaces providing a type of local relief comparable with that provided by spaces 38), the expansion of the blocks under the influence of the heat of the furnace and the displacement of the blocks *e* relative to the blocks *f* will result in no separation of the layers of the blocks or will result in a delayed separation thereof. The extent of the delay in the separation of the layers of the blocks will depend of course upon the degree to which the top and bottom surfaces of the blocks *e* and *f* are beveled which determines the extent of the spaces 46 between the blocks *e* and *f*.

In floor or wall structures assembled from blocks of the configuration *c* and *d* or *e* and *f*, contact is maintained between the blocks not only on the bevelled sides but also over a substantial portion of the bottoms and tops of the blocks.

From the foregoing description, it will be apparent that the furnace lining is divided into two distinct portions, one portion of which comprises a plurality of blocks resiliently anchored to the foundation of the furnace wall structure by means acting to restrain movement of this portion of the lining toward the furnace. The second portion of the lining comprises a plurality of blocks contacting the blocks comprising the first portion along oblique surfaces of contact and so arranged that the blocks of the first portion act to maintain the blocks of the second portion in position while at the same time, under the influence of expansion forces, having relative movement with respect to the blocks comprising the second portion in a direction substantially normal to the plane of the face of the lining, whereby to relieve the lining from expansion stresses.

The form of invention herein shown and described is to be considered a preferred form only, and it is understood that the invention is not to be limited to the specific structure set forth.

Having thus described our invention, what we claim is:

1. A furnace lining structure comprising a plurality of blocks in relatively sliding contact with respect to each other, each of said blocks having an oblique side in contact with an oblique side of an adjacent block.

2. A furnace lining structure comprising a plurality of blocks in relatively sliding contact with respect to each other, each of said

blocks having sides in contact with oblique sides of adjacent blocks.

3. A furnace lining structure comprising a plurality of layers of blocks, the blocks in each layer being in relatively sliding contact with respect to each other and having bevelled sides in engagement with reciprocally bevelled sides of other blocks in the same layer.

4. A furnace floor structure comprising a plurality of blocks adapted to slide with respect to each other and having bevelled sides so arranged that the contact between adjacent blocks is on reciprocally bevelled surfaces.

5. A furnace floor structure comprising a plurality of blocks in relatively sliding contact with respect to each other, each block having bevelled sides, each side being in contact with a bevelled side of an adjacent block and means for maintaining the blocks in contact with each other.

6. A furnace floor structure comprising a plurality of blocks in relatively sliding contact with respect to each other, each block having a bevelled side in contact with a bevelled side of an adjacent block and means including a yielding member for maintaining the blocks in contact with each other.

7. A horizontal floor structure comprising a plurality of superimposed layers of refractory material, each layer consisting of a plurality of blocks having bevelled sides in contact with bevelled sides of adjacent blocks, and means engaging the uppermost layer of refractory material for restraining vertical movement of the blocks.

8. A horizontal furnace floor structure comprising a plurality of superimposed layers of refractory material, each layer consisting of a plurality of blocks having bevelled sides in contact with bevelled sides of adjacent blocks, and means including a yielding member engaging the uppermost layer of refractory material for restraining vertical movement of the blocks.

9. As a new article of manufacture, a unit for furnace linings comprising a block of refractory material of frusto-pyramidal configuration.

10. As a new article of manufacture; a unit for furnace linings comprising a refractory block having top and bottom surfaces lying in parallel planes and having converging bevelled sides joining said surfaces.

11. A furnace floor unit comprising a block having top and bottom surfaces lying in parallel planes and having sides lying in planes converging above the top surface of the block, the planes of said sides intersecting said top surface in non-parallel lines.

12. A refractory unit for furnace floors comprising a block having top and bottom surfaces and having oblique sides lying in planes converging above the top surface of

the block, said planes intersecting the top surface of the block in lines lying substantially at right angles to each other.

13. A furnace floor unit comprising a block having top and bottom surfaces and having two opposite sides lying in planes converging above the top surface of the block and two other opposite sides lying in planes converging below the bottom surface of the block.

14. A horizontal furnace floor structure comprising a plurality of contacting blocks having reciprocally bevelled surfaces of contact so arranged that expansion of the blocks will cause them to move relatively to one another in a substantially vertical direction.

15. A section of a furnace floor comprising a block having parallel square top and bottom surfaces, the top surface being of smaller area than the bottom surface, and straight oblique sides at 45° angle to the top and bottom surfaces, a second block of the same construction placed in inverted position with respect to the first block and arranged diagonally with respect thereto, and two blocks having parallel rectangular top and bottom surfaces, the greater extent of one rectangular surface extending at right angles to the greater extent of the other rectangular surface, and sides connecting the rectangular surfaces at 45° angle thereto, blocks with rectangular surfaces being arranged one to each side of each block with square surfaces and with the sides of the blocks in contacting relation.

16. A horizontal furnace floor comprising a layer of blocks in relatively sliding contact with respect to each other, alternate blocks having bevelled sides converging below the blocks and intermediate blocks having reciprocally bevelled sides, whereby horizontal compression forces cause said alternate blocks to creep up on said intermediate blocks.

17. A furnace lining structure comprising a layer of blocks in relatively sliding contact with respect to each other, said blocks being arranged in rows extending in a plurality of directions, alternate blocks in each row having oblique sides and intermediate blocks in each row having reciprocally oblique sides whereby compression forces in the direction of any row cause said alternate and said intermediate blocks to move with respect to each other in a direction substantially normal to the face of said lining.

18. A furnace lining structure comprising a layer of blocks in relatively sliding contact with respect to each other, said blocks being arranged in two rows substantially at right angles to each other, alternate blocks in each row having oblique sides and intermediate blocks in each row having reciprocally oblique sides, whereby compression forces in the direction of any row cause said alternate

and said intermediate blocks to move relative to each other in a direction substantially normal to the face of said lining.

19. A furnace comprising a framework, steel plates carried by said framework, floor supporting material carried by said plates, and floor structure carried by said floor supporting material, comprising a plurality of superimposed layers of horizontally disposed interfitted refractory blocks, some of said blocks having plane parallel square top and bottom surfaces, the bottom surface being one-fourth the area of the top surface, and oblique plane sides at an angle at 45° to the top and bottom surfaces, other of said blocks being similar to the first mentioned blocks, but inverted with respect thereto, intermediate blocks having top and bottom surfaces of rectangular form with the greater extent of the one surface extending at right angles to the greater extent of the other surface and having oblique sides at 45° to the top and bottom surfaces, all of said blocks being arranged so that the oblique surfaces contact each other, retaining members secured in some of the blocks of the type having a smaller area of lower surface than upper surface and extending through said steel plates, and elastic members reacting against said retaining members and said steel plates to urge the blocks toward the steel plates.

20. A block having top and bottom surfaces and bevelled sides and having central projections extending from the top and bottom surfaces.

21. A furnace floor unit comprising a block of refractory material of substantially frusto-pyramidal configuration and having a projection extending therefrom.

22. A furnace floor structure comprising a plurality of superimposed layers of blocks, each block having a top and bottom surface and bevelled sides, each block being in contact only with adjacent blocks in the same layer and with the blocks in other layers immediately above and below each of said blocks.

23. A furnace floor structure comprising a plurality of superimposed layers of blocks, each block having a top and bottom surface and bevelled sides, and spacing projections extending from the top and bottom surfaces of each block, each block being in contact only with reciprocally bevelled sides of adjacent blocks in the same layer and with the projections extending from the blocks in other layers.

24. A furnace floor structure comprising a plurality of superimposed layers of refractory material, each layer consisting of a plurality of blocks, each block having a top and bottom surface and bevelled sides, and spacing projections extending from the top and bottom surfaces of each block, each block in each layer having its bevelled sides in

contact with the reciprocally bevelled sides of adjacent blocks in the same layer and having its projections in contact with the projections of the blocks in other layers whereby spaces are provided between portions of each block and the portions of the blocks in other layers which extend into the zones of each of the said blocks to provide a delayed separation of the layers of refractory material upon expansion of the blocks.

25. A furnace floor unit comprising a block of substantially frusto-pyramidal configuration having the peripheral zone of its bottom surface bevelled.

26. A furnace floor unit comprising a block having top and bottom surfaces and bevelled sides and having the end portions of one of said surfaces bevelled.

27. A furnace floor unit comprising a block having top and bottom surfaces and bevelled sides and having a portion of one of said surfaces bevelled.

28. A furnace floor structure comprising a plurality of superimposed layers of blocks, each block having top and bottom surfaces and bevelled sides and having portions of one of said surfaces bevelled, the blocks in each layer having their bevelled sides in contact with the bevelled sides of adjacent blocks in the same layer and having the unbevelled portions of their surfaces in contact only with the unbevelled portions of the surfaces of blocks in other layers.

29. A furnace floor structure comprising a plurality of superimposed layers of refractory material, each layer consisting of a plurality of blocks having top and bottom surfaces and bevelled sides, a portion of one of said surfaces being bevelled, the bevelled sides of the blocks in each layer being in contact with the bevelled sides of adjacent blocks in the same layer, the unbevelled portions of the surfaces of each block in a given layer being in contact only with the unbevelled portions of the surfaces of adjacent blocks in other layers whereby spaces are provided between the bevelled surfaces of the blocks in adjacent layers to provide a delayed separation of the layers of blocks under the influence of the heat of the furnace.

30. In a furnace wall structure, means providing a foundation and means providing a refractory lining, said lining comprising a first portion resiliently anchored to said foundation and a second portion adjacent to said first portion, said portions having adjacent oblique contact surfaces arranged so that said first portion maintains said second portion in position, the resilient anchorage of said first portion permitting movement thereof with respect to said second portion toward the furnace upon expansion of said lining under the influence of furnace heat.

31. In a furnace wall structure, means providing a foundation and means providing a

refractory lining, said lining comprising a first portion including a plurality of separate refractory blocks and a second portion comprising a plurality of separate refractory blocks, elastic means for urging the blocks of said first portion toward said foundation, the blocks of said first portion and said second portion having oblique contact surfaces and the blocks of the second portion being arranged with respect to the blocks of the first portion so as to be retained in position by the blocks of the first portion, said oblique contact surfaces causing relative movement of the two portions with respect to each other in a direction substantially normal to the face of the lining due to the expansion of the lining under the influence of furnace heat.

32. In a furnace wall structure, means providing a foundation, a furnace lining comprising a plurality of spaced blocks, means for elastically anchoring each of said blocks to said foundation, and a plurality of intermediate blocks between said first mentioned blocks, said blocks having oblique surfaces of contact and said surfaces being arranged so that expansion of the blocks in the plane of the lining causes movement of said first named blocks toward the furnace against the resistance of the elastic anchoring means.

In testimony whereof we have affixed our signatures.

MARTIN FRISCH.
HAROLD O. WOOLLEY.

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