COMBUSTION CHAMBER LINER AND METHOD FOR MAKING SAME

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FIG.1

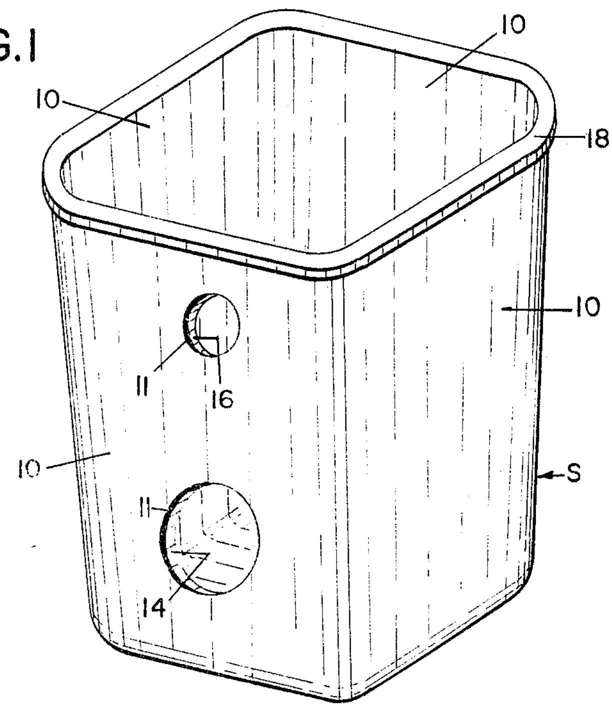
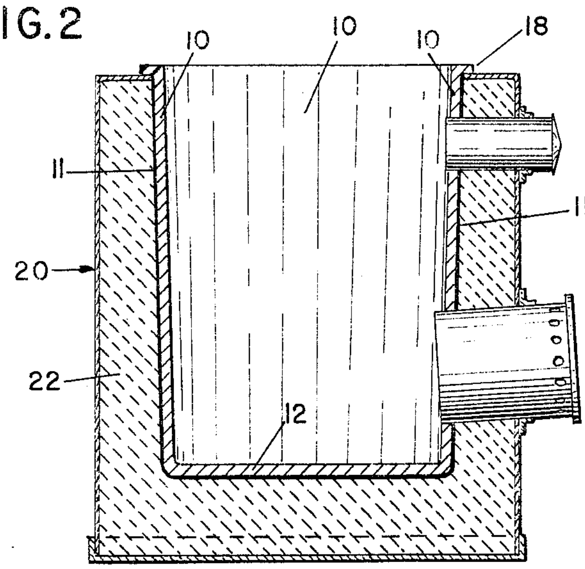


FIG.2



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This invention relates to refractory materials and more particularly to improved combustion chamber liners made from alumina-silica refractory fiber material.

Combustion chamber liners made from alumina-silica refractory fiber material are of light weight porous structure and of high thermal efficiency. This type of construction results in achieving combustion chamber temperatures of up to 2300 degrees Fahrenheit, which effects a substantial saving in fuel for the amount of heat generated. Also, this form of construction is desirable because its results in a quiet operation, and helps lighten the overall weight of the boiler. One problem, however, is that the high temperature causes the side walls of the combustion chamber to bulge and buckle.

To obtain high temperatures inside the combustion chamber liner, the liner is enclosed by a liner of insulating material such as vermiculite. While this is necessary to obtain high temperatures it also causes the walls to bulge inwardly when the high temperature weakens the fiber material making up the liner.

It is an object of this invention to so strengthen the side walls of a combustion chamber made from alumina-silica refractory fiber material so that they will stand up under high temperature without bulging.

Another object of this invention is to provide a cementitious refractory material as a coating to the outside surfaces of a combustion chamber liner made from refractory fibers to structurally strengthen the same.

Another object of this invention is to provide a coating for a combustion chamber which forms a chemical bond between the coating and the surface of the combustion chamber to which it is applied to add structural strength thereto.

A further object of this invention is to provide a process for strengthening and supporting the walls of a liner of refractory fiber for a combustion chamber.

Other objects and features of the invention will appear as the description of the particular embodiment selected to illustrate the invention progresses. In the accompanying drawings, which form a part of this specification, like characters of reference have been applied to corresponding parts throughout the several views which make up the drawings.

The drawings show a combustion chamber liner suitable for use in the combustion chamber of an oil-fired boiler which may be strengthened in the manner disclosed in the instant invention.

In FIG. 1 of the drawings, the combustion chamber liner used to illustrate the invention forms a shell which may be of any desired configuration. We have shown the shell having a rectangular configuration with four side walls **10**. The liner could also have been made in cylindrical shape or any other configuration desired. The bottom of the chamber is enclosed by a bottom wall **12**.

The front part of the chamber is provided with a suitable opening **14** through which a nozzle of an oil burner is inserted. A suitable opening **16** may also be provided above the oil burner opening **14** to permit visual inspection of the oil burner flame.

The upper end of the combustion chamber liner **10** is provided with a flange **18** which extends around the perimeter of the combustion chamber liner. In FIGURE

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2 of the drawing, this flange **18** facilitates supporting the combustion chamber liner **10** at the upper end of the outer jacket **20** which encloses the combustion chamber liner **10**. The area between the liner **10** and the outer jacket **20** is then filled with vermiculite **22** and the assembly is attached to the bottom of the boiler. The co-pending application of Chadwick et al., Serial No. 183,863, filed March 30, 1962, now Patent No. 3,165,092, shows a boiler having such a combustion chamber component attached thereto in this manner.

It has been found that when liners of this type are subjected to combustion, temperatures on the inside skin of the liner may reach 2300 degrees Farenheit. This high temperature is desirable because it results in a high thermal efficiency which gives excellent fuel economy. The problem encountered, however, is that the side walls of the liner, made from alumina silica refractory fiber, tend to sag and bulge. This may possibly be due in part to the pressure exerted on the side walls by the vermiculite which is packed in between the liner **10** and the jacket **20**.

The reason vermiculite was employed to back up the liner was to obtain a low cost increase in thermal efficiency. By using a liner, of the type described, in combination with the vermiculite, it enables the inside combustion chamber temeratures of the liner **10** to be lowered from 2300 degrees Fahrenheit to a temperature on the outside of the liner of approximately 1800 degrees. This 1800 degree temperature was not objectionable because this temperature did not break down the alumina silica refractory material of the chamber but temperature in excess of this tended to cause a breakdown or weakening in the composition of the alumina silica refractory material of the chamber.

We have found that by applying a coating **11** of aluminum dihydrogen phosphate to the outside of the liner, the liner **10** is strengthened as a result of sintering at elevated temperatures to thereby form a ceramic bond which will support the liner against sagging or bulging under high temperatures.

The protective coating herein disclosed suitably may have a thickness ranging from 0.001 inch to about 0.030 inch. Higher operating temperatures may require a thicker coating and lower temperatures will not require as thick a coating. This coating may be formed in situ by coating the outside walls of the combustion chamber liner with ortho phosphoric acid and then contacting the thus-treated walls with hydrated alumina, by spraying, brushing, or painting, to cause the formation of a protective coating of aluminum dihydrogen phosphate. Similarly, the protective coating of this invention may be formed by the direct application of a mixture containing 39 to 60 percent by weight of aluminum dihydrogen phosphate; 39 to 60 percent by weight of a filler such as alumina, zircon and mixtures thereof; and one to five percent by weight of a plasticizer such as bentonite, kaolin and mixtures thereof. For best results, a small volume of water is added to the mixture to disperse the plasticizer.

Such a mixture (A) may be made from:

Aluminum dihydrogen phosphate	ml	125
Tabular alumina (grade T–61)	gm	125
Bentonite	gm	3
Water	ml	10

Another mixture (B) which is known to be satisfactory as a coating may be made from:

Aluminum dihydrogen phosphate	ml	125
Tabular alumina (grade T–61)	gm	125
Kaolin	gm	3
Water	ml	10

Another satisfactory coating mixture (C) consists of:

Aluminum dihydrogen phosphate	ml	125
Zircon	gm	125
Kaolin	gm	3
Water	ml	10

Another coating mixture (D) successfully used in the practice of this invention contains 125 mg. Aluminum dihydrogen phosphate ("Alkophos C"—an aqueous composition containing 33.1 percent of P_2O_5 and 8.6 percent of Al_2O_3); 125 gm. of alumina (325 mesh); and 3 gm. of plastic kaolin ("Ajax P_1," Georgia Kaolin Co.).

The above mixture was applied to a fibrous refractory specimen marketed under the name Pyrolite. The treated specimen and an untreated specimen were subjected to a temperature of 1,000° C. for 72 hours. Both specimens were examined microscopically. In the specimen treated by the process of the invention, there was no evidence found of any cracking during heating. Other properties of the two specimens were compared:

Property	Coated Specimen	Uncoated Specimen
Modulus of Rupture lb./sq. inch	23.04	9.66
Shrinkage, percent of length, 18 hours at 1,000° C.	0.0	2.26

In another example of the successful practice of the instant invention, the following results were obtained with identical coated and uncoated chamber liners.

A. *Uncoated chamber liner*

Test started 1:30 p.m.—first day.
Test stopped 7:30 a.m.—fourth day.
Oil firing rate—1.10 gallons per hour.
CO_2 flue gases—14%.
Inside wall temperature—2300° F.
Outside wall temperature—1850° F. (after 2 hours).
Shrinkage of liner on width (w)—1³⁄₁₆".
Shrinkage of liner on length (1)—⁹⁄₁₆.

B. *Chamber liner coated with mixture "D"*

[Test times—(same as above)]

Oil firing rate—1.10 gallons per hour.
CO_2 flue gases—14%.
Inside wall temperature—2300° F.
Outside wall temperature—1850° F. (after 2 hours).
Liner shrinkage on width (w)—"0".
Liner shrinkage on length (l)—⁵⁄₃₂".

C. *Chamber liner coated with mixture "A"*

Test conditions:
Started 2:30 p.m.—first day.
Stopped 11:30 a.m.—second day.
Started 8:00 a.m.—first day.
Stopped 7:30 a.m.—third day.
Oil firing rate—1.10 gallons per hour.
CO_2 flue gases—14%.
Inside wall temperature—2305° F.
Outside wall temperature—1885° F. (after 2 hours).
Shrinkage on width (w)—¼".
Shrinkage on length (l)—⅜".

Equally successful results were obtained with liners coated with mixtures "B" and "C."

It is clear from the above data that the provision of a coating of aluminum dihydrogen phosphate in accordance with the invention rendered the treated specimens stronger and reduced their shrinkage by oxidation. Additionally, it has been found that applying a coating consisting of one of the mixtures just mentioned to the outside of the combustion liner **10**, adds materially to the flexural strength of the side walls of the combustion chamber liner **10** so that its tendency to buckle and shrink is avoided.

It has been found that for a liner having an exterior surface of approximately 720 sq. in., an application of one-half pint of the coating mixtures of the invention to the outside surfaces of the liner will achieve the results desired.

The invention hereinabove described may, therefore, be varied in construction within the scope of the claims, for the particular device selected to illustrate the invention is but one of many possible embodiments of the same. The invention, therefore, is not to be restricted to the precise details of the structure shown and described.

What is claimed is:

1. A refractory fibrous liner for combustion chambers having at least on the external surfaces thereof a protective coating consisting essentially of aluminum dihydrogen phosphate.

2. A refractory fibrous liner for combustion chambers, said liner having at least on the external surfaces thereof, a protective coating comprising from 39 to 60 percent by weight of aluminum dihydrogen phosphate, from 39 to 60 percent by weight of a filler and from one to five percent by weight of a plasticizer.

3. A liner according to claim **2**, wherein said filler is selected from the group consisting of alumina and zircon and mixtures thereof.

4. A liner according to claim **2** wherein said plasticizer is selected from the group consisting of kaolin and bentonite and mixtures thereof.

5. A process for protecting refractory combustion chamber liners against oxidation comprising applying a protective coating of aluminum dihydrogen phosphate on at least the external surfaces of said liner.

6. A process for strengthening and protecting refractory fibrous combustion chamber liners against oxidation, comprising applying phosphoric acid to at least the external surfaces of said liners and then contacting said surfaces with hydrated alumina to form in situ a coating of aluminum dihydrogen phosphate.

7. A process for strengthening and protecting refractory fibrous combustion chamber liners comprising providing at least on the external surfaces of said liners a coating of aluminum dihydrogen phosphate having a thickness ranging from about .001 to .03 inch.

8. The process of strengthening the side walls of a combustion chamber made from alumina-silica refractory fiber consisting of applying a coating of ortho phosphoric acid to the outside of the chamber walls liner then applying hydrated alumina separately to the outside walls of the combustion chamber liner to cause the acid and hydrated alumina to react to form aluminum dihydrogen phosphate.

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