Sept. 26, 1967 R. R. SCHNEIDER 3,343,824

ROTARY KILN

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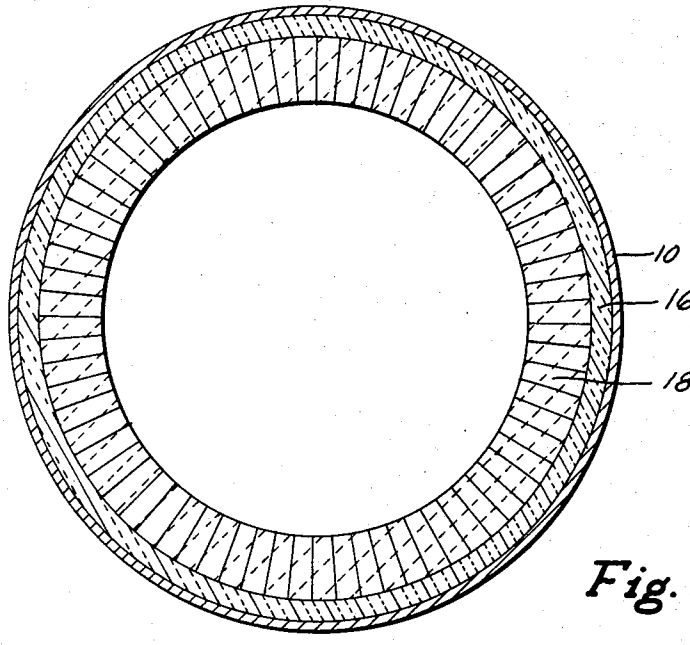


Fig. 2

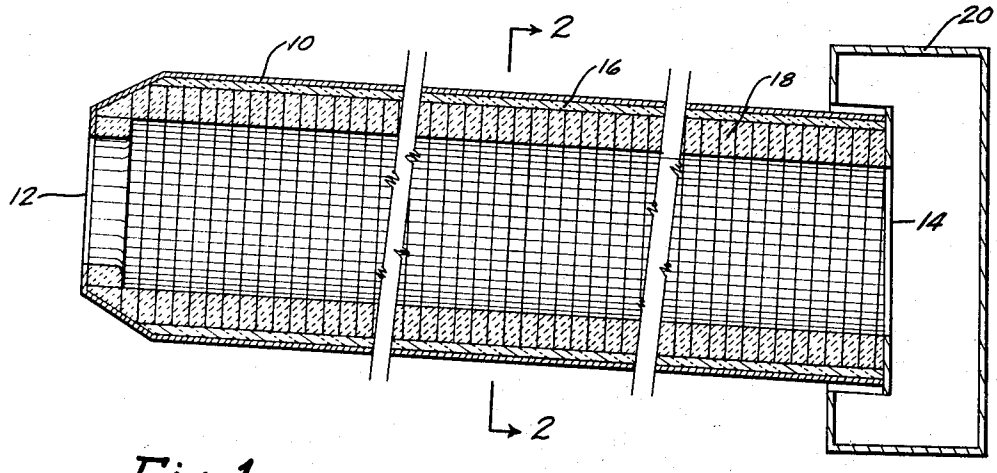


Fig. 1

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ROTARY KILN

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ABSTRACT OF THE DISCLOSURE

The present invention is concerned with an insulating material for a rotary kiln between the brick working lining and the metal shell. The insulating material consists of one or more continuous, integral, annular segments of pressed sheets of asbestos fibers of uniform thickness secured to the shell.

Lining structures heretofore proposed for kilns employed in the calcining of minerals, have not uncommonly included provisions for insulation of the end of the kiln into which materials to be calcined are fed, and sometimes provisions for the insulation of the zone intermediate the feed zone and the hot zone, known as the "precalcining" zone. Proposals have also been made to insulate the hot zone of such kilns using refractory insulating materials. While these latter proposal were originally efficient they eventually resulted in a kiln lining having a useful life so shortened as to preclude repetition of testing.

Prior art teachings for the design of rotary kiln firing zones, without insulation, have usually included provision of a complete lining of precast brick laid directly against the kiln shell to provide an annulus of as much as 9" or more in depth. The brick lining was customarily one of many well known refractory materials, such as, forsterite, fireclays, high aluminas, magnesite, chrome ore, and compatible mixtures of the foregoing. Where basic refractory materials are employed in the kiln, it has been customary to provide metal encasement for reasons well known in the refractories art. Further, any of these well known refractory linings may contain provisions for metal shims between brick to take up slack and tighten the overall lining. Such shims, in many cases, extend all the way to the outer metal shell of the kiln.

While this type of kiln lining presents a strong working surface of suitable hardness and of the heat resistance necessary for the calcining of mineral substances, such refractory materials are at the same time relatively good heat conducting materials and thus relatively poor insulating materials. In the firing zone of a kiln lined in this manner, the temperature at the working surface of the brick during a calcining operation, for example, when calcining dolomite, may be on the order of 2500° F. The refractory materials, above mentioned, customarily employed for lining the kiln have a coefficient of thermal conductivity on the order of 8 to 25 B.t.u./hr./sq.ft./deg. Fahr./in. thickness. Assuming the lower thermal conductivity value, the working temperature and thickness of brick noted above give a temperature of approximately 800° F. at the interface of the base of the brick and the supporting steel shell and thus a heat loss of about 2700 B.t.u./hr./sq.ft. The temperature differential of 1700° F. between the working face of the brick and the base causes the brick to expand more at the working faces than at the bases, resulting in severe expansion strains and stress crack formation in the brick. This weakens the structure materially and as mechanical stresses on the brick are reversed with each rotation of the kiln under load, the weakened lining structure soon requires shutdown for expensive relining.

Another problem that must be considered in lining

rotary kilns is then when calcining materials such as limestone and cement which exert a highly abrasive action on the kiln lining, it is desirable to form a coating of several inches or so on the refractory lining of the material being calcined to protect the lining. Owing to the hardness and heat resistance of the lining materials, the linings must be subjected to extremely high temperatures before a coating adheres thereto. Since the above mentioned refractory materials are good thermal conductors, the temperature of the shell also becomes extremely high and tends to deform.

In an attempt to overcome these shortcomings, insulating brick composed of zirconia or diatomaceous earth, for instance, were applied to the inner surface of the metal shell in the calcincing zone to a depth of about 3" and the working lining was disposed in contact therewith. Although by constructing a kiln lining in this manner, effective heat insulation of the kiln interior is obtained and a relatively low temperature at the outer surface of the shell body thereby results with consequent reduction of the heat losses, the temperature at the interface between the insulating material and the refractory brick is generally higher than the temperature at which the insulating brick has effective load strength. Thus, at the temperatures of calcining operations, i.e. 2500° F., most of the more commonly known substances, which are good heat insulators, have a very low crushing strength and consequently, a monolithic layer of such good insulating material at these temperatures tends to fracture and allow the overlying refractory brick to shift position as the kiln is rotated under load conditions which in turn reduces firm support, therefore, weakening the arch construction of the circular brick courses and causing rapid deterioration of the lining.

Other workers have suggested using refractory castables and cements for insulating purposes and securing them to the metal shell by the use of metallic pins attached thereto. One such worker, in the United States Patent 1,378,710, suggested using a two to three inch layer of loose asbestos material or porous stones as the insulating layer. However, here more so than above, the working lining would tend to shift position as the kiln is rotated under load conditions and cause destruction thereof. This would be particularly true with refractory linings constructed of metal encased basic brick and shimmed linings where the metal members would exert a constant pressure against the relatively loosely packed material.

An object of the present invention is to provide a rotary kiln for calcining minerals such as limestone and dolomite in which at least the hot zone is provided with means for preventing the high heat losses heretofore experienced and yet having substantially longer life than prior art constructions.

Another object of the invention is to provide a means for readily facilitating a coating of the material being calcined on the surfaces of the working lining in a relatively short period of time.

A further object of the invention is to provide an insulating lining in a rotary kiln which will maintain the working lining in position as the kiln is rotated under load conditions and will compensate for the thermal expansion of the refractory lining without destruction thereof.

Other objects of the invention will be apparent hereinafter.

In the drawings

FIG. 1 is a broken longitudinal section of a rotary kiln; and

FIG. 2 is a transverse vertical section of a kiln hot zone having the structure of this invention.

In accordance with the present invention, there is pro-

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vided a rotary kiln having a cylindrical metal shell rotatable about its longitudinal axis and inclined from a horizontal. On the inner surfaces of the metallic shell, in at least the hot zone, is disposed a relatively thin, continuous and integral layer of pressed asbestos sheet material of substantially uniform thickness. The integral asbestos sheet is secured directly to the shell by means of a refractory cement, such as, commercially available calcium aluminate cement. A working lining of refractory brick is disposed on and supported by the asbestos sheet and may be secured thereto by any suitable bonding mortar depending upon the composition of the refractory brick.

The asbestos sheet employed in the present invention is generally produced by compressing, at a high pressure, a batch of randomly oriented asbestos fibers to a self-sustaining integral thickness of from about ⅛ to ¼". Preferred asbestos sheet is characterized by having a density of about 60 p.c.f., a service temperature of from about 1000 to 1200° F. and a coefficient of thermal conductivity of about 0.8 to 1.5 B.t.u./hr./sq.ft./deg. Fahr./in. thickness. It is important that the asbestos sheet be applied to the metal frame in substantially uniform thickness with a paucity of joints so as to insure even distribution of stresses from the working lining during the operation of the kiln. An asbestos sheet thickness of about ¼" is sufficient to provide a temperature differential of about 2000° between the working face of the brick and the supporting steel shell while the interface temperature remains at about 1100° F.

Referring to the drawing, a cylindrical metal shell **10** is shown encasing the body of a rotary kiln having a feed end **12** and a discharge end **14**. The kiln may be fired by any suitable burner as is well understood in the art. The shell **10** is the supporting structure for the kiln lining. Disposed on the kiln shell **10** and cemented thereto is an annular continuous and integral sheet of pressed asbestos fibers **16**. In the firing zone of the kiln, a vertical cross section of which is shown in FIGURE 2, the annulus of asbestos sheet is overlayed with refractory brick **18**, preferably of the precast nonacidic type as mentioned hereinabove, such as, forsterite, dead burned magnesite, high alumina, or chrome ore. In this zone, in contrast to completely uninsulated structures, the temperature gradient through the refractory brick is comparatively small, whereby the refractory brick lining is subject to less internal strain than is the case where a large temperature differential from the working faces to the bases thereof exists.

A hood **20** is provided as a covering means at the discharge end of the kiln which is standard practice in the design of rotary kilns. As is shown in FIG. 1, the asbestos sheet is applied also in the precalcining zone which may be desirable in certain operations. However, the greatest need for the insulation of the present invention is realized in the hot or calcining zone of the kiln.

Merely by way of example, the steel shell of a rotary kiln hot zone of 10' in length was lined uniformly with about ¼" of pressed asbestos sheet. The sheet was secured to the shell with commerical calcium aluminate cement. The insulating sheet was overlayed with basic refractory brick containing about 70% dead burned magnesite, 10% chrome ore, and 10% alumina. The kiln was set in operation for the calcining of dolomite with a hot zone temperature of about 2600° F. The lining began picking up a coating of dolomite almost immediately and after three or four hours the lining had about 4" of such coating. The shell temperature for the first hour was about 840° F. as the lining picked up a coating the shell temperature decreased to about 650° F. The lining is expected to last for about 200 days of continuous use without repair.

In the foregoing discussion there is mentioned "integral" sheets of asbestos. This is to clearly differentiate from loosely packed insulating material and describe use of relatively long lengths of sheet material, for example, sheets long enough to form a complete turn about the interior of a kiln shell and serve as back-up for a plurality of adjacent courses of brick forming the working linings. Accordingly, the insulating back-up lining consists of a plurality of continuous, integral annular segments of pressed sheets of asbestos fibers such that the back-up lining is capable of compensating for the thermal expansion of the refractory lining without deterioration thereof.

While the invention has been described with reference to particular embodiments and examples, it will be understood, of course, that modifications, substitutions and the like may be made therein without departing from its scope.

Having thus described the invention in detail and with sufficient particularity as to enable those skilled in the art to practice it, what is desired to have protected by Letters Patent is set forth in the following claims:

1 claim:

1. A rotary kiln consisting of a cylindrical metallic shell containing means for rotating it about its longitudinal axis which is inclined from the horizontal, an annular, continuous pressed sheet of asbestos fibers having a uniform thickness of between about ⅛" and ¼", and a coefficient of thermal conductivity between about 0.8 and 1.5 B.t.u./hour/square foot/° F.-inch thickness secured to the shell and an annulus of refractory brick overlaying and supported by said asbestos sheet.

2. The rotary kiln of claim **1**, in which, the asbestos sheet is secured to the shell with a refractory cement.

3. A rotary kiln consisting of a cylindrical metallic shell containing means for rotating it about its longitudinal axis which is inclined from the horizontal, a plurality of continuous, integral, annular segments of pressed sheets of asbestos fibers of uniform thickness of between about ⅛" and ¼" and a coefficient of thermal conductivity between about 0.8 and 1.5 B.t.u./hour/square foot/° F.-inch thickness secured to the shell and an annulus of refractory brick overlaying and supported by said asbestos sheets, each annular segment being capable of supporting a plurality of adjacent courses of refractory brick and compensating for the thermal expansion of the refractory lining without deterioration thereof.

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