R. C. PURDY AND M. F. BEECHER.

LIGHT WEIGHT REFRACTORY BRICK.

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1,345,632. Patented July 6, 1920

Fig. 1.

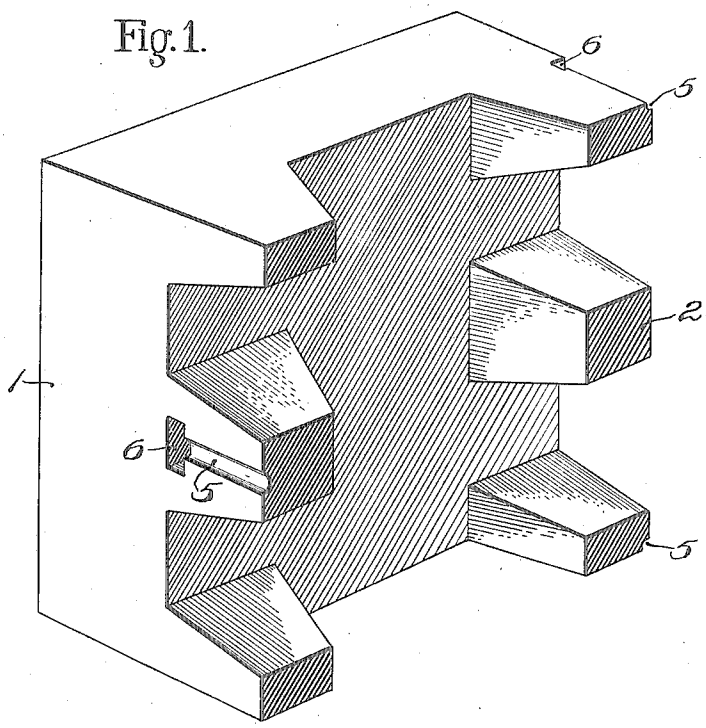
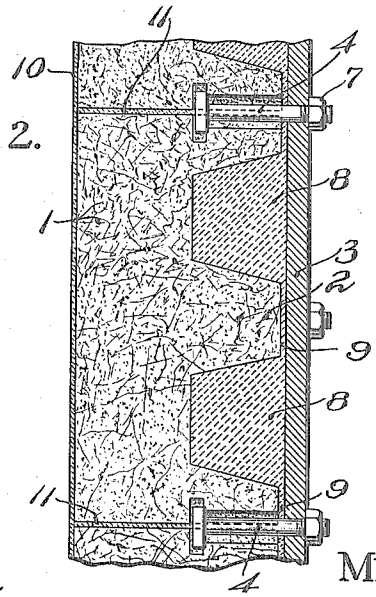


Fig. 2.



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LIGHT-WEIGHT REFRACTORY BRICK.

1,345,632. Specification of Letters Patent. Patented July 6, 1920.

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To all whom it may concern:

Be it known that we, Ross C. PURDY and MILTON F. BEECHER, citizens of the United States of America, residing at Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Light-Weight Refractory Bricks, of which the following is a full, clear, and exact specification.

Our invention relates to light weight refractory bricks, and more particularly to light weight refractory insulating fire bricks adapted for furnace linings.

The ordinary commercial fire brick of the standard dimensions 9″x4½″x2½″ varies in weight from 6½ to 8 pounds, averaging 7 pounds. The weight of the fire bricks necessary to line the furnaces in a torpedo boat destroyer is such that a decrease of one pound in weight for each brick gives roughly four tons decrease in the total weight of the boat. Hence it is highly desirable that a very light weight brick be utilized, in order that the efficiency of the fighting machine may be increased by adding more armament to it, or in order that the speed of the boat may be improved. At the same time, it is necessary that the lighter weight brick possess large mechanical strength and extremely high refractory qualities in view of the fact that the fast traveling boats require forced feed furnaces whose fire box linings are subjected to intense heat conditions. Light weight refractory bricks are equally desirable in water tube boilers where a certain portion of the bricks are supported by the tubes, or as arches in locomotive fire boxes or in other similar places where the attendent saving in weight would be advantageous. Moreover, there is an increasing demand for bricks which depend upon their porosity for heat insulation, and which, at the same time, have the refractoriness of a No. 1 fire brick.

It has heretofore been proposed to lighten the weight of fire bricks and to increase their porosity by mixing combustible material such as sawdust with the clay and burning out this material during the firing process. It is equally feasible to employ crushed coal, cut straw, mill chaff or any other readily combustible material which on burning leaves no appreciable amount of ash. To carry out such a process, it is necessary that the sawdust, coal, etc., be finely pulverized and carefully screened. Only very small particles should be used since the pores should be as small as possible. The combustible matter must also be intimately mixed with the clay by a long pugging operation, otherwise the brick warps seriously. In view of these difficulties, bricks as heretofore made have had a coarse cellular structure and therefore poor insulation qualities. Moreover no light weight No. 1 refractory fire brick has been made heretofore which could be considered satisfactory for the purpose above specified.

It is accordingly an object of our invention to improve the heat insulating qualities of bricks and to provide a very low weight fire brick which has high refractory qualities and sufficient strength to adapt it for use as a furnace lining when subjected to intense heat and mechanical stress.

With this and other objects in view as will be apparent from the following disclosure, our invention resides in the composition of matter set forth herein and covered by the appended claims.

In the drawings, in which like reference numerals indicate like parts, we have shown one form in which a brick may be made and its manner of application to a fire box wall;

Figure 1 illustrating a brick in perspective view; and

Fig. 2 showing a portion of a fire box wall in a vertical sectional view.

The main object of our invention has been satisfied by introducing the combustible ingredient through the medium of a naturally occurring material comprising essentially a carbonaceous or lignitic material and a clay material intimately mixed. Hence, instead of adding combustible matter to clay, we utilize a carbonaceous refractory clay containing a sufficiently large amount of fine combustible material intimately mixed throughout the mass to produce the desired porosity in the brick. For such a material, we preferably use a type of clay heretofore considered worthless by fire brick manufacturers. This clay is of the nature of lignite and is often so called, but it is in reality a lignite clay containing a No. 1 refractory clay material approximating 50%

of the total mass, which when burned produces an open burning clay ash of a light buff color which consists mainly of a refractory clay. The refractoriness of this ash is about that of cone 32. This clay in the raw state is plastic, has sufficient bonding strength for fire bricks, and adds fine working properties to the fire brick mixture. Such a natural carbonaceous clay has extremely finely divided combustible matter distributed throughout its mass and more uniformly than obtainable by mechanically mixing coal or saw dust with clay, hence the shrinkage noticeable upon burning is well distributed throughout the brick and to a measure dissipated, with the result that warpage is reduced to a minimum.

To produce a satisfactory porous or light weight No. 1 refractory brick from a lignite clay, we may combine therewith a clay mass, comprising a single clay or a mixture of clays, which when burned has high mechanical strength, is low shrinking, plastic and capable of adapting the brick to withstand expansion and contraction under heat changes and has highly refractory qualities. To this end, we use non-silicious clays or those containing no silica sand, since these give superior refractoriness, and preferably a type of clay heretofore unused in this art, *i. e.*, a clay of high alumina content.

One kind of high alumina clay and the one we prefer to use contains a large proportion of Diaspore and Gibbsite. This clay varies from 65% to 75% in its content of alumina in combined forms. The water of combination in the clay varies from 12% to 14%. The silica content varies from 5% to 7%. There are also small amounts of iron and titanium present, with traces of alkalis and alkaline earths. This clay in the raw state is hard and does not slake down readily in water, and its fracture has an oölitic appearance. The essential features of such a clay are its high content of alumina and its high refractory qualities.

We find that the high alumina clay when washed in water tends to break up into two parts of practically equal proportions, one being a plastic mass of fine clay and the other made up of rather hard granular particles. These granular particles tend to give a coarse texture to the brick, whereby it may stand heat changes. If, however, the high alumina clay is not used it is desirable to add to the mixture burned clay grog, comprising burned fire clay lumps, this grog serving as the coarse particles which provide flexibility in the bricks permitting expansion and contraction under changes in temperature.

We may also add other refractory clays to give greater plasticity to the raw material, examples of these being kaolin and refractory ball clay. It is to be noted however that the high alumina clay has the combined qualities of the refractory, lean, high shrinking, open burning kaolin, and the refractory plastic, mechanically strong burning ball clay.

As a specific example of a composition of matter involving lignite clay which will produce a light weight refractory fire brick of exceptional insulating properties the following ingredients may be used:

Lignite clay	60%
Burned clay grog	20%
Kaolin	10%
Refractory ball clay	10%

If they are mixed in the proportions specified, and burned at the temperature of cone 13 in accordance with known methods, a brick of standard dimensions weighing about 3¾ pounds will be produced. However, such a fire brick while low in weight possesses a porosity of about 60% and is structurally weak. For a brick of such desired qualities, it should be noted that while the mechanical strength of the cold brick has no bearing on its load supporting ability at furnace tempertures in general, it is a fact that considering this general composition there is a definite relation, and a brick as light and porous as this would fail by crushing in a standard load test at high temperatures. By substituting high alumina clay for the clay grog, this difficulty is overcome, the porosity is but slightly lowered and the standard load carrying capacity and refractoriness of a No. 1 fire brick retained. A satisfactory mixture may be compounded in the following proportions:

Lignite clay	50%
High alumina clay	30%
Kaolin	10%
Refractory ball clay	10%

A brick will be produced by the burning operation which weighs 4½ pounds and is highly refractory and capable of withstanding intense heat and large stresses. This composition gives a minimum weight for the necessary refractoriness and load carrying capacity of the best grades of No. 1 fire clay bricks and is highly superior in strength, shape and insulating properties to one made of clay mechanically mixed with such combustible matter as coal, sawdust, straw, grain, chaff, etc. The refractory lignite clay and the refractory, plastic clays produce a refractory skeleton which serves to retain the shape of the brick in spite of the shrinkage of the lignite clay, due to the uniformity of distribution of the carbonaceous material. As a result, a superior, highly serviceable product is obtained for use as a refractory.

At the same time, due to the uniformity of distribution of the carbon in the refrac-

tory lignite clay, the skeleton of the burned brick is cellular in structure producing in this No. 1 refractory fire clay brick added and most valuable insulating properties.

It should be distinctly understood that various ingredients may be used with the carbonaceous clay and that their proportions may be varied within wide limits, depending upon the physical characteristics of the brick to be desired. It is also feasible to utilize, in place of the refractory lignite clay above described, other natural clay materials which contain sufficient carbonaceous matter intimately incorporated therein to produce the desired cellular structure and lightness in weight. Any suitable method of manufacture within the knowledge and skill of those familiar with making fire bricks may be adopted for producing these articles.

As a practical application of this type of fire brick to marine fire boxes, reference is had to the drawings showing a special form of brick and the manner of applying it to a furnace wall. The brick is so designed, as shown in Fig. 1, that it may be applied rigidly to the metal wall of the fire box or to the ordinary brick structure of other types of furnace. In order to improve the insulating qualities of the furnace wall, we provide this brick 1 with feet which may be in the form of ridges or of separated projecting lugs 2 as shown in the drawings. The bricks are fastened to the wall 3 by means of bolts 4. For this purpose, adjacent faces of bricks are provided with cooperating semi-cylindrical channels 5 having recesses 6 at their ends for holding bolt-heads. These bolts 4, having their heads locked against the shoulders of the recesses 6, pass through suitable perforations in the furnace metal wall and are fastened thereto by nuts 7 or other suitable means.

In order to insulate the brick from the furnace wall to the greatest possible extent, the spaces 8 between the feet 2 are filled with diatomaceous earth, or other suitable insulation such as asbestos cement. A thin layer 9 of this material may also be placed beneath the feet of the brick, as illustrated. Slagging of the brick face exposed to the heat is prevented by a surface coating 10 of a refractory alumina cement, comprising crystalline alumina and clay or suitable vitrifying ceramic materials. This vitrifying alumina cement fills the face pores of the brick and serves as a protecting coating against slagging with the fuel clinker. The bricks may be set in a suitable refractory cement 11 such as above described and the joints carefully filled to prevent access of the flames to the rear wall of the fire box. It is to be noted that this brick is preferably made the size of three ordinary bricks, thereby serving to reduce the number and the extent of the joints between bricks and the necessity for filling in these spaces with suitable cement, and tending to form a more rigid and permanent fire box structure.

By means of this composition of matter we provide a fire brick of minimum weight for the necessary refractory qualities and mechanical strength. If it is made according to the shape and dimensions described and the fire box wall is built as illustrated, the weight of a fire box wall is reduced about 40% below that of walls made of the ordinary fire brick as heretofore employed. Furthermore, by utilizing this composition, we produce a brick which has minute pores substantially uniformly distributed throughout its mass and hence has better heat insulating qualities than heretofore obtainable in this type of brick. By varying the composition of the brick within the scope of our claims we may provide a superior insulating brick of the ordinary type or we may combine therewith the refractory characteristics of the fire brick and so make a brick which may serve not only to insulate against the action of heat but to withstand a high degree of heat and have the standard load carrying capacity as well.

We claim:—

1. A composition of matter for a porous brick comprising a burned carbonaceous refractory clay mass having a high degree of porosity.

2. A composition of matter for a porous brick comprising a burned refractory lignite clay mass.

3. A composition of matter for a porous brick consisting of the product resulting from burning a natural refractory clay containing combustible matter mixed with a low shrinking, hard burning clay mass.

4. A composition of matter for a light weight brick consisting of the product resulting from burning a lignite clay material and a highly refractory clay mass.

5. A composition of matter for a light weight fire brick consisting of a burned mixture comprising a carbonaceous clay material and a low shrinking, highly refractory clay mass having a high alumina content.

6. A composition of matter for a light weight fire brick consisting of a burned mixture comprising lignite clay material and a highly refractory clay containing a high content of alumina in chemical combination.

7. A composition of matter for a light weight fire brick consisting of a burned mixture comprising clay material containing combustible matter, a highly refractory, low shrinking, non-silicious clay mass and a plastic clay.

8. A composition of matter for a light weight fire brick consisting of a burned mixture comprising clay material containing combustible matter, a highly refractory,

non-silicious clay, a plastic clay and a clay material which will give a coarse texture to the brick and adapt it to withstand expansion and contraction under heat changes.

9. A composition of matter for a light weight fire brick consisting of a burned clay mixture comprising refractory lignite clay, a clay high in alumina, kaolin and refractory ball clay.

Signed at Worcester, Massachusetts, this 29th day of October, 1918.

ROSS C. PURDY.
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