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2,451,679

FURNACE LINING STRUCTURE

Filed June 25, 1945

Fig. 1.

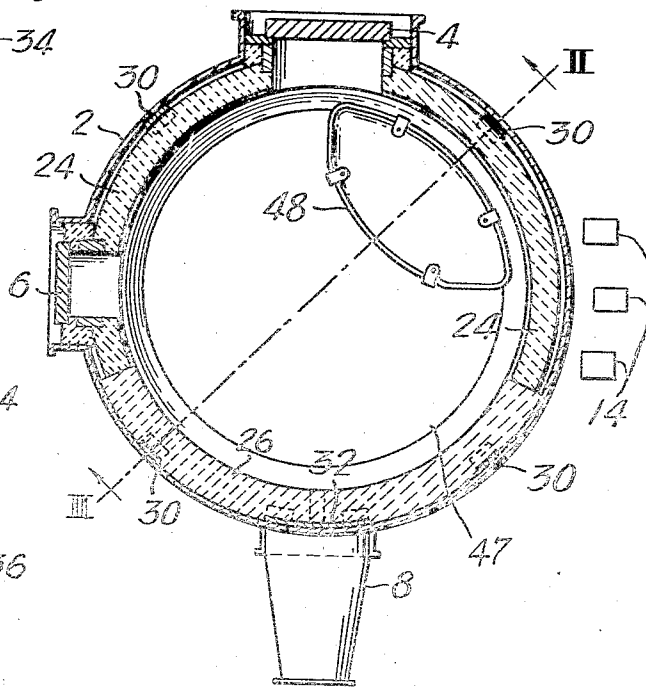
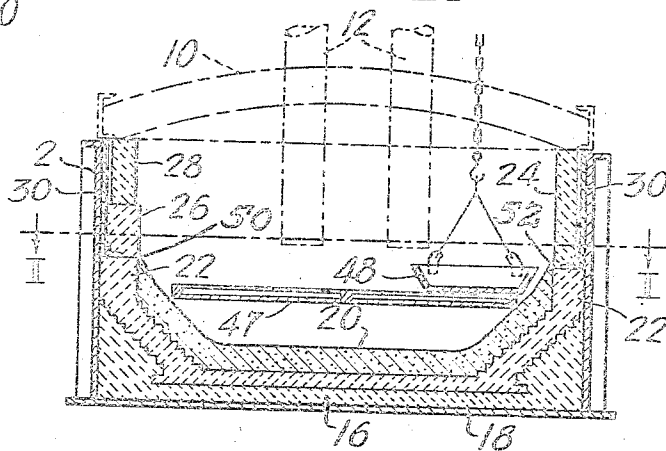


Fig. 2.



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Fig. 3.

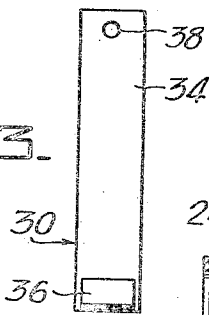


Fig. 4.

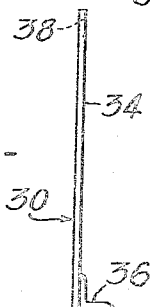


Fig. 5.

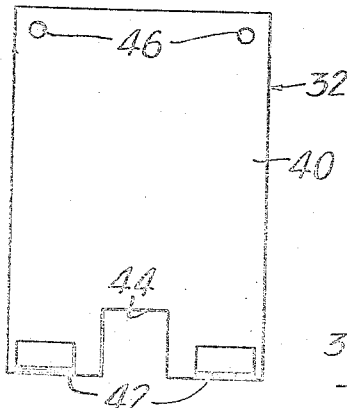
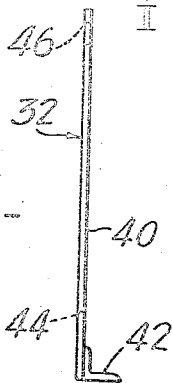


Fig. 6.



UNITED STATES PATENT OFFICE

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FURNACE LINING STRUCTURE

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4 Claims. (Cl. 266—43)

1 This invention relates to a method of and apparatus for removing the refractory linings in furnaces.

The invention has among its objects the provision of a method for quickly and conveniently loosening the furnace lining and for removing it from the furnace.

A further object of the invention lies in the provision of apparatus for readily loosening the furnace lining preparatory to its removal from the furnace, and for catching the loosened lining as it falls into the furnace, thereby facilitating its removal.

These and further objects of the invention will become more apparent in the following description.

The method and apparatus of the present invention display advantages in various types of furnaces in which the linings must be periodically renewed by reason of their deterioration by the contents of the furnace, the furnace atmosphere, or the high temperature to which they are subjected. The invention will be described in connection with its use with an electric furnace, but it is to be understood that it may be used to advantage in various other types of furnaces. The electric furnace chosen to be described to illustrate use of the present invention is shown in the accompanying drawings, in which:

Figure 1 is a view of an electric furnace in horizontal section taken along the line I—I in Figure 2;

Figure 2 is a view in vertical section through the furnace taken along the line II—II in Figure 1;

Figure 3 is a view in side elevation of an insert or pull-out plate employed in connection with the lining of the furnace;

Figure 4 is a view in end elevation of the insert shown in Figure 3;

Figure 5 is a view in side elevation of a larger insert suitable for use at a furnace opening, such as the tapping spout; and

Figure 6 is a view in end elevation of the insert shown in Figure 5.

The electric furnace shown in Figures 1 and 2 is of the three-phase, three-electrode type, generally known as the Heroult electric furnace. It consists of a generally cylindrical metal shell 2 through which suitable side openings are provided, such as the charging door 4, the operating door 6, and the tapping spout 8. The furnace, which is provided with a refractory bottom and with side linings, presently to be described, is further provided, when in operating condition,

2 with an arched refractory roof 10 through which project three electrodes 12 between which the arc is struck and maintained to provide heating means for the furnace. Roof 10 is removable for the purpose of relining the furnace, and electrodes 12 are mounted upon pivoted electrode holders 14, schematically shown in Figure 1 in inoperative position, so that they can be swung to the side of the furnace to permit removal of the roof.

The bottom 20 of the furnace is formed by layers of refractory material 16 resting upon the bottom metal plate 18 of the furnace which is secured to the shell 2. The hearth of the furnace, within which is contained the bath of material, for example, molten metal, is formed of a layer of granular material, such as burned magnesite grain sintered in place in the case of a basic furnace. Adjacent the top edges of the bottom 20 and resting upon the side portion of the furnace bottom foundation 18 is a relatively thick layer of refractory 22 which will be called the top supporting hearth brick.

The lining of the furnace, which is that portion normally above the bath in the hearth, is laid within shell 2 and rests upon the top supporting hearth brick. Such lining in the rear of the furnace, that is, adjacent the charging door, is designated 24 whereas that in the front of the furnace adjacent the tapping spout is designated 26 at the bottom thicker portion thereof and 28 at the upper portion which has a thickness comparable to that at the rear of the furnace. Part 26 is made of such increased thickness because the furnace is of the tilting type and the metal and slag rises into contact with such portion 26 of the lining when the furnace is tilted to discharge the melt.

When an electric furnace of the type shown and described is employed in the production of steel, the lining must be renewed after an average of seventy to eighty heats of steel have been produced, or after thirty-five or forty days of continuous operation. The relining operation consists in removing the refractory wall brick from the top supporting hearth brick to the roof and replacing it with new furnace brick. The normal time required for relining varies from twenty-four to thirty hours, depending upon the difficulties encountered in removing the old lining. Removal of the lining has been accomplished, according to prior art practices, by first removing the electrodes and roof of the furnace, and placing a water-cooled plate within the furnace to cover the entire bottom thereof. There-

after, laborers entered the furnace after it had cooled sufficiently, and with sledge hammers, picks, crowbars, and chisels, broke out a sufficient number of bricks to allow the entire furnace lining to be pried away from the shell and to fall on the water-cooled plate. The loosening of the lining in this manner is difficult because the heat of operation of the furnaces fuses the bricks of the lining together and converts them into an essentially monolithic structure. Removal of the lining is particularly difficult in the vicinity of the tapping spout, where the bricks are bound by metal and slag adhering thereto. After the entire lining has been deposited on the metal plate at the bottom of the furnace, the furnace is tilted and the loose brick removed therefrom by hand and shovel thrown into a debris-carrying device, such as an old ladle placed in the back of the furnace.

The present invention dispenses to a large extent with the manual operations heretofore necessary for the loosening and removal of the furnace lining. In the practice of the invention a plurality of metal inserts are placed in the furnace lining at points spaced substantially equally thereabout. Such inserts are adapted to be pulled out by a crane and have sufficient engagement with the furnace lining so that when they are lifted they carry with them, at least for a short distance, a substantial portion of the furnace lining, thereby breaking it free from adjoining portions of the lining and allowing it to fall into the hearth of the furnace. Preferably the portion of the insert which directly imposes the lifting force upon the lining is of such size and shape as to engage only the lower edge of the lining adjacent the shell, whereby continued vertical or substantially vertical lifting of the insert causes the loosened lining to pivot about its lower edge on the hearth side. As a result of such arrangement the loosened lining falls a substantial distance into the hearth in roughly horizontal position, allowing it to be caught readily in a debris box or the like, an operation which would be more difficult if the loosened lining were to fall vertically and in vertical position down the side of the lower retained lining.

In the modification shown, such inserts are of two types, the first of which, shown in Figures 3 and 4, is designated the small insert or pull-out plate. Such insert consists of a vertical plate portion 34 having a portion of an L-shaped angle iron 36 welded to the bottom thereof as shown, and a hole 38 in the top thereof for the reception of lifting means. The second type of insert, which is called the large insert or pull-out plate, is shown in Figures 5 and 6. Such insert consists of a vertical plate 40 curved to conform to the furnace shell and having at the bottom thereof two short pieces of L angle bars 42 welded thereto as shown. The central bottom portion of plate 40 is cut away at 44 to provide for the tap hole. The top of plate 40 is provided with two holes 46 for the reception of the lifting means.

The inserts are placed in the furnace shell, as shown, before the lining is laid, with the elongated vertical portion thereof in contact with the shell and with the L-shaped bars at the bottom thereof resting upon the top of the top supporting hearth brick 22 so that the projecting leg of the L bar extends toward the interior of the furnace. This leg, which directly sustains the weight of the lining to be loosened when the insert is lifted, is made of a length substantially

less than the thickness of the lining at that point, both to protect it from the furnace heat and to cause the loosened lining to fall in the preferred manner above described. The furnace lining is then laid in the conventional manner, portions of the bricks contacting the inserts being cut away, if necessary, to receive the inserts so as to allow the inner hearth side of the lining at the inserts to conform to the remainder of the smooth interior surface thereof. The vertical portions 34 and 40 of the inserts are made of such height that they are completely covered by the lining brick.

When the furnace so provided with inserts in the lining thereof has been operated for such a time that the lining needs renewal, the furnace roof and electrodes are removed as formerly, a water-cooled plate 47 is inserted in the furnace to cover the bottom thereof, and, after the furnace has cooled sufficiently, men working from outside on ladders or scaffolding manually dislodge the bricks over the holes 38 and 46 in the inserts. The location of such holes can readily be ascertained if the inserts are put in in certain known locations with respect to fixed structures on the furnace, such as the doors and spout. When the holes in the inserts have been uncovered, a debris box 48, having an outer contour conforming to the inner surface of the lining, is placed within the furnace, as by a crane equipped with the chain and sling shown in Figure 2, in a position beneath the lining and centrally located with respect to the insert which is to be pulled. The debris box may rest on plate 47 as shown, the chain and sling being then disconnected therefrom until the box must be moved or emptied.

A suitable lifting means, such as a crane hook, is then engaged in the hole in the particular insert to be pulled and the insert is pulled upwardly, or upwardly and slightly inwardly, of the furnace. The engagement of the insert, particularly by reason of the engagement of the projecting leg on the L-shaped bottom thereof with the furnace lining, is sufficient to carry a large portion of such lining upwardly with it and thus to break it free from the furnace shell and from the adjoining portions of the lining. By reason of the fact that the projecting leg of the L-shaped bottom of the insert in the preferred embodiment engages only the edge of the lining to be loosened adjacent the furnace shell, a substantially vertical lifting of the insert has the effect of causing the loosened lining in general to pivot about its lower edge adjacent the hearth and to fall into the debris box in substantially horizontal position. In Figure 2 the lower edge about which the loosened lining pivots on the top supporting hearth brick 22 at the right of the furnace section is designated 52 and that at the left of the furnace section, where the thicker bottom lining is employed is designated 50. It will be understood that, since the lining is composed of individual bricks held together by a bonding material, sometimes the break between the lining to be retained, that is, the top supporting hearth brick, and the lining to be removed, especially at points somewhat distant from the inserts, takes place at levels somewhat different from that of edges 50 and 52. In some cases, furthermore, pulling of the inserts may cause a general collapse of the lining rather than the removal of substantial sections by causing them to pivot as a whole. Usually, however, the parts of the lining to be removed remain bonded together firmly enough to

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be lifted and pivoted as a whole in the manner described, especially in the vicinity of the inserts. The portion of the lining thus broken free falls inwardly of the furnace, and when the debris box is properly located the greater part of the lining falls within it. The debris box is then emptied and placed adjacent another portion of the furnace lining which is to be removed in the same manner as above. This operation is repeated, usually at successive inserts around the furnace, until all the inserts have been pulled, and then any lining remaining, which may be in the nature of a shallow layer on portions of the top supporting hearth brick 22 between the points at which the inserts were located, may be removed by hand. The furnace is then relined as formerly, with the modification, however, that the inserts, which are substantially unharmed by repeated use, due to their being enclosed in the refractory, are cleaned and then inserted in the furnace, as described, before application of the lining.

It will be apparent that the invention makes possible the saving of considerable time in the removal of an old lining from a furnace and its replacement by a new lining. On the average, use of the invention allows such operation to be completed on a furnace of the type shown with the saving of eight hours in the total idle period of the furnace. In addition, it makes possible the saving of a large amount of disagreeable labor, since workmen must be within the hearth of the furnace during the lining removing operation only for the purpose of removing the few small portions of the lining remaining after pulling the inserts.

Having thus fully disclosed the method and apparatus for the present invention, I claim as new the following.

I claim:

1. In a furnace comprising a shell and a refractory lining, a plurality of metal inserts of generally L-shape, said inserts being of substantial area, one leg of the inserts being mounted in upright position between the shell and the lining and the other projecting outwardly from the shell under a portion of the lining, said inserts being spaced at intervals around the furnace, whereby pulling of the inserts in a direction upwardly of the furnace effects dislodgement of the furnace lining.

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2. In a furnace comprising a shell and a refractory lining, a plurality of metal inserts of generally L-shape, said inserts being of substantial area, one leg of the inserts being mounted in upright position between the shell and the lining and the other projecting outwardly from the shell under a portion of the lining, said inserts being spaced at approximately uniform intervals around the furnaces, said inserts having means at the upper end of the leg between the furnace shell and the lining for the attachment of a lifting means for pulling the inserts upwardly to effect dislodgement of substantially all the lining.

3. In a furnace comprising a vertical furnace shell and a horizontal refractory support or annular shape disposed therein and lying adjacent the inner periphery of the shell, and a refractory lining resting on top of the support and against the shell, at least one metal insert of generally L-shape, said insert being of substantial area, one leg of the insert being mounted in upright position between the shell and the lining and the other projecting outwardly from the shell under the edge of the lining and being of substantially less length radially of the furnace than the thickness of the lining, said insert having means at the upper end of the leg between the furnace shell and the lining for the attachment of a lifting means for pulling the inserts upwardly whereby the portion of the lining in the vicinity of the insert is broken loose from the shell, support, and adjacent portions of the lining, pivots about the bottom edge thereof and falls inwardly.

4. In the furnace set out in claim 3, a plurality of said inserts spaced at intervals around the furnace, whereby pulling of the inserts vertically effects dislodgement of substantially all the furnace lining.

STANLEY A. KOMOROWSKI.

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