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APPARATUS FOR HEAT EXCHANGE

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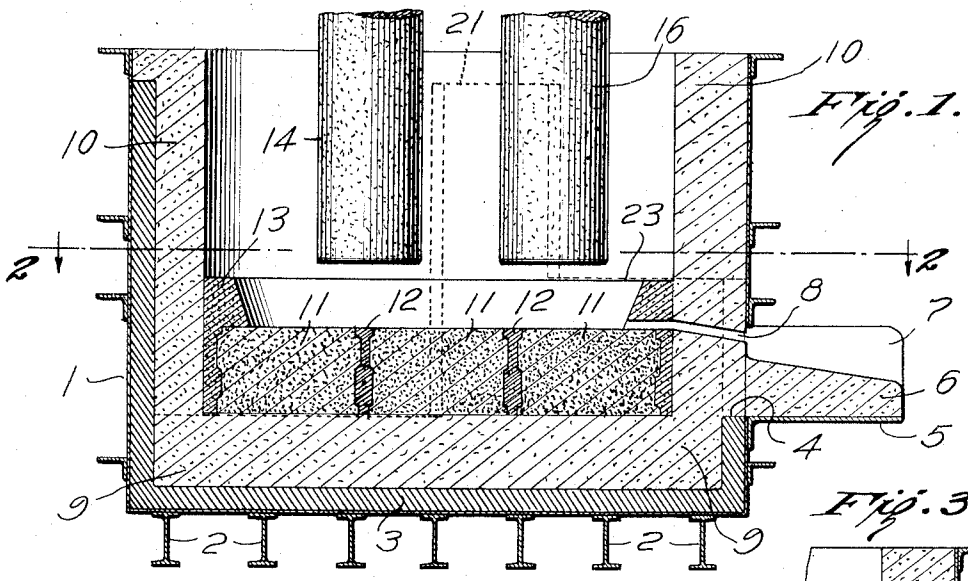


Fig. 1.

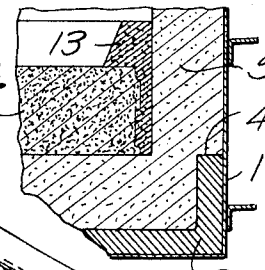


Fig. 4.

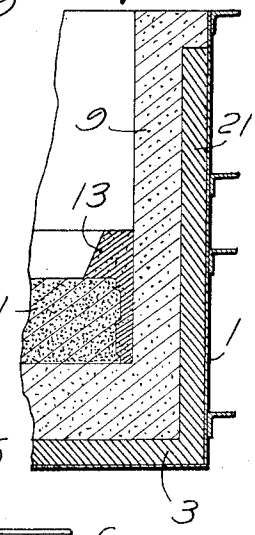


Fig. 3.

Fig. 2.

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APPARATUS FOR HEAT EXCHANGE

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8 Claims. (Cl. 13—9)

This invention relates to a method of heat exchange and also to an apparatus for practicing the method. It involves the treatment of high melting materials requiring large amounts of heat for fusion or reduction.

More particularly it relates to the use in heat exchange of a construction involving electric arcs or resistance or combined arc and resistance formed between a plurality of electrodes and usually three phase three electrode systems. This may be used for various purposes, such for example as transferring large amounts of heat at high temperatures from the electric arc, resistance and the like, to materials or mixtures of materials whereby the same are caused to react either chemically or physically, or both, to give desired compositions. I may use my method of heat exchange for the production in a mold of a desired form of high melting point material or I may utilize my invention for the purpose of producing a liquid mass, such as alloy steels by reaction of various metals, and remove the molten material from the heat exchange apparatus by allowing the same to flow out through a pouring opening. Other obvious uses are readily apparent.

My invention resides essentially in providing horizontal zones of isothermal lines at the walls of the apparatus so as to effectively utilize the heat units generated between the electrodes. In order to accomplish this I provide a hollow body or container within which the electrodes are placed and within which arcs play. The interior walls of the body are so spaced from the electrodes that substantially all of the material within the same is uniformly heated. This may be accomplished where three electrodes are equally spaced by forming the interior walls roughly in the form of a triangle with each of the electrodes in proximity to an angle of the triangle. For simplicity of construction and effectiveness of result, the corners of the triangle are rounded, the curvature thereof being approximately the same as that of the electrodes, that is, on radii having common centers. The pouring opening may be provided at one of the angles of the triangle.

In prior heat exchange apparatus of this kind it was usual to make the hollow body square or rectangular in cross section. This was inefficient for several reasons. There were zones of varying temperatures along the walls giving unequal heat transfer, and in high temperature work, some material was unfused or semi-fused. This gave an inferior product. Heat transfer was not uniform, thus increasing heat losses and decreasing efficiency which was serious in high temperature work. Semi-fused and unreacted materials built up along the walls interfering with and preventing smooth operation, and caused variations in input of energy. The effective cross-sectional area of the apparatus was materially reduced. My invention overcomes and obviates all these disadvantages and difficulties, and in a simple manner provides a heat exchange system which gives uniformly excellent operation and efficiency.

In order to obtain the isothermal lines in horizontal planes constituting the basis of this invention without the use of too much special curved bricks necessary to line the apparatus, I provide at certain specified points, heat insulating material, preferably of refractory character. The heat insulating material is inserted outside of the refractory material lining the apparatus and at points substantially between the pairs of electrodes. Such heat insulating material extends to substantially the height of the apparatus. To still further insure isothermal lines, I may, if desired, extend the heat insulating material to surround the pouring opening and in addition I provide the bottom of the apparatus with similar material.

As heat insulating material I may use any of the well-known types of insulating material suitable for use at high temperatures. For example, I have successfully used a brick form of heat insulation made from kieselguhr or diatomaceous earth which has been calcined or baked at a high temperature. This has a high degree of heat insulation. I have also used a refractory heat insulating material made from refractory material containing a high percentage of alumina, having a high porosity, and having been burned at a high temperature.

The invention is more fully set forth below and is illustrated in the accompanying drawing constituting a part hereof, and in which like reference characters indicate like parts, and wherein—

Fig. 1 is a vertical cross-sectional view of a heat exchange apparatus made in accordance with my invention, the electrodes being shown in elevation;

Fig. 2 is a horizontal cross-sectional view thereof taken along the line 2—2 of Fig. 1;

Fig. 3 is a vertical fragmentary cross-sectional view taken along the line 3—3 of Fig. 2 to illustrate the heat insulation intermediate the electrodes, and

Fig. 4 is a vertical fragmentary cross-sectional view taken along the line 4—4 of Fig. 3, showing

the heat insulation in the bottom of the apparatus.

Referring to the drawing, a steel shell 1 having roughly a triangular cross-section with rounded corners rests upon a suitable support, such as the I-beams 2. I may utilize a layer of refractory heat insulating material 3 on the bottom of the shell and extending upwardly along the sides thereof to point 4, which is a material distance below the hearth or working portion of the apparatus. A steel member 5 is secured to one side of the shell 1 and is lined with refractory material or fire brick 6 in such a manner as to provide a spout 7 into which the pouring opening 8 of the apparatus leads.

Refractory material or fire brick 9 lines the bottom of the apparatus resting upon the heat insulating material 3. It extends along the walls of the shell 1 as shown at 10 to substantially the top thereof. Upon the fire brick are placed carbon or graphite bricks constituting the floor of the apparatus, and the spaces therebetween are filled with carbon cement 12. Along the edges of the interior of the apparatus I provide a tapered portion 13 made of carbon cement allowed to set in place. This forms the hearth of the heat exchange apparatus.

Vertically suspended electrodes 14, 15, and 16 substantially equally spaced and thus forming an equilateral triangle, project into the hearth of the apparatus. The electrode 14 is placed adjacent to the rounded angle 17 of the apparatus, the electrode 15 is placed adjacent to the rounded angle 18, and the electrode 16 is placed adjacent to the pouring opening 8. This latter positioning gives a considerable advantage in that when it is desired to use the apparatus for producing molten materials, it causes the pouring opening to be at approximately the same temperature as the molten mass and thus facilitates removal thereof from the apparatus through spout 7, while avoiding chilling of the molten mass in opening 8 particularly when said material is of very high melting point. Between the electrodes 14 and 15, and adjacent to the shell 1 is heat insulating material 19 which extends vertically along the shell from the bottom to substantially the top thereof. In similar manner between electrodes 15 and 16 is heat insulation 20 and between electrodes 14 and 16 is heat insulation 21.

If heat insulation 19, 20 and 21 were not present, the radiation losses from the apparatus would be such that in order to obtain isothermal lines, it would be necessary for the interior walls of the apparatus to be curved inwardly along lines as shown by dotted line 22 between electrodes 14 and 15. This would necessitate the use of considerable special brick of curved shape and would moreover lessen the active cross-sectional area and the capacity of the apparatus. By properly placing heat insulation as at 19, 20 and 21, isothermal lines are obtained along the interior wall surfaces of the heat exchange apparatus. Heat insulation 23 and 24 is extended along the opening 8 to the front 25 of the apparatus. The height thereof is a material distance above the level of said opening and it aids in maintaining the same free from chilled material during pouring.

Although I have described my invention setting forth a single embodiment thereof and indicating that several uses might be made of my invention, it is not limited to the same. For instance, instead of melting materials in the apparatus and then removing the same in molten state, I may make the apparatus of split form and use it as a mold. In such case the material is placed in the apparatus, arcs are struck and the heat therefrom caused to pass into the material, causing chemical reactions or physical blending or other changes to take place, after which the electrodes are removed and the mass is allowed to solidify. The apparatus may then be taken apart and the solidified material removed.

My invention is not limited to the shape of apparatus illustrated in the drawing, nor to the exact positioning of the various elements shown and described herein. For example, I may provide only two electrodes and suspend the same in the body of the apparatus, the cross-section of which is an ellipse with the electrodes in proximity thereto. The pouring opening, if any, may be either intermediate the electrodes or at an end of the ellipse. In the form illustrated in the drawing, the pouring opening may be intermediate a pair of electrodes. The materials of construction such as carbon, fire brick and heat insulation may be varied at will and other materials well-known in the art may be used in place of those here described. My invention is not limited to the details above set forth but is broad and should be construed in accordance with the claims appended hereto.

I claim:

1. Heat exchange apparatus comprising a hollow body, a single set of multiphase arc electrodes therein, the interior walls of said body being uniformly spaced from said electrodes to define isothermal lines, said walls being of refractory material and having discontinuous sections of heat insulating material embedded therein at points intermediate said electrodes.

2. Heat exchange apparatus comprising a hollow body, three multiphase arc electrodes therein, the interior walls of said body being uniformly spaced from said electrodes to define isothermal lines, said walls being of refractory material and having discontinuous sections of heat insulating material embedded therein at points intermediate said electrodes, and heat insulation extending beneath the bed of said body.

3. Heat exchange apparatus comprising a hollow body, three multiphase arc electrodes therein, refractory material lining the walls and bottom thereof, heat insulating material in the bottom of said body below said refractory material and extending partially upwards along the walls, and substantially to the top of said body at points intermediate said electrodes.

4. Heat exchange apparatus comprising a hollow body, three multiphase arc electrodes therein, the interior walls of said body being uniformly spaced from said electrodes to define isothermal lines, said walls being of refractory material and having discontinuous sections of heat insulating material embedded therein at points intermediate said electrodes, and a pouring opening adjacent to one of said electrodes.

5. Heat exchange apparatus comprising a hollow body, three multiphase arc electrodes therein, the interior walls of said body being uniformly spaced from said electrodes to define isothermal lines, said walls being of refractory material and having discontinuous sections of heat insulating material embedded therein at points intermediate said electrodes, and a pouring opening adjacent to one of said electrodes, said heat insulation extending on opposite sides of said pouring opening.

6. Heat exchange apparatus comprising a hollow body, three multiphase arc electrodes therein,

the interior walls of said body being uniformly spaced from said electrodes to define isothermal lines, said interior walls forming a triangle, said electrodes being in the angles of said triangle, discontinuous sections of heat insulation along the sides of said triangle and extending substantially the height of said body.

7. Heat exchange apparatus comprising a hollow body, a single set of multiphase arc electrodes therein, the interior walls of said body being so spaced from said electrodes as to define isothermal lines, said walls being of refractory material and having discontinuous sections of heat insulating material embedded therein at points intermediate said electrodes and a pouring opening in said body.

8. Heat exchange apparatus comprising a hollow body, a single set of multiphase arc electrodes therein, the interior walls of said body being uniformly spaced from said electrodes to define isothermal lines, said walls being of fireclay, the floor of said apparatus being of carbonaceous material, a shell surrounding said body, discontinuous sections of refractory heat insulating material intermediate said electrodes interposed between said fireclay and said shell, and a pouring opening in said body.

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