United States Patent

[11] **3,580,322**

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[45] Patented **May 25, 1971**

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[54] **FLEXIBLE REFRACTORY CURTAIN**
3 Claims, 11 Drawing Figs.

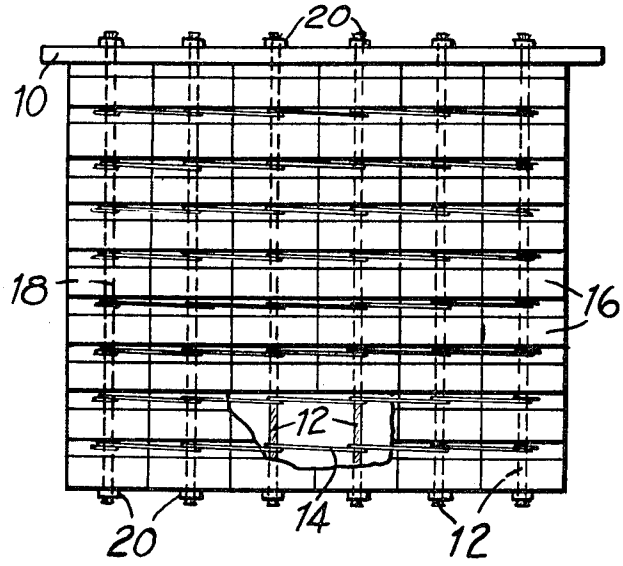
[52] **U.S. Cl.** **160/231**
[51] **Int. Cl.** **E06b 9/24**
[50] **Field of Search** 160/231, 332; 52/177, 233, 342, 343, 630, 660, 663, 596, 601, 606; 15/238, 239, 240; 61/38

[56] **References Cited**
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Primary Examiner—Peter M. Caun
Attorney—Allan R. Redrow

ABSTRACT: A flexible refractory curtain or covering is disclosed which is made up of an essentially horizontal supporting rod or tube to which is attached a network of flexible vertical and horizontal wires or cables to which are affixed segments made from a refractory material like silicon carbide, alumina or the like. The segments are so shaped and assembled on the flexible network that when the curtain is hanging in a vertical position the segments mate to form an effectively solid wall which functions as a barrier to the passage of heat and gases.



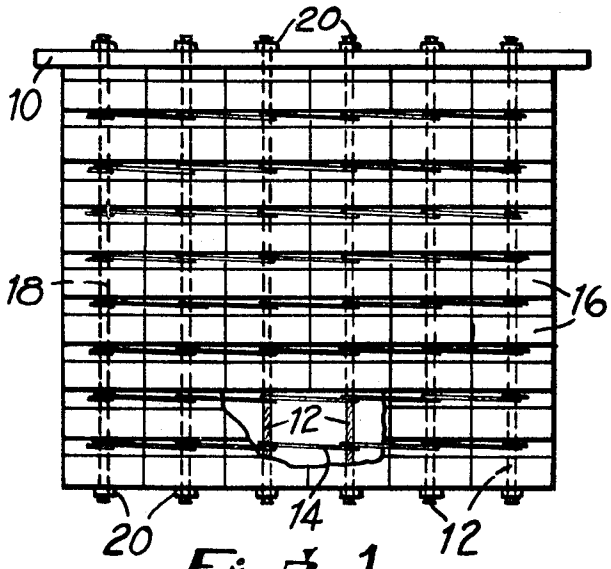


Fig. 1

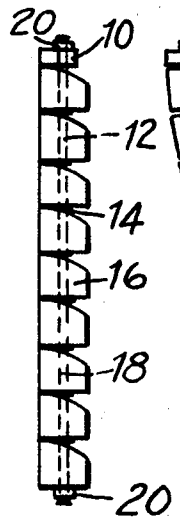


Fig. 2

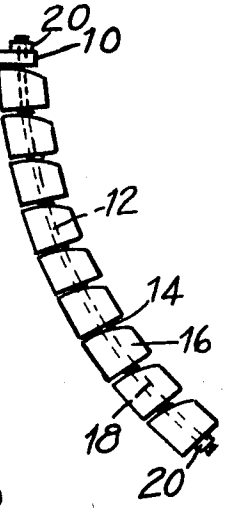


Fig. 3

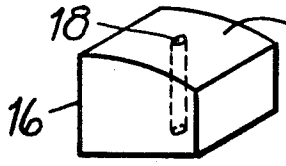


Fig. 4

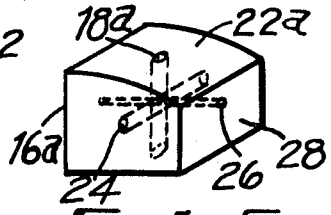


Fig. 5

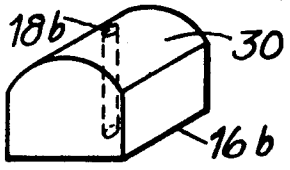


Fig. 6

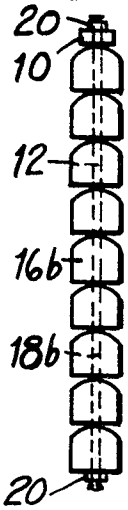


Fig. 7

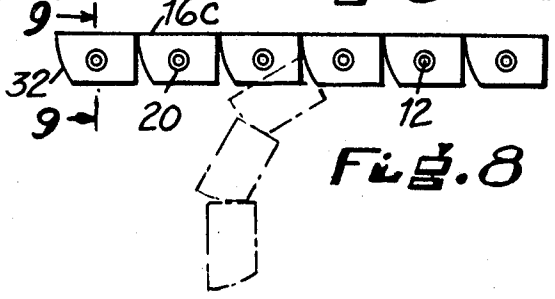


Fig. 8

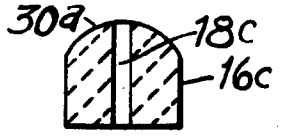


Fig. 9

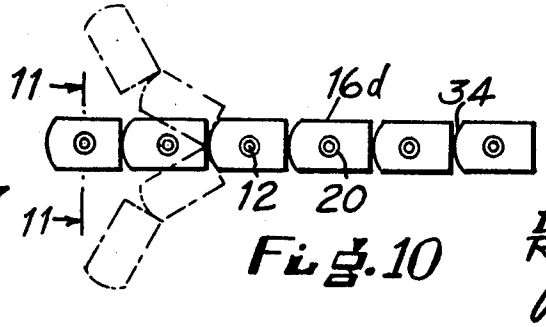


Fig. 10

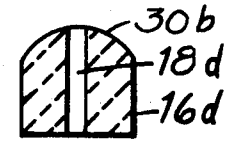


Fig. 11

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FLEXIBLE REFRACTORY CURTAIN

BACKGROUND OF THE INVENTION

The invention relates to high temperature processing equipment such as kilns, calciners, and coke ovens. More particularly the invention is concerned with baffles or shields for retaining heat and/or gases in the operation of such equipment.

Most frequently the exit end of high temperature kilns, calciners, and the like, are left open to the environment because of the lack of or unavailability of a suitably utilitarian covering means. This is particularly true when such equipment is used in the continuous processing or synthesis of such raw materials as silicon carbide, boron nitride, boron carbide, calcium oxide, magnesium oxide, and the like. Such kilns are usually constructed in a rather elaborate manner so that the configuration of the container holding the reaction mixture, passes very closely to the walls of the kiln as it traverses through, so that the outer surfaces and edges of the container act as a baffle preventing excessive heat migration and loss. Further, kilns are sometimes constructed with a relatively long cooling zone at the end of the heat treatment process, which functions as a heat-loss retarder as well as serving as a gradual cool-down zone for products which require such a treatment subsequent to the high temperature firing phase of the heat cycle.

Prior to the instant invention, exits and other exterior openings in high temperature kilns, have been closed by such means as hanging-chain seals, graphite or asbestos cloth curtains, and of course doors made of a steel backing to which are attached refractory segments or bricks. Interior baffles, because of the elevated temperature and the practical requirement that they be flexible, have been fairly well restricted to graphite or asbestos curtains.

These devices do, however, have their shortcomings. The hanging-chain seal type of curtain is an inefficient heat retainer because of the high conductivity of the metal and, because of the natural openness of a chain link construction. The multitude of small openings also makes it an inefficient restrainer for gases generated within the furnace. Graphite and asbestos curtains are more effective than the hanging-chain seal device by virtue of their lacking the multitude of openings contained in the chain construction, but these are not very resistant to abrasive wear as would be required in applications where such curtains would be pushed open by moving reaction mix or containers holding such a mix. Refractory lined steel doors are the most efficient means for retaining gases and heat. Doors, however, cannot normally be incorporated as baffles on the interior of kilns and, therefore, are limited principally to use as a closure for exterior openings.

SUMMARY OF THE INVENTION

In brief, the invention is a flexible refractory curtain comprised of flexible cable, the strands of which are continuous filaments of a high-temperature resistant material such as glass, ceramic, carbon or metal, and/or metal wire, such as steel or copper, or metal chain, to which are attached refractory segments made of such refractory materials as silicon carbide, aluminum oxide, silica, silicon oxynitride, zirconium oxide, boron carbide, and the like. The curtain may be assembled by any of several means for example, by threading on a vertical cable, refractory segments containing a hole passing through them approximately in the center, in the manner one would string beads. These are then fastened to a horizontal upper supporting bar composed of high-temperature resistant material such as a ceramic or a metal, and fastened to one another by passing a wire or light weight cable in a horizontal direction looping the light weight wire or cable around each of the heavier vertical cables. In this manner each segment is supported by the segments underneath it in the vertical direction and the group of stringed segments are held together in the horizontal direction by the wire or cable between the segments and around each vertical cable. The segments can vary in size and thickness depending on the overall size of the curtain or the degree of thermal insulation desired. A unique feature of the refractory curtain is that it can be made flexible or bendable in from 1 to 4 directions depending upon the configuration of the refractory segments used, thereby making the curtain as flexible as the intended application requires; this will be subsequently explained in more detail.

Because the refractory segments are thick relative to the practical usable thickness of graphite or asbestos cloth curtains, these refractory curtains have a longer service life and are more efficient insulators. Furthermore, the refractory curtains can be so constructed that when they are in the relaxed position, that is hanging vertically, the curtain presents a barrier that is effectively free of openings through which heat and gases can escape. This overcomes the major shortcoming of the hanging-chain type curtain which is not a very efficient barrier to heat and gases for the reasons stated above.

It is therefore, the object of this invention to provide a versatile, highly efficient heat and/or gas barrier in the form of a flexible refractory curtain, that can be used on interior sections of kilns and furnaces as well as to cover exterior openings, and that is relatively resistant to wear from rubbing contact with hot, granular materials.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of a flexible refractory curtain partly cut away to show the construction of the horizontal and vertical members of the secondary supporting means.

FIG. **2** is a side or edge view of the refractory curtain of FIG. **1**.

FIG. **3** is the same edge view as FIG. **2**, but showing the curtain in a flexed position.

FIG. **4** is a refractory segment for construction of a refractory curtain flexible in one direction.

FIG. **5** is another refractory segment for construction of a curtain flexible in one direction.

FIG. **6** is a refractory segment for construction of a curtain flexible in two directions.

FIG. **7** is a side view of a curtain flexible in two directions.

FIG. **8** is a bottom view of a refractory curtain flexible in three directions and showing the bottom view of several segments like that shown in FIG. **9**.

FIG. **9** is a section through one of the segments used in the curtain of FIG. **8**.

FIG. **10** is a bottom view of a refractory curtain flexible in four directions and showing the bottom view of several segments like that shown in FIG. **11**.

FIG. **11** is a section through one of the segments used in the curtain of FIG. **10**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1** and **2** show a front and side view respectively of a flexible refractory curtain made in accordance with the invention. Preferably, a strong steel bar is used as the horizontal upper principal supporting means **10** to which are attached, by means of the retainers **20**, flexible steel cables **12**. Prefabricated refractory segments **16** containing therein a hole **18** located approximately in the center of the segment, are then threaded onto the steel cables **12**. One horizontal row of segments **16** is threaded onto the steel cables **12** and positioned against or slightly spaced from the supporting bar **10**. A metal wire or thin cable **14** is then securely wrapped around the first cable, pulled taut enough to bring the two adjacent segments in contact with each other and then the wire is wrapped around the next cable pulling the wire taut again, and so on wrapping around each cable and pulling taut until the entire first row of segments is traversed in the horizontal direction. The wire **14** is securely fastened or wrapped around the last cable. The thin cable or wire merely prevents the segments from separating and therefore bears no great amount of load. Subsequent rows of segments are threaded onto the cables and the retaining wires placed as described, until a curtain of desired length is constructed. When the last row of seg-

ments is properly placed, the protruding ends of the cables are then fitted with a retainer means such as the common press fit-types, or the cable may even be looped over and tied in the well-known manner. In this design the wires or thin steel cables **14** pass from one heavy cable **12** to the next, between the segments.

The curtain shown in FIGS. **1** and **2**, because of the configuration of the segments **16**, flexes or bends in only one direction as shown in FIG. **3**. The singular direction of the flexibility is a result of the segments having only one convex side or face **22**, as shown in FIG. **4**, thereby allowing the segments to move only in the direction of the singular convexity.

An alternate method of assembly for a curtain of the type depicted in FIGS. **1** and **2** can be accomplished using refractory segments of slightly different design than that of FIG. **4**. In this method a segment **16***a*as shown in FIG. **5** would be used which may be of the same overall configuration as that of FIG. **4** but now containing a vertical hole **18***a* and a horizontal hole **24** connecting with the hole **18***a*, with both holes **18***a* and **24** passing completely through the segment in their respective directions. There is also provided, a hole **26** preferably of smaller diameter, passing from the exterior face **28** of the segment **16***a* through and connecting with the intersecting point of the holes **18***a* and **24** and beyond for a short distance, as shown. Using this type of segment, equally heavy cables may be used for both the vertical and horizontal supporting means. A horizontal row of segments **16***a* is threaded on adjacently and vertically oriented cables by passing each cable through the hole **18***a*. A cable of smaller or similar thickness is then threaded through the holes **24** and around each vertical cable until it has passed through all the horizontal segments. The segments are then held in place, by affixing to the ends of the horizontal cable, retainer means **20** such as those of FIGS. **1** and **2**. A steel pin, or a pin made from some other heat-resistant material, is then driven into the hole **26** to frictionally engage the crossed wires to hold the segment fixed in position relative to the wires or it may be driven through both cables at their point of crossover as they pass through the holes **18***a* and **24**. This assembly step is repeated until a curtain of desired size has been assembled, at which point retainer means are affixed to the ends of the vertical cables. This arrangement is desirable where greater resistance to horizontal forces on the curtain is required.

The invention is not limited to construction of a refractory curtain that is flexible in only one direction. The refractory blocks or segments may be constructed so as to permit flexing of the finished curtain in two, three, or even four directions. These various degrees of flexibility can be more readily understood by referring to FIGS. **6—11** while keeping in mind, the general mode of assembly and configuration of the refractory segments and supporting means shown in FIGS. **1** and **2**. If a curtain is desired with flexibility in two directions along horizontal axes, instead of only one, as in the flexible curtain of FIGS. **1**, **2** and **3** which result from the particular configuration of the segment **16** of FIG. **4**, one need only redesign the segment of FIG. **4** by substituting the curved surface **30** of FIG. **6** for the curved surface **22** of FIG. **4**, resulting in segment **16***b*. A refractory curtain made up of the segments **16***b* of FIG. **6**, assembled in the same manner as the curtain of FIGS. **1** and **2**, would then be capable of flexing or bending in two directions along horizontal axes as shown in the edge view, FIG. **7**, of such a curtain.

An additional degree of flexibility may be built into the curtain by further modifying the shape of the segment as illustrated in FIGS. **8** and **9**. FIG. **8** is a bottom view of a hanging curtain showing the bottom of the segments **16***c* with the curved surface **32**, and the cables **12** passing through the retainers **20**. FIG. **9** is a section through segment **16***c* at **9–9** in FIG. **8**, showing the second curved surface **30***a* which corresponds to the curved surface **30** in FIG. **6**. When segments **16***c* are assembled in a like manner as in the construction of the curtain in FIGS. **1** and **2**, the resulting curtain will then flex along horizontal axes in the two directions shown in FIG. **7**, and in addition, will flex along vertical axes in one direction as shown in FIG. **8**.

The curtain may be provided with still a further degree of flexibility by yet an additional modification in the design of the refractory segments. FIG. **10** is a bottom view of a hanging curtain showing the bottom of the segments **16***d* with curved surface **34** and the cables **12** passing through the retainers **20**. Note the type of curvature of the surface **34** of the segment **16***d* in FIG. **10** as compared to the curved surface **32** of segment **16***c* in FIG. **8**. FIG. **11** is a section through segment **16***d* at **11–11** in FIG. **10** showing the curved surface **30***b* which corresponds to surface **30***a* in FIG. **9**, and to surface **30** in FIG. **6**. The segments **16***d*,designed with the two curved surfaces **34** and **30***b* when assembled into a curtain of the general configuration of that in FIG. **1**, result in a curtain that can flex in two directions along vertical axes as shown in FIG. **10** in addition to the two directions along horizontal axes as in FIG. **7**.

Curtains made with any of the described segment configurations, all have in common that when in the relaxed position, they present an effectively solid wall which functions efficiently as a barrier or baffle to the passage of heat and gases.

An almost infinite number of variations in strength, weight, and dimensions of the supporting means and the segments is possible. Which of these one might select to use would be influenced by such things as the overall dimensions of the curtain, the degree of heat insulation and impermeability to gas desired, and the specific degree or direction of flexibility required.

It is possible that many modifications of my invention may occur to those skilled in the art which will fall within the scope of the following claims:

I claim:

1. A flexible refractory curtain having a horizontal upper principal supporting means, and a secondary flexible supporting means appended therefrom comprised of interconnected horizontal and vertical members to which are attached refractory segments having at least one of the top and bottom sides of each segment convex in configuration, a hole originating at the approximate center of the top side and passing in a vertical direction through and terminating open endedly at the bottom side of said segment, said hole providing the means for attaching the segments to said vertical members of said flexible secondary supporting means.

2. The flexible refractory curtain of claim **1** wherein said segments are generally rectangular in configuration, each having essentially flat end sides, front side, and back side, and a convex top side or bottom side.

3. The refractory segments of claim **1** containing in addition thereto a hole originating at one vertical side which passes through the segment in a horizontal direction, said hole terminating open endedly at the opposite vertical side thereby providing a means for attaching said segments to said horizontal members of said flexible secondary supporting means, said segments containing in addition a third hole of smaller diameter originating at either the front or back side of the segment, passing through the segment in a horizontal direction meeting with the intersection of said horizontal and vertical holes and passing beyond and terminating prior to reaching the opposite side of said segments, said smaller diameter horizontal hole being adapted to receive a pin composed of a heat-resistant material and to guide said pin so as to cause it to pass through the horizontal and vertical members of said secondary supporting means.