June 27, 1933. C. HART 1,916,170

FURNACE LINING

Filed June 18, 1930

Fig. 1.

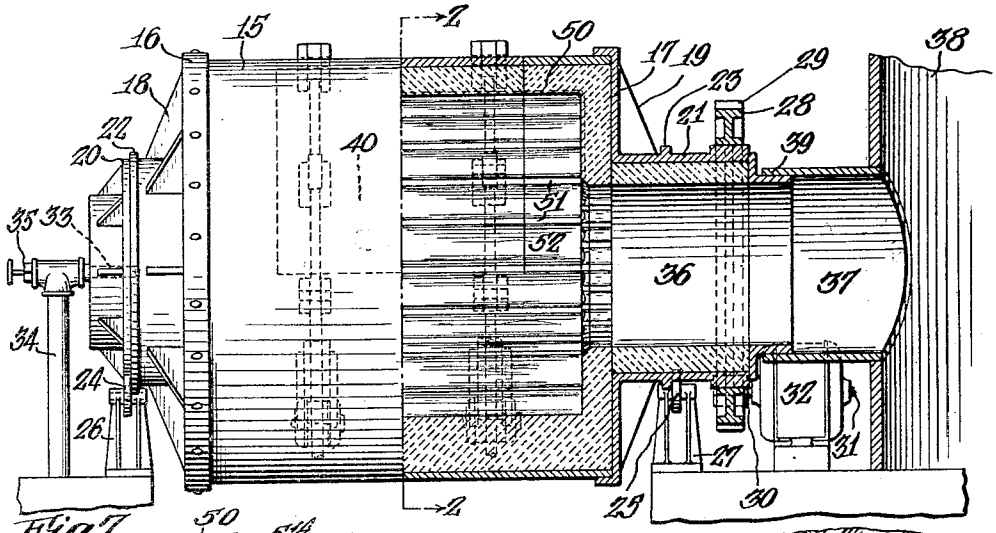


Fig. 7.

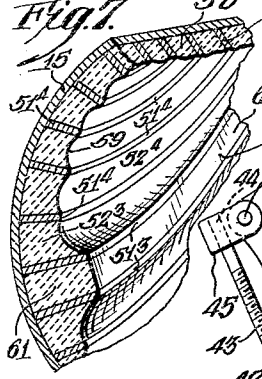


Fig. 2.

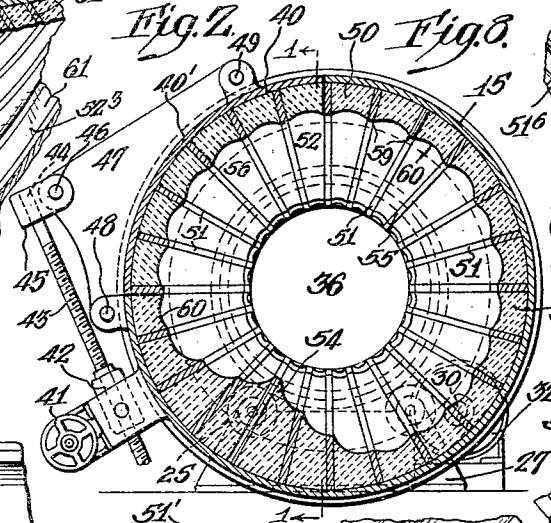


Fig. 8.

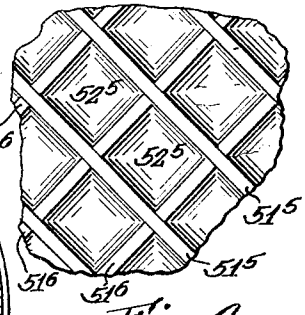


Fig. 3.

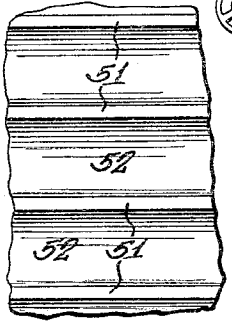


Fig. 4.

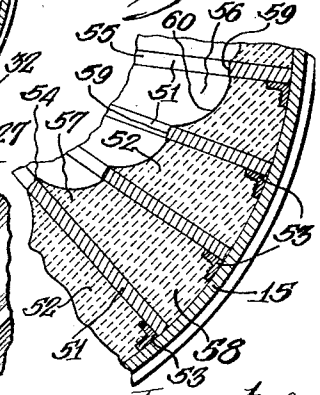


Fig. 5.

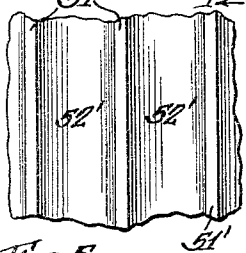
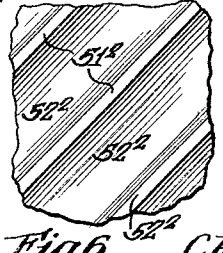


Fig. 6.



Witnesses:
Elmer W. Hackett
Walter Chiam.

Inventor
Charles Hart
by
Attorney.

Patented June 27, 1933 1,916,170

UNITED STATES PATENT OFFICE

CHARLES HART, OF MEDIA, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-HALF TO WILLIAM STEELL JACKSON, OF PHILADELPHIA, PENNSYLVANIA

FURNACE LINING

Application filed June 18, 1930. Serial No. 461,893.

My invention relates to furnace linings and more particularly to linings for mechanical puddling furnaces.

A purpose of my invention is to provide a furnace lining with metallic strengthening ribs, and to pack the spaces between the ribs with refractory material.

A further purpose is to extend metallic braces throughout the body of the refractory lining of a furnace exposed to the charge so that crushing and breaking strains arising from the charge, and particularly shock due to the rolling of the puddled ball about the furnace lining, will be borne by the metal braces rather than by the weaker refractory material, while at the same time the lining of the desired chemical properties will consist mainly of refractory material between the braces.

A further purpose is to strengthen exposed portions of a furnace lining which are particularly subject to crushing and spalling, as for example, skimming and breaking walls and mixing vanes, by extending metallic ribs throughout the body of such structures, and desirably exposing them to the surface at prominent points to bear the additional strains to be met there.

A further purpose is to build a mechanical puddling furnace lining of metallic strips, packing refractory material between them to a thickness less than the strips, so that the alternate elevations at the strips and depressions between the strips will form an undulating surface very desirable for mixing the charge when the furnace is rotated or oscillated.

A further purpose is to spirally direct strengthening ribs exposed to the charge in a rotatory or oscillatory furnace lining to assist in stirring by directing the charge against the end wall of the furnace.

Further purposes will appear in the specification and in the claims.

In the drawing several forms embodying my invention are illustrated. I have selected from among the many possible forms those which are convenient to manufacture, efficient in use, and which well illustrate the principles involved.

Figure 1 is a side elevation of a mechanical puddling furnace to which my invention has been applied, half of which has been sectioned upon the line 1—1 of Figure 2.

Figure 2 is a section taken on the line 2—2 of Figure 1 but omitting the stack and the suporting structure shown in Figure 1.

Figure 3 is an enlarged fragmentary elevation of my furnace lining as viewed from the interior in a radial direction.

Figure 4 is a fragmentary section corresponding generally to Figure 2, but greatly enlarged.

Figures 5 and 6 are generally similar to Figure 3, but show slight variations in the furnace lining structure.

Figure 7 is a fragmentary sectional perspective view of another modified form of my furnace lining.

Figure 8 corresponds generally to Figure 3 except that the strengthening ribs in the lining are differently disposed.

Referring to Figures 1 and 2, the furnace comprises generally an external metallic casing 15 supported at either end by the heads 16 and 17, braced at 18 and 19 from the hubs 20 and 21. The hubs carry bands 22 and 23 which rest in and rotate or oscillate upon rollers 24 and 25 in supports 26 and 27, so that the furnace may be rotated or oscillated as desired. The hub 21 also supports a driving band 28 having gear teeth 29 engaging the driving gear 30 on the shaft 31 of the motor 32, to turn the furnace.

Suitable gaseous or liquid fuel is admitted through the burner 33 from the pipe 34, controlled by the valve 35. Air is drawn in around the burner. The products of combustion from the furnace discharge through the neck 36 into the flue 37 and up the stack 38. The flue and the neck are desirably interrelated as at 39 in any suitable manner so that the furnace may rotate without excessive loss of draft.

For charging and discharging, the furnace has a door 40, which may very desirably be mechanically controlled by the electric motor and speed reduction units 41, as through the driving connections at 42 and impart rotation to the screws 43, supported

in the bearings 44 of the collars 45. The collars 45 are pivoted at 46 to the lifting arms 47, pivotally secured to the furnace casing at 48. The lifting arms 47 are secured to the door frame 40' at the pivotal and rotatable bearings 49.

It will be understood that the description herein recited of the mechanical details of the furnace structure is entirely irrelevant to the claim features of my invention, and is given merely to make clear the drawing which I show of my best form.

As best seen in Figure 2, the furnace casing 15 supports a lining 50 about the interior, to hold the "bottom" and the charge. Previous practice has been to form this lining of some suitable, preferably basic, refractory material, as for example magnesite. While magnesite is a satisfactory lining chemically it frequently fails due to mechanical shock when the wrought iron ball rolls over the lining and drops from the advancing side of the rotating furnace to a point near the bottom.

Particularly where a projection of any kind extends into the furnace, the lining will suffer excessively from the constant pounding by the metal during its semi-solid stage at the end of the puddling operation.

It has previously been suggested in the patent to Maccallum, No. 1,106,725, that the roof and upper walls of steel furnaces may be formed of small independent pipe sections packed with refractory and set like bricks endwise in the furnace wall, refractory material being placed between them to serve as mortar. This is unsatisfactory because, it greatly decreases the strength of the lining in a direction parallel to the surface, as the short pipes do not unite the lining wall.

The above patent also proposes to build up a steel furnace roof of refractory filled in pockets formed by a metal frame. Maccallum of course does not propose to have his roof lining come in contact with the charge, and indeed it would be impossible under the conditions in a steel furnace.

In attempting to design a lining to stand the severe conditions of shock encountered in a mechanical puddling furnace, I have discovered that by extending ribs continuously along the lining and packing refractory between them I can obtain a much greater strength and stiffness in the plane of the surface, as for example to resist the impact of the puddled ball, and at the same time can assist in mixing the charge due to the maintained irregularity of the surface.

As seen in Figure 2, and more clearly in Figures 3 and 4, the ribs 51 extend the full length of the furnace and also along the ends to the opening at each end. Between the ribs 51 refractory material has been packed as at 52. This packed material may very desirably be magnesite.

My bracing strips 51 may be secured to the body 15 of the furnace as by brackets 53, seen in Figure 4. While these brackets are desirable, they are not necessary for the proper use of my invention, because the great length of the ribs and their continuous packing with refractory material tends to give them rigidity without attachment to the body of the furnace. Where ribs of considerable radial extent are used, as in the dam or breaking wall 54, the ribs will very desirably be united to the furnace casing because of the abnormal angular strains to which they will be subjected.

Even without the use of attaching means between the ribs and the external casing, my lining is very strong and firm. Additional firmness is imparted by extending the ribs radially inward across the ends as at 55, thus locking the ribs against slipping inward by virtue of the wedge action of the refractory material packed between the ribs at points 56. It will be seen that the refractory material fills a space between the ribs of increasing width as the radial distance from the axis increases. The wedge shaped packing of the refractory, while not necessary to my invention. is advantageous.

It will be seen in Figure 4 that the distance between the ribs at some point 57 near the inside of the lining cross section is less than that at the outside as at 58. The cavity between the ribs into which the refractory is packed thus has the general cross section of a trapesium, so that the refractory cannot possibly slide inward, and it will be constantly held against the ribs by wedge action against their sides.

In Figures 1 to 4 I indicate that the ribs may be placed in generally radial planes. This has a distinct advantage in the application of my invention to a mechanical puddling furnace because the lining may conveniently have alternate projections and hollows extending in radial planes and serving to assist in the mixing of the metal.

In these figures I indicate that the metal ribs protrude relatively far inwardly as at 59, while the adjacent refractory material does not extend so far inwardly as at 60. Each strengthening rib in the lining will form a miniature mixing wall or breaker, while each hollow in the refractory between the ribs will permit metal flowing from the ribs to lap over itself as it mounts the next slope to the succeeding rib.

This process will be continuously repeated as the furnace rotates or oscillates, so that the ribs will not only strengthen the entire lining, but will more particularly strengthen the inner projecting portions of the lining at the point where increased strength is most needed, that is, at the peak of the projection.

Since my invention is advantageous in providing miniature breaking walls about the

entire lining, it will of course much increase the efficacy of a large breaking wall such as 54. The metal flowing over the wall 54 as the furnace oscillates or rotates will encounter not only the general irregularity of the wall in outline, but also the local undulations due to the alternate ribs and hollows. This advantage is supplementary to the desirable strengthening of the breaking wall by the ribs.

My invention is not restricted to mechanical puddling furnaces, nor is it limited to rotating or oscillating furnaces at all, nor to furnaces for mixing wrought iron. It offers considerable advantage in the construction of linings for open hearths, air furnaces, cement kilns, ovens and many other metallurgical and industrial uses.

In Figures 5, 6, 7 and 8 I illustrate modified forms of my furnace lining. It will be understood that these forms may be considered applied to the furnace of Figures 1 to 4, or as making up part of the wall of any other furnace to which my invention might be applied, whether it is movable or stationary, and whether or not it is used in the mixing of wrought iron.

Where Figures 5, 6, 7 and 8 represent their respective forms applied to the furnace of Figures 1 to 4, they differ from the form of Figures 1 to 4 in the mode of disposing the ribs. In Figure 5 the ribs 51′ extend circumferentially about the lining, with refractory material 52′ packed between the ribs. This disposition is disadvantageous in the making of wrought iron because the ribs are not available to perform their most efficient mixing function, but nevertheless I consider this construction superior to the linings now in use, and anticipate that it may prove highly advantageous in furnaces other than puddling furnaces.

In Figure 6 the ribs 51^2 are spirally disposed, and have refractory material 52^2 packed between. The direction of the ribs is advantageous because it will impart a rotary motion to the puddled ball, tending to make the ball spherical rather than ellipsoidal. The spiral ribs will also produce end mixing in the liquid charge, because they will tend to feed the charge toward one of the other of the ends of the furnace, where the charge will lap over itself in striking the end wall, thus obtaining a desirable type of mixing.

In Figure 7 I show spirally disposed ribs 51^3 bracing a spiral mixing vane 61. The direction of the strengthening ribs 51^3 is here the same as that of the mixing vane so that no strengthening rib runs transverse to the mixing vane at any point. The ribs 51^3, forming part of the mixing vane, are much longer radially than the adjacent ribs 51^4.

It will be seen that the spiral mixing vane 61 will be much more effective in projecting the charge against the end of the furnace for mixing purposes than are the spiral strengthening ribs 51^3, but that the spiral strengthening ribs facilitate the use of and accentuate the result obtained from the mixing vane 61, at the same time strengthening the mixing vane against breaking or spalling when it may be subjected to impact, as for example from the puddled ball.

Of course the ribs need not necessarily lie in the plane of the spiral vane, but could extend for example in any of the directions shown in Figures 3 to 6 and 8.

The use of spiral ribs 51^4 in the lining proper concurrently with the mixing vane, while desirable is not necessary to my invention, although the ribs 51^4 cooperate to support the mixing vane 61 and the mixing vane ribs 51^3, and will preferably be spiral along the same pitch as the mixing vane.

Refractory material is packed between the ribs 51^3 at 52^3, and between the ribs 51^4 at 52^4.

In Figure 8 I show strengthening ribs 51^5 and 51^6 running transversely with respect to one another. One set of ribs may consist of short units extending only between the adjacent members of the transverse set of ribs, and supported from the furnace body as shown in Figure 4, or else one or both sets of ribs may be slotted to interfit as desired. Refractory material 52^5 is packed in the closed space between the ribs. It will be evident that this form is distinctly advantageous, not only because of its irregular surface which will assist in mixing, but also because the strengthening ribs provide interlocking support in all directions. The interlocking ribs brace one another and are effectively metallic honeycomb.

While I indicate that refractory material will be packed about the strengthening ribs, it will of course be understood that the refractory portion of the lining may consist of bricks or of a single brick between each adjacent set of ribs, or of pulverized refractory or refractory crumbs, with or without binder.

When I say that my strengthening ribs are "exposed to the furnace interior" or "exposed to the charge" I mean that the inner end of each rib extends inward to substantially the same distance or to a greater distance than the adjacent refractory material. I do not means that some slight refractory covering over the rib may not exist, or that the rib will not be covered by the "bottom" or fettling, since this will ordinarily be the case.

The mere placing of a thin refractory coating over the end of the rib will not avoid the use of the broad principle of my invention, which is to support the greater part of the impact from the charge against the lining by the rib.

The infinite demands for furnace movable construction will doubtless suggest to designers the use of the lining of my invention in a

great variety of furnaces and for many different uses in any particular furnace, but I believe that I am the first to place in a furnace lining strengthening ribs perpendicular to the lining surface, exposed to the charge and extending for a substantial distance along the lining in any direction.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain part or all of the benefits of my invention without copying the structure shown, and I, therefore, intend herein to claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a rotatory or oscillating furnace, a furnace body, means for turning the body about an axis, a furnace lining within the body having a surface parallel to the axis and having ends, and a plurality of metallic strengthening ribs, each rib being integral, being embedded in the lining and being exposed to the charge along the surface parallel to the axis and also at the ends.

2. In a rotatory or oscillatory mixing furnace, a furnace body, a furnace lining within the body and a breaking wall extending inward from the general surface of the lining consisting of a plurality of metallic ribs extending along the wall and exposed to the charge, and refractory material between the ribs.

3. In a rotatory or oscillatory mixing furnace, a furnace body and a refractory lining within the body consisting of a plurality of spiral metallic ribs and refractory material between the ribs, the refractory material between each pair of adjacent ribs extending inward to the longitudinal edges of the ribs near the ribs and, between the ribs, extending inward less than the inward extension of said adjacent ribs, whereby end mixing of the charge will take place when the furnace is in motion.

4. In a rotatory or oscillatory mixing furnace, a furnace body, a furnace lining within the body and a spiral mixing vane in the lining consisting of a plurality of metallic ribs exposed to the charge and extending inward farther than the remaining portion of the lining, and refractory material between adjoining ribs and extending inward farther than said remaining portion of the lining.

5. In a rotatory or oscillatory mixing furnace, a furnace body, a furnace lining within the body consisting of spiral ribs exposed to the charge and refractory material between the ribs, and a spiral mixing vane formed of a plurality of ribs of greater inward extension than those of the lining and refractory material between the ribs.

6. In a furnace lining, a plurality of metallic ribs generally parallel, other ribs generally transverse with respect to the first and intersecting them, and refractory material between the respective ribs and extending inward substantially the same distance as the ribs.

7. In a furnace lining, a honeycomb like structure of mutually braced metallic ribs, some generally parallel to and others generally transverse to one another, and refractory material between the ribs.

8. In a rotatory or oscillatory puddling furnace, a cylindrical furnace body and a furnace lining within the body having axial undulations, comprising a radially and axially extending metallic rib following the peak of each undulation, exposed to the charge and spaced more widely from its neighbor at its outer edge than at its inner edge, and refractory material in the depressions between the peaks and rising to the peaks of the undulations.

9. In a rotatory or oscillatory puddling furnace, a furnace body and a furnace lining within the body having an undulating inner surface, comprising a metallic rib extending along the peak of each undulation, exposed to the charge, and refractory material in the depressions between the peaks and rising to the peaks of the undulations.

10. In a rotatory or oscillatory puddling furnace, a furnace body and a furnace lining within the body having an undulating inner surface, comprising a metallic rib extending along the peak of each undulation, exposed to the charge and secured to the furnace body and refractory material in the depressions between the peaks and rising to the peaks of the undulations.

CHARLES HART.