United States Patent

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[73] Assignee Universal Oil Products Company,
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[54] **HEAT PROTECTED METAL WALL**
2 Claims, 8 Drawing Figs.

[52] U.S. Cl. 52/741, 29/460, 29/480, 52/364, 52/378, 52/714, 264/30, 264/35, 264/269
[51] Int. Cl. B04g 21/04, B04b 1/16
[50] Field of Search 52/720, 249, 405, 98, 612, 410, 361, 454, 410, 685; 52/744, 378, 741; 52/364, 714; 29/460, 480; 264/30, 35, 269

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ABSTRACT: The method and means for providing a two-layer heat-protected metal wall for use in high temperature chambers in which metal holding members having bendable end portions are welded to the metal wall, a lightweight castable insulating material is applied adjacent to the metal wall, the holding members are bent to extend beyond such material, and a castable monolithic refractory material is applied adjacent to the lightweight material, to completely embed the holding members. The two layers are thus anchored and supported to the metal wall by means of the holding members.

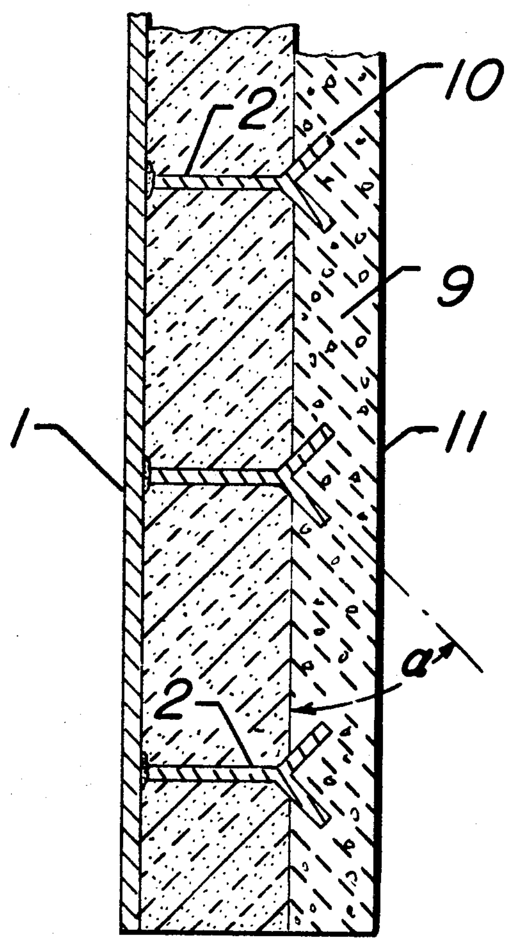
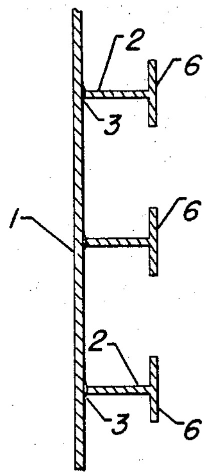


Figure 1



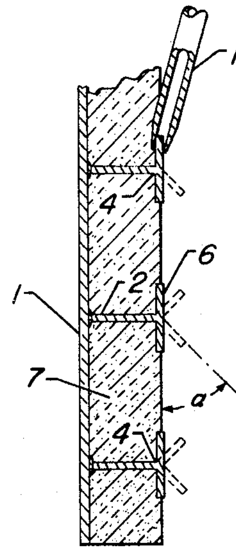


Figure 2

Figure 3

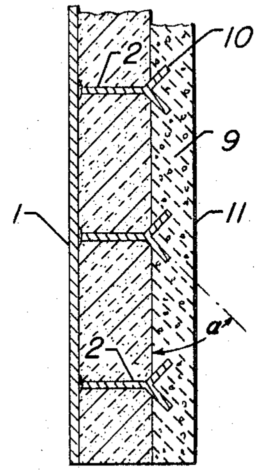
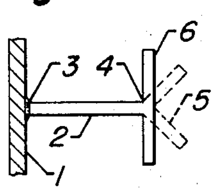


Figure 4a



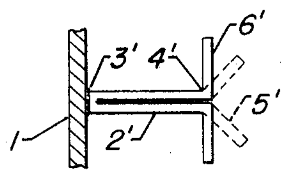
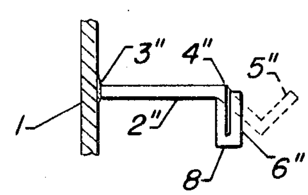


Figure 4b

Figure 4c



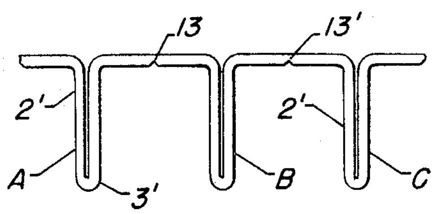


Figure 4d

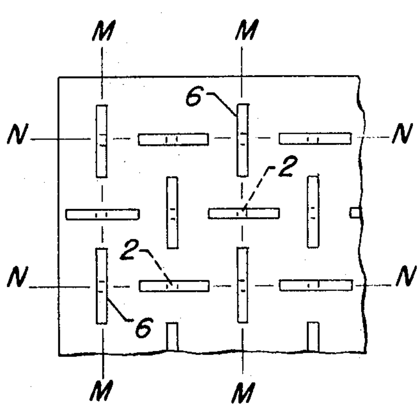


Figure 5

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HEAT PROTECTED METAL WALL

This invention relates to a heat-protected metal wall for use in high temperature application under mechanically severe conditions and particularly to the method and means of constructing such a wall. The term "wall" as used herein is not to be limited to vertical walls and to use in chambers only, but should be construed to apply to the floors, ceilings and to other applications. Such designation is used merely as a means to simplify the explanation of the present improvement. Heretofore many types of insulated walls have been utilized in chambers ranging from simple ovens to complex reactors. When extremely high temperatures are employed in a chamber, it is necessary to protect the walls of a chamber from heat so that the metallic portions will not have their temperature limits exceeded. Under high temperature conditions, the interior of a chamber, where the high temperatures exist, cannot be metal, and it is therefore necessary to have some heat-resistant material connected to the metal wall or built within it, which shields the metal wall from the high temperatures.

Such protection may be accomplished in various ways with the utilization of different types of material. The term "refractory" as used herein is a hard, dense material weighing in the area of 130 pounds per cubic foot, and which is highly resistant to heat damage. Due to its density, it has a comparatively high termal conductivity factor. A refractory also will generally be resistant to abrasion and may in some circumstances be impervious to liquid or gas penetration.

Another material usable as a protection means for metal walls from heat is an insulation. The terms "insulation" and "insulating" as used herein refer to a material that is comparatively soft, weighing in the area of 35 pounds per cubic foot. Such material has a comparatively low thermal conductivity factor but does not have a high resistance to heat damage, abrasion or fluid penetration, as does a refractory material.

On one hand, using only a refractory as a protecting means for a metal wall would require, due to its high conductivity, quite a sizable thickness of material to reduce internal chamber temperatures down to safe metal temperature and thus to minimize heat loss due to radiation on the outside of a metal wall. For example, under operating conditions calling for chamber temperatures of 1800° F. and the requirement that the metal wall temperature be lowered to 300° F., a refractory having a thermal conductivity factor (k) value of 6:0 B.t.u. per hour, per square foot per degree Fahrenheit temperature change per inch of thickness (hereinafter units for k factors will not be given) at a mean temperature of 1000° F. would require a protective lining thickness of 15 inches. At a density of 130 pounds per cubic foot, each square foot would weigh 160 pounds. Such weight would impose a severe structural strain on a chamber and would add substantially to the weight of the chamber, itself. In comparison to a lightweight insulation, it would require stronger and more expensive supporting structures, and would consequently increase installation time.

On the other hand, overcoming the weight problem by using only an insulating material as a protection means, would present problems due to abrasive, mechanical, and heat damage.

A lining or protective means embodying low weight, and high insulating properties, and one being resistant to heat and abrasive damage requires a combination of these two materials in two layers. With this type of two layer lining, it will only require a 3 inch thickness of insulation covered with 3 inch of refractory castable material to reduce an 1800° F. internal operating temperature of 270° F. at the metal wall. Not only is the overall 15 inch thickness of all refractory type lining reduced to a two layer lining of 6 inch, but the weight per square foot of the two layers is only 42 pounds.

It is therefore an object of this invention to provide for a heat-protected metal wall having two layers of lining material, with the outermost layer having the major characteristics of resisting abrasive and heat damage, and protecting the inner layer from extremely high temperature conditions, and the innermost layer having the major characteristics of preventing heat transfer to the metal wall.

It is a specific object of this invention to provide for a heat protected metal wall having two layers of lining material, with the outermost layer being a refractory material and the inner most material as insulating material.

It is another object of this invention to provide the means of anchoring these two layers of lining material to the metal wall.

Still another object of this present invention is to provide for an economical method of constructing such a two layer heat protected wall.

In a broad aspect, this invention provides for a holding member, for anchoring and supporting multiple layers of castable materials to a wall, which comprises a straight portion and a transverse, bendable end portion, whereby said transverse portion is utilized as a gauge for screeding of a first layer of castable material thereover and as an anchoring means for a second layer of castable material after said end portion is bent at an acute angle to said first layer.

In another aspect this invention provides for a method of constructing a multiple layer heat-protected wall comprising the steps of connecting holding members with bendable end portions to a metal wall at substantially right angles thereto, with the end portions of said holding members being substantially parallel to the surface of said metal wall, applying a layer of lightweight castable insulation material in the plastic state into continuous contact with said metal wall to a thickness that substantially covers said holding members, then after allowing for setting of said lightweight material, bending each partially exposed end portion of said holding members at an acute angle to said layer of lightweight material, and applying a subsequent layer of castable monolithic refractory material in its plastic state into continuous contact with said lightweight material to a thickness completely covering the bent portions of said holding member, whereby the latter provide the means of support and reinforcement for both said lightweight insulation material and for said monolithic refractory material.

As can be seen, this invention provides for a method and means of applying two layers of lining material to a metal wall. One of these layers is a layer of lightweight insulation having excellent insulating qualities which is applied in its plastic state to the metal wall. This material's basic function is that of insulation, because it is relatively lightweight and has the characteristics of low thermal conductivity. It however, is not particularly resistant to abrasion and high temperatures. For this reason, the subsequent layer of monolithic refractory material is applied to be in contact with this lightweight insulating material.

This, hard, monolithic layer of refractory material may have either air or hydraulic-setting characteristics or in fact may be a chemically bonded refractory material. The monolithic refractory layer has a double function in this present invention, the first function being to protect the initial layer of insulation from extreme temperatures; in this respect it serves as an insulation. Because of its hardness and ability to withstand high temperatures, its second function is to provide a layer resistant to abrasive and heat damage. The refractory may also serve, in part, to protect the layer of insulation from penetration by fluids and from chemical damage, although typical refractories are only effective in such prevention in a limiting sense.

This layer of monolithic refractory material may be comparably thin and therefore very lightweight, since its insulating function basically exists to protect the lightweight insulating material between it and the metal wall and not to protect the metal wall, itself. This monolithic refractory material should, however, be thick enough to be mechanically sound and to embed the holding members or anchors which will be described in more detail hereinafter.

The holding members are formed so that their end portions are parallel to the wall at a distance from the wall equal to the calculated, intended thickness of the lightweight material. The holding members must be of sufficient length so that after they are bent to an acute angle with the layer of lightweight material, their ends will terminate well within the monolithic layer but sufficiently far out from the outside surface of the monolithic material so as not conduct large quantities of heat directly to the metal shell.

It is important to note that these anchors or holding members are special in that their design is primarily based on a dual purpose in that they serve: (1) as a means for screeding the applied layer of insulation material to a uniform calculated thickness, and (2) as the anchoring means for the refractory layer after their end portions are bent outwardly. Without the use of this type of anchor, it would be impossible to apply a two layer castable lining either pneumatically or manually.

Reference to the accompanying drawing and the following description thereof, will serve to point out and more fully illustrate the design and construction of my invention as well as to assist in further pointing out advantageous features in connection therewith.

DESCRIPTION OF THE DRAWING

FIG. 1 is a sectional view of a portion of the heat-protected wall of this present invention before application of any insulation material.

FIG. 2 is a sectional view of a portion of the heat-protected wall of the present invention after application of the layer of lightweight material.

FIG. 3 is a sectional view of a portion of the heat-protected wall of the present invention in completed form.

FIGS. 4*a*, 4*b*, 4*c*, and 4*d* are details of the various types of holding members usable in the present invention.

FIG. 5 is an elevational view of a portion of the heat-protected wall of this invention illustrating a preferred arrangement of the holding members.

Referring now in more detail to FIG. 1, there is shown a portion of a metal wall 1, which may be constructed of carbon steel and in its use in a chamber may be supported with columns, ribs, etc. depending on the stresses involved. The first step in construction of the heat-protected wall of this invention involves the welding of a plurality of holding members 2 to metal wall 1 at 3. Such holding members may be made from standard gauge steel wire; however, other materials suitable for anchoring insulation materials are contemplated as within the scope of this present invention. As heretofore mentioned the means for affixing or attaching these members to the wall 1 may be of any desirable known method such as welding, bolting, etc. but the preferred method is welding.

As is shown in FIGS. 4*a*, 4*b*, and 4*c* these holding members may be of different types. FIG. 4*a* illustrates one preferred type of holding member 2 manufactured initially in the form of a T. In FIG. 4*b* it is noted that member 2′ is actually one piece that is bent at an angle of 180° at the point of weld 3′ and then split to form a T at point 4′. Pin 2″ of FIG. 4*c* illustrated an L-shaped pin which is bent at an angle of 180° at 8. The dashed portions (5,5′ and 5″) of these holding members illustrate their shape as would exist within the completed insulated wall of the present invention. It is noted that all the holding members are bent or initially formed at 4, 4′, 4″ to have a transverse bendable end portion 6, 6′, 6″ parallel to the wall 1. This transverse portion 6, 6′, 6″ is parallel to the wall 1 so as to facilitate the spreading of the castable lightweight insulating material during its plastic state. The distance from 3, 3′, 3″ to 4, 4′, 4″ is made equal to the intended thickness of the layer of lightweight insulation material to be applied. All holding members are capable of being utilized in the same manner as will be described hereinafter. By illustrating these particular types of holding members it is the intent that they be limiting upon this present invention for other types are contemplated within the scope of this present invention.

It should be noted that these anchors or holding members are designed and arranged to have a minimum amount of metal within the lining and yet designed to retain their function of support and anchoring. Under typical installation requirements this would call for an anchor of equivalent crosssectional area of a number 8 gauge wire and a spacing of not less than 6 inches apart. Minimizing effective metal volume is important so as to prevent the holding members from defeating the purpose of the lining, that of protecting the metal wall from heat. In other words, if the anchors are made too large and arranged too closely, they will tend to conduct heat from the interior of this chamber directly to the metal wall.

One particular adaptation of these holding members is illustrated in FIG. 4*d* which shows a series of holding members 2′ which have been formed from a single wire and notched at points 13 and 13′. Such an arrangement is shown to aid in the explanation of one method of welding the holding members to a metal wall, which is made relatively simple through such an arrangement. The procedure follows: as the welder welds member A to the wall he utilizes B and C along with other remaining members (not shown) as a handle. When the joint becomes permanent, he merely breaks off members B and C from A at 13, and then proceeds to weld the next holding member in place. This illustration is presented as merely an example of one method of affixing the holding members to the metal wall 1 and should not be limiting upon this present invention.

In order to provide a uniform anchoring means for support of the two layers of material, the holding members 2 are preferably connected to metal wall 1 in a spaced pattern of a plurality of two-way rows M–M and N–N as shown in FIG. 5. In addition, the alternate members 2 in each of the respective rows are turned so that the end portions 6 are at right angles to one another so that there is in turn obtained a maximum bond between the holding members and the monolithic refractory material layer, which is applied over the end portions 6 after they are bent, as will be described hereinafter. If all holding members were positioned in one direction, there would be a tendency for cracks to occur in this outer layer. For rapid connection, all holding members that are turned in one direction in the various adjacent rows are welded in place; then subsequently all of the members in the right-angle direction to these initial members are welded in place in the given area between the others. This procedure precludes the welder from alternating directions and is especially helpful when utilizing the series of holding members of FIG. 4*d*.

The second step in construction of the wall, as shown in FIG. 2, consists of applying the lightweight insulating material 7 to the metal wall 1 to a sufficient depth so as to cover all of the vertical portion of the anchors or pins 2, but yet not so deep as to completely embed them. Typically this lightweight material will consist of insulating aggregates bonded by a cement, as for example a Haydite-Vermiculite bonded in a calcium aluminate cement. The thickness of this layer will, of course, depend upon proposed operating temperatures, as for example, a chamber with operation temperatures in the area of 1800° F. will require a thickness of 3 inches of insulation material, having a thermal conductivity factor (k) equal to 1.04, in order to reduce the temperature at the metal wall to a "safe" metal temperature of 270° F. These values are given assuming that the chamber temperature is initially reduced to a lower "safe" temperature of approximately 1320° F. by the refractory layer, as will hereinafter be explained.

It is to be noted that spreading and trowelling of the lightweight material is made relatively simple because the holding members 2 are initially bent at 4 to be parallel to wall 1. In other words, since members 2 have their end portions 6 parallel to the metal wall, the trowelling and spreading can be accomplished with large trowels that can slide easily over them; consequently there is no need to trowel or screed around the members 2. In addition, since the holding members 2 will be of standard size, the gauging of the depth of material 7 will be facilitated without the use of any gauging instruments, without the use of any screeding rods, or without any guess work.

The lightweight insulation material 7 is now allowed to set and harden. The advantages of using a castable or cementlike material having lightweight characteristics over that of a block type of material such as rock wool, or fiberglass, which must be applied in a block form, is threefold. To begin with, an insulating wall is not usually prefabricated and installed within a chamber as is, but normally made within the chamber itself, by utilizing the chamber's shell as the basis for construction. Generally, the work in such chambers is quite confined and installation of large blocks of rock wool or fiberglass becomes quite difficult because of their bulk. On the other hand, the application of a material that is in its plastic state has a distinct advantage in that it can be carried into the chamber in containers and then applied either manually or by pneumatic methods upon the inner walls of the chamber. Another advantage is that of the cost of the material itself. Rock wool, fiberglass and other types of block-type insulation material are generally found to be more expensive than castable materials that are applied in their plastic state. Still another advantage is the savings in the cost of installation of the insulating material itself; i.e. the same tradesman can both apply the initial lightweight insulating material, and after it is set, apply the monolithic refractory material. Thus, there is no requirement to bring in another tradesman to make the second application of material.

The holding members **2** are the sole support and reinforcing means for the insulation material **7**, even as it sets. As mentioned heretofore, the transverse bendable end portions **6** aid in gauging the depth of the material as it is spread onto wall **1** and also allow free movement of the screeding boards or trowels. After material **7** is set, the holding members are bent away from the surface at an acute angle *a* to the surface of the lightweight material **7** as shown in FIG. **2**. A tool similar to the handle sleeve **12** may be utilized as the device to bend the members **2**. The angle *a* as shown is approximately 45°, however, any angle may be the only limit being the initial design consideration in the establishment of support and reinforcement of the monolithic refractory material layer. After all the holding members **2** are bent to the position as shown in FIGS. **2** and **3**, the subsequent layer of monolithic refractory material **9** is applied in its plastic state. It is during this application that the holding members **2** are completely embedded within the refractory material **9**, as shown in FIG. **3**. It is to be noted that the distance from the top of members **2** at **10** to the surface of the monolithic refractory material **11** is critical in the design of the insulated wall. If this distance is too small, heat will be transmitted directly to the holding member, and through the holding member to the metal wall **1**, therefore, defeating the purpose of the insulated wall itself. Of course, the thickness of the monolithic refractory will depend upon the mechanical strength of such a layer, but it will also depend upon the operating temperatures of the chamber and the "-safe" temperature of the layer of insulating material. In other words, it must be of sufficient thickness to reduce the internal temperature of the chamber to a temperature at the surface of the insulating material below that which will harm such material. Under a chamber operation temperature of 1800° F., a thickness of 3 inches of refractory material, having a thermal conductivity factor (k) equal to 6.0, would sufficiently lower the chamber temperature to the "safe" temperature for the insulation layer, of 1320° F., as was hereinbefore assumed.

From the foregoing description, it is seen that the heat-protected wall of this invention, can be easily constructed by utilizing holding members **2**. These members serve to be the sole support for both the initial layer of castable insulation material and also for the subsequent layer of monolithic refractory material. Holding members **2** are shaped so that the initial layer of insulation material can be trowelled in an efficient manner and in such a way that uniform depth is obtained. The resulting wall, being of multiple layers and thus making full use of the characteristics of the two types of material, will be sufficiently light so as not to cause structural failure of the chamber it is utilized in. This disclosure clearly illustrates this fact. As was indicated hereinbefore, a two layer wall, of 3 inches of refractory, having a k factor of 6.0, and of 3 inches of insulation, having a k factor of 1.07, will reduce a chamber temperature of 1800° F. to 270° F. The insulation material's density of 35 pounds per cubic foot and the refractory's density of 130 pounds per cubic foot would give a total lining weight of 42 pounds per square foot wall. This weight favorably provides advantage over the 15 inch thick, single layer lining of refractory material which weighed 160 pounds per square foot. Since the outer layer of material is a refractory, the wall will also be resistant to abrasive and heat damage, and in part, to chemical damage.

Although I have described my present invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that various changes in the combination and arrangements of parts may be regarded to be within the spirit and scope of the present invention, as herein claimed.

I claim:

1. A method of constructing a multiple layer heat-protected wall comprising the steps of connecting holding members with bendable end portions to a metal wall at substantially right angles thereto, with the end portions of said holding members being substantially parallel to the surface of said metal wall, spreading a layer of lightweight castable insulation material in its plastic state into continuous contact with said metal wall to a thickness that substantially covers but does not completely embed said holding members while utilizing said end portions of said holding members as a gauge for screeding, then after allowing for setting of said lightweight insulation material, bending each partially exposed end portion of said holding member at an acute angle to said spreaded layer of lightweight material, and applying a subsequent layer of castable monolithic refractory material in its plastic state into continuous contact with said lightweight material to a thickness completely embedding the bent portions of said holding members, whereby the latter provides the means of support and reinforcement for both said lightweight insulation material and for said monolithic refractory material.

2. The method of claim **1** further characterized in that said holding members are connected to said metal wall in a spaced pattern of a plurality of two-way rows in which said bent end portions of adjacent holding members are at right angles to each other.