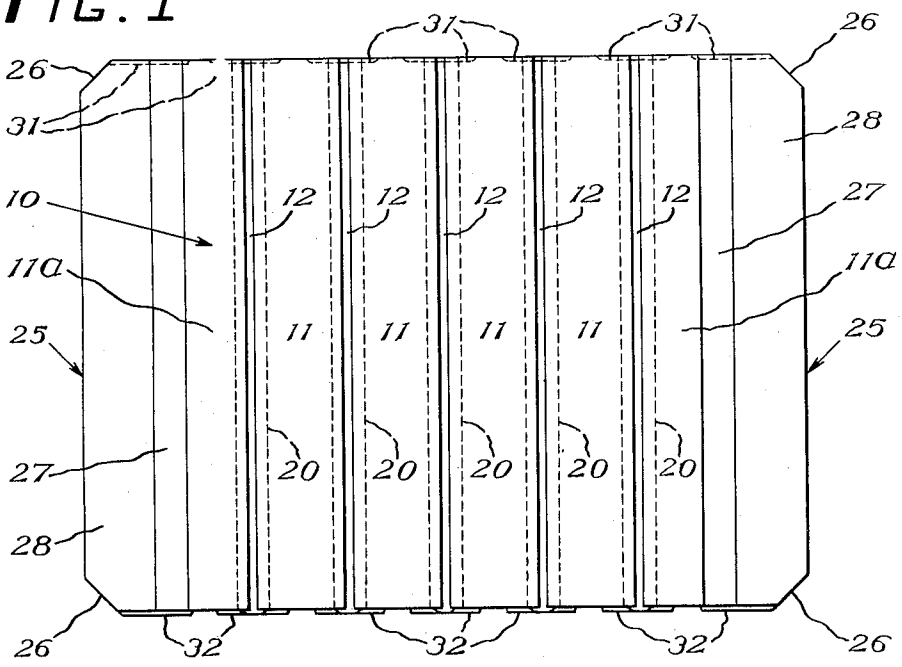
July 18, 1950 L. H. MILLIGAN 2,515,416

BATT

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FIG. 1



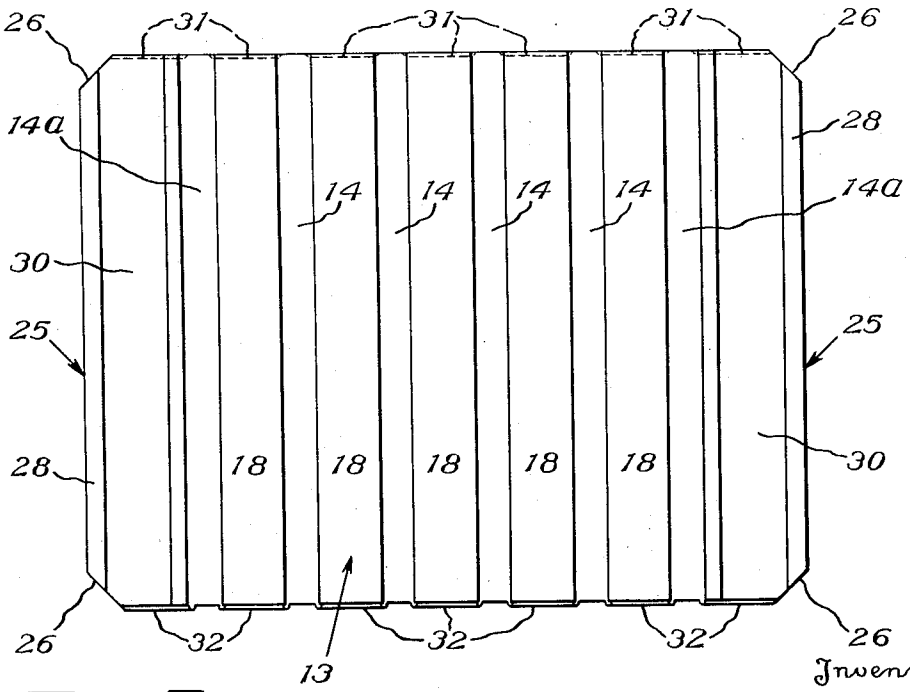


FIG. 2

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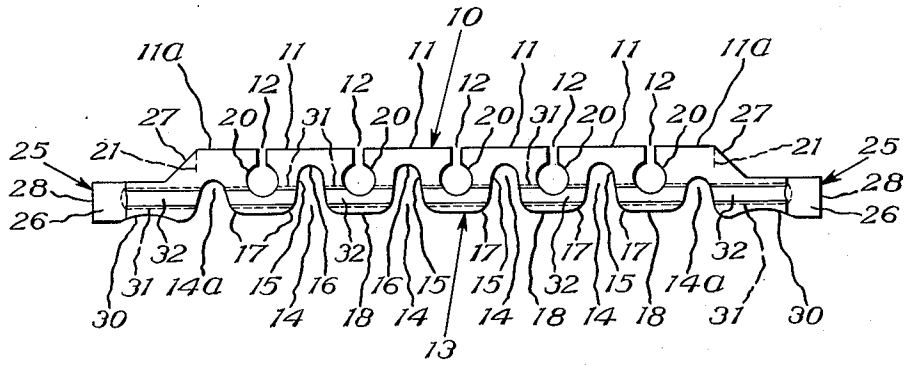
By George Crampton Attorney

July 18, 1950 L. H. MILLIGAN 2,515,416

BATT

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FIG. 3



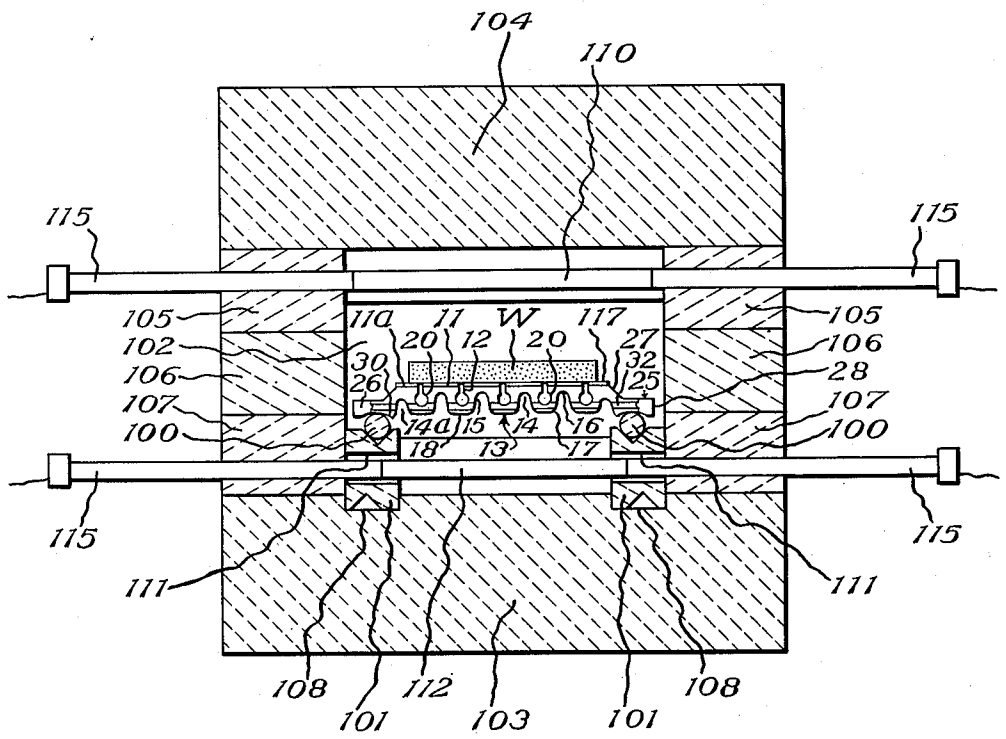


FIG. 4

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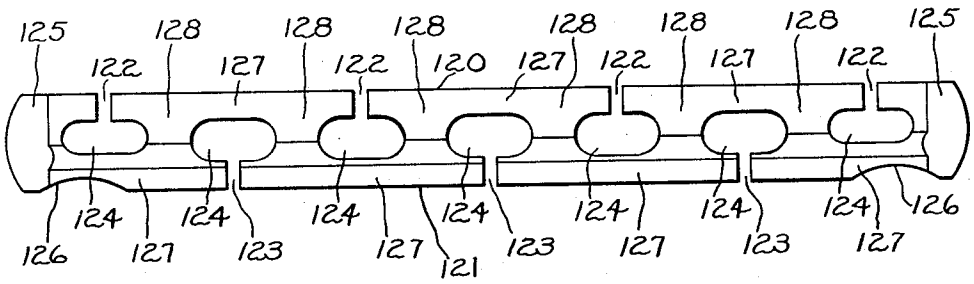


FIG. 5

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UNITED STATES PATENT OFFICE

2,515,416

BATT

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5 Claims. (Cl. 25—153)

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The invention relates to batts for use in kilns, furnaces and the like.

One object of the invention is to provide a refractory batt capable of withstanding intense thermal shock. Another object of the invention is to provide a refractory batt capable of withstanding irregular heating or cooling of high differential, that is where one part of the batt is at a different temperature from that of another part. Another object of the invention is to provide a batt which is mechanically strong, resistant to heat shock and thermal differential and which readily conducts heat.

Another object of the invention is to provide a batt particularly applicable for use where the batt itself is the moving carrier for the ware. Another object of the invention is to provide a batt which can be pushed through a kiln supported by spaced parallel rods. Another object is to provide a batt of the character indicated which can be pushed through a kiln having zones of sharp rise and drop in temperature without fracturing. Another object of the invention is to provide a refractory batt for use in a kiln provided with sources of heat above and below the batt, the ware being carried on the batt and the batt being supported solely at the ends thereof. Another object of the invention is to provide a batt of the character indicated of long life. Another object is to provide a long-life batt of large size. Another object is to provide long-life batts for building stands of ware that are to be heated and cooled from the directions of the edges of the batts.

Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements and arrangements of parts all as will be illustratively described herein and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings illustrating one of many possible embodiments of the mechanical features of this invention,

Figure 1 is a top plan view of a batt constructed in accordance with the invention,

Figure 2 is a bottom plan view of the batt,

Figure 3 is an end view of the batt,

Figure 4 is a sectional view through a tunnel kiln showing the batt with ware on it therein, illustrating a use of the batt which markedly improves the operation of such a kiln,

Figure 5 is an end view of a batt illustrating another embodiment of the invention.

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As conducive to a clearer understanding of the present invention, a batt is a plate or other shape to hold ceramic or other ware during a heating operation. Thus, for example, "green" ceramic articles, such as unfired molded spark plugs, dishes or grinding wheels are placed on batts which are then put into or passed through a kiln, and the spark plugs, grinding wheels or dishes are fired, that is to say, vitrified. The batt is therefore necessarily a refractory article.

Many ceramic manufacturers have estimated the cost of batts on the total cost of their product and in practically all cases it has been found that the cost of batts is a large percentage of the cost of manufacturing the ceramic product which is sold. This is so because there is not merely a first cost of the batts but the cost of continually replacing batts. A batt is cold when it is placed in a kiln but becomes heated to the firing temperature or temperatures, usually high, in the kiln, then it is allowed to cool or may be rapidly cooled by special means such as blowing air on it, and later on, after becoming cold, it is used again to support more "green" ware and is again heated, allowed to cool, and so on. Batts do not indefinitely survive this alternate heating to high temperatures and cooling even if the temperature gradients are gentle. Eventually the batts break or crack and while a cracked batt may be used, it eventually becomes a broken batt and thereafter is useful if at all only for smaller pieces of ware, and eventually, after further cracking or breaking, not at all. The foregoing being true even when the slope of the temperature-time curve is very slight, it is all the more true and the percentage of the cost of batts to the total cost of manufacture of the product is much greater when the slope of the temperature-time curve is steep.

For some time past, tunnel kilns have been replacing periodic kilns and in the tunnel kilns the slope of the temperature-time curve is steeper than in the periodic kilns, and efforts have continually been made to steepen the slopes of these curves in order to obtain greater production and in order that the manufacturer may fill orders more promptly. A particular type of tunnel kiln having a very steep temperature-time curve is illustrated in cross-section in Figure 4; in this kiln, as will be more clearly explained hereinafter, the batts themselves constitute the slowly movable conveyers for the ware. Thus a batt at the entrance end of a kiln receives thrust from a ram or the like and pushes the batt ahead of it, which pushes the batt next ahead,

which pushes the batt next ahead and so on until we reach the batt emerging from the tunnel. To the disruptive forces of thermal shock is added mechanical strain tending to break such batts. Kilns of the type shown in Figure 4 have successfully made small articles such as small grinding wheels utilizing narrow batts but it is desired to vitrify larger grinding wheels in such kilns to do which calls for the use of wider batts. The use of such wider batts in kilns of the type indicated in Figure 4 has been found to result in such large increase of batt breakage as greatly to increase the proportion of cost of batts to the total cost of manufacturing the grinding wheels. Furthermore, utilizing plain batts in such kilns many batts have broken in the kiln thus clogging or jamming the kiln and necessitating a shut-down, which is expensive.

Batts are customarily made of materials that are matured to a strong condition at temperatures higher than those experienced by the batt in use. This gives a product having maximum stability in use against change in dimensions, etc. It is advantageous to employ materials of as low expansivity as feasible so as to reduce the amount of dimensional change and resulting stress as a function of temperature change. Batts and other kiln furniture have long been made of refractory fire clays. These give products of satisfactory expansivity characteristics but of relatively low strength and low heat conductivity. Silicon carbide as the main ingredient of batt mixtures gives improved products because in addition to low expansivity they have high strength and high heat conductivity. Likewise, batts composed of mullite which mullite may have been essentially originally of the electric furnace fused variety, or may have been developed by the maturing operation to which the batt was subjected in manufacture, have advantages over fire clay batts. Furthermore, refractory batts for very high temperature use may now be made as sintered or recrystallized products, often substantially bondless, many of which may be classed as pure oxide refractories. This invention, although described particularly for silicon carbide products, is also advantageous when embodied in batts composed of other refractory materials.

As an example of a bonded silicon carbide composition for batts according to the present invention, I may make a mixture according to the following formula:

Example

Material:	Parts by weight
No. 14 to No. 24 grit size silicon carbide	45
No. 30 to No. 90 grit size silicon carbide	25
No. 100 grit size and finer silicon carbide	18
Ball clay	12
Dextrine powder	2
Rye flour	1
Water	4
Total	107

The silicon carbide is the ordinary black grade and is put into a mixing machine of conventional type and the dextrine is added. After mixing for a minute or two the water is added and mixing is continued for a minute or two more. Then the ball clay and rye flour are screened into the mix together and the mixing

is continued for five minutes more. This procedure produces a damp granular mixture that is suitable for tamping or pressing.

Referring now to Figure 3, a batt according to this invention has a plane side 10 comprising as better shown in Figure 1 a plurality of plane rectangular portions 11 separated by straight slots 12. As shown, the rectangles of the portions 11 are identical and this is a preferred construction, but the rectangles of the end portions 11*a* are shown as narrower although here again they might be identical with the other rectangles.

The other side 13 of the batt is parallel to side 10, but the side 13 has a plurality of deep grooves 14 which are straight and parallel to the slots 12 but are in staggered relation with them as clearly shown in Figure 3. The grooves 14 have nearly parallel side walls 15 and rounded bottoms 16; they merge by way of rounded shoulders 17 with plane rectangular portions 18 which are like unto the portions 11 and of equal length therewith but not so wide. The grooves 14 are of a depth to extend beyond the level of the slots 12 or may be so, except that as shown the grooves 14*a* which are outside or beyond the slots 12 are of lesser depth. Between the grooves 14 and between the grooves 14*a* and merging with the slots 12 under them are bores 20, which may be cylindrical but might be of other shapes such as polygonal in cross section. These bores 20 are parallel to each other and to the grooves 14 and they extend through the entire width of the batts. This term "width" to save confusion is used in this specification to indicate the dimension along which the batts are propagated, and in Figures 1 and 2 this dimension is indicated as less than the dimension at right angles thereto which for convenience will be termed the length of the batts, but so far as the invention is concerned, the dimension in the direction of the bores 20 might be greater than the dimension of the batts parallel to the faces perpendicular to the bores 20.

The foregoing construction makes an accordion construction with the pleats in the direction of the thickness of the batts to permit expansion and contraction without breakage in the direction of the length of the batts. Furthermore, it will be seen that the face 10 has a total plane area very large in proportion to its total area by reason of the width of the portions 11 as compared to the narrowness of the slots 12. This face or side 10 is thus readily adapted to receive ware. On the other hand, the face or side 13 has a total plane area which is somewhat less than half of the total area of the face or side; this will ordinarily be the underside of the batt.

So far as the use of the batt for the vitrifying of many kinds of ware is concerned and so far as the use of the batt in many types of kilns is concerned, in the direction of length the batt might terminate at the dotted lines 21 in Figure 3, these dotted lines representing plane rectangular edges of the batt. However, for the preferred construction of the batt for use in a tunnel kiln of the type indicated in Figure 4, I preferably provide the following additional portions and features, it being understood that all portions of the batt are preferably portions of one integral piece.

Thus I provide extensions 25, 25 on the ends of the batt which are generally rectangular in plan view although they may have truncated corners 26 and which are of a length in the direction of the width of the batts the same as the

rest thereof. These extensions involve sloping portions 27 on the upper side so that the portions 28 exterior thereof shall be relatively thin. On the underside of the extensions 25 are shallow wide grooves 30. Furthermore, I preferably provide a groove 31 on one thick edge of the batt and a tongue 32 on the other thick edge of the batt.

Referring now to Figure 4, a batt as above described is shown having its extensions 25 resting on refractory rods 100 laid in grooves of refractory supporting members 101 located at the bottom of a kiln tunnel 102. The kiln tunnel 102 may be formed by a large refractory bottom 103 and a large refractory top 104 separated on each side by bricks 105, 106 and 107. Grooves 108 are provided in the bottom 103 to locate the members 101 adjacent the bricks 107. The tunnel 102 is a long tunnel whose length is approximately perpendicular to the plane of the section Figure 4. At a certain locus in the tunnel 102 between the entrance end and the exit end thereof are a plurality of electrical resistor bars 110 extending horizontally through the bricks 105 and near the roof of the tunnel, that is to say near the refractory tunnel top 104. Likewise extending through the bricks 107 and through holes 111 in the members 101 and close to the bottom 103 are electrical resistor bars 112. The bars 110 and 112 preferably are recrystallized silicon carbide resistor rods, round in cross section and having cold ends 115. Such resistor bars or rods are now well known in the art, so I shall not further describe them.

The rods 100 as well as the supporting members 101 extend from end to end of the tunnel 102. There are many of the rods 100 and they are all parallel to each other and spaced the same distance apart. Their ends are preferably tapered so that the batts will ride from one to another without jolting. The batts maintain their position on the rods in the direction of the length of the batts which is the same as the width of the tunnel because the extensions 25 are in contact with the rods 100 at the grooves 30. I provide a long line of batts touching each other for propagation through the tunnel 102 in the direction of the width of the batts as heretofore explained. When starting the kiln, the first batt is pushed in the tunnel 102 by a ram or the like. Thereafter at predetermined intervals of time additional batts, one by one, are pushed into the tunnel, each new batt engaging the last one of the series. Thus the batts constitute the sole conveying means in the tunnel 102 and it can be be seen that no metal parts are required in the tunnel.

Resting on a layer of silica sand 117 or like comminuted refractory material on each batt is a grinding wheel W or other article to be vitrified. As this grinding wheel W proceeds through the tunnel 102, it is first gradually heated to the vitrifying temperature, maintained there for a certain period of time, and then gradually cooled. Each batt may carry an article to be vitrified or there may be a plurality of articles on some or all of the batts, depending upon the size of the articles and the requirements of production.

In a tunnel kiln such as herein briefly described, preheating was at the rate of about 17.5° C. per minute from a temperature of 200° C. to 900° C., then in the heating zone the temperature rise continued at the same rate to a temperature of about 1260° C. and was there maintained for about twenty-five minutes. Then, in the annealing zone, the temperature dropped from 1260° C. to 100° C. in 154 minutes. This annealing then was at the rate of about 7.53° C. per minute. Such temperature changes cause thermal shock which an ordinary batt could not withstand. Initially only narrow batts supporting small wheels were used in such a tunnel kiln. It was desired, however, to vitrify larger wheels such as the wheel W shown in Figure 4 the size of which will be apparent when it is pointed out that the distance between the centers of the rods 100 was nine and one-half inches. Batts wide enough to support such wheels and of ordinary construction soon fractured. Batts according to the present invention as above described being eleven and one-quarter inches long and eight and one-half inches wide were put in operation in this kiln and in over 100 heating cycles showed no sign of cracking and of course therefore no fracture. These batts were introduced into the kiln so that the tongue 32 on one batt would enter the groove 31 on the adjacent batt. This was a matter of precaution so that two batts would hold a broken batt between them and although this precaution was found to be unnecessary during the testing, the feature is nevertheless advantageous because over a long period of time extending perhaps into years a batt may break.

The reason why these batts are able to withstand thermal shock which would break ordinary batts is because the thin walls between the grooves 14 and the bores 20 can flex somewhat when the batt is heated, thus relieving the strain due to the fact that one edge of the batt is hotter than the other edge. The actual length of the pre-heating zone was about 3 feet 10 inches and in this zone the temperature gradient totalled 700° C. So therefore in the pre-heating zone one edge of the batt was subjected to a temperature of about 130° C. above the other edge of the batt. This is severe usage for any refractory article. In the annealing zone, the total distance was about 15 feet and the temperature drop was 1160° C. and so therefore the same batt 8.5'' wide would be almost 55° hotter on the trailing edge than on the leading edge. When it is considered that these temperature differentials are maintained at a wide range of temperatures, the severity of the conditions will be still further appreciated.

One advantage of the batt construction of the invention is that for a given thickness of batt the weight thereof is much less than it would be if the batt were solid. The batts must be handled when they are outside of a kiln and accordingly lightness is a desirable quality. Furthermore the greater the mass of the batts the more heat units will be taken out of the kiln thus wasting heat. This is another reason why a light weight batt is desired.

A modified form of batt is illustrated in Figure 5. This batt has a plane top face 120 and a plane bottom face 121. The surface of the face 120 is interrupted by straight slots 122 which extend the full distance of the width of the batt. The surface 121 is interrupted by straight slots 123 which likewise extend the full distance of the width of the batt. Rounded rectangular bores 124 likewise extending the full distance of the length of the batt are located at the bottoms of the slots 122 and at the tops of the slots 123. Slots 123 alternate with slots 122 as shown. This edge view of Figure 5 is sufficiently illustrative; the batt is rectangular in plan view except for truncated corners 125. This batt may have grooves 126 at the edges of the plane surface

121 if it is to be used in a tunnel kiln such as illustrated in Figure 4; otherwise these grooves may be omitted. This batt as well as the batt earlier described can be used in other kinds of tunnel kilns and also in periodic kilns.

The batt of Figure 5 is resistant to thermal shock because the thin portions 127 and also the walls 128 can flex somewhat when heated and subjected to differential heating. The molding of a batt such as shown in Figure 5 may be done by apparatus and methods similar to those already described. Many other variations in shape may be made within the scope of this invention.

In each embodiment of the invention herein illustrated the batt is in the form of a plate having surfaces, each surface being broken by parallel depressions (slots and bores or grooves) arranged alternately so that a depression from one surface is followed by a depression from the other surface which is followed by a depression from the first surface so arranged as to leave walls between the depressions which are less in thickness than the overall thickness of the batt, so that when the batt is differentially heated said walls by flexure prevent fracture of the batt.

It will thus be seen that there has been provided by this invention batt constructions in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiments above set forth, it is to be understood that all matter hereinbefore set forth are shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A batt for kilns, furnaces and the like comprising a piece of refractory material in the shape of a plate having one side face with parallel grooves each groove having substantially parallel side walls and a rounded bottom and, on the other side slots in staggered relation to said grooves but parallel to them and to each other, said slots extending into bores between the grooves, said bores being substantially cylindrical except for the slots, thus forming an accordion structure in the direction of thickness.

2. A batt for kilns, furnaces and the like comprising a piece of refractory material in the shape of a plate having parallel slots on each side and

parallel bores in the batt merging with said slots, the bores being parallel to the slots and the slots of one side being staggered with relation to the slots of the other side that is the slots on one side being between the slots on the other side and each of the slots being parallel to all of the other slots.

3. A batt for kilns, furnaces and the like in the form of a plate having surfaces, each surface being broken by parallel depressions arranged alternately so that a depression from one surface is followed by a depression from the other surface which is followed by a depression from the first surface so arranged as to leave walls between the depressions which are less in thickness than the overall thickness of the batt, so that when the batt is differentially heated said walls by flexure prevent fracture of the batt.

4. A batt for kilns, furnaces and the like comprising a piece of refractory material in the shape of a plate having one side face with parallel grooves and, on the other side slots in staggered relation to said grooves but parallel to them and to each other, said slots extending into bores between the grooves, said bores being substantially cylindrical except for the slots, thus forming an accordion-like structure which extends in the direction of the thickness of the batt.

5. A batt for kilns, furnaces and the like in the form of a plate having opposite parallel surfaces, each surface being broken by parallel depressions arranged alternately so that a depression from one surface is followed by a depression from the other surface which is followed by a depression from the first surface so arranged as to leave walls between the depressions which are less in thickness than the overall thickness of the batt, so that when the batt is differentially heated said walls by flexure prevent fracture of the batt, said depressions between the end depressions extending from one surface of the batt at least half way to the opposite surface of the batt.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,893,123	Beth	Jan. 3, 1933
2,246,448	Mahan, Jr.	June 17, 1941