Nov. 10, 1942. W. JOHNSTON, JR 2,301,880

REINFORCED CINDER POT

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FIG. I.

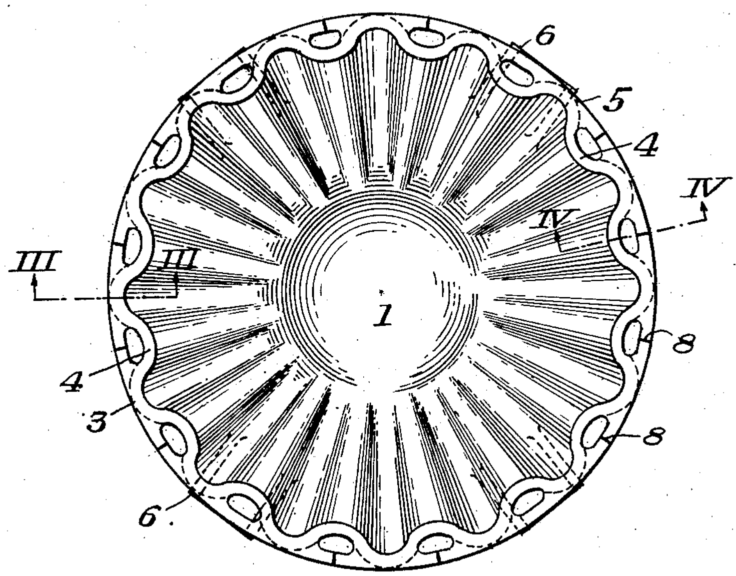

FIG. II.

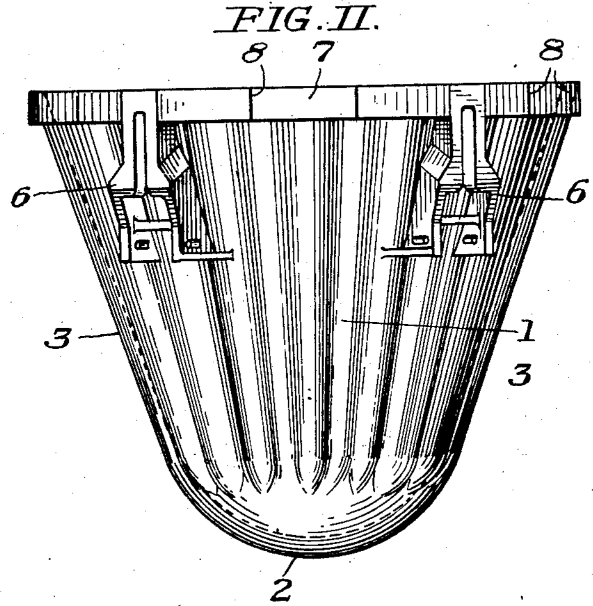

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FIG. III.

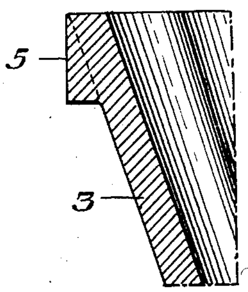


FIG. IV.

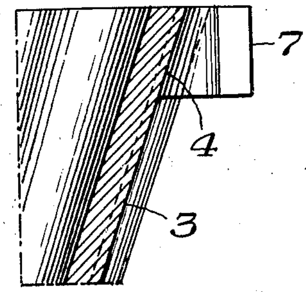


FIG. V.

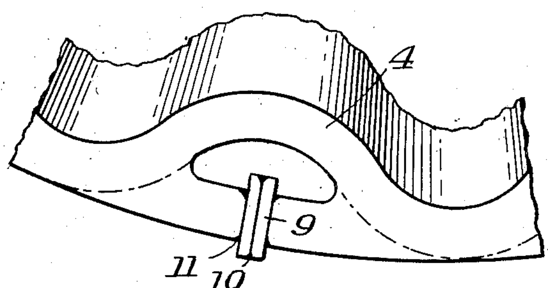


FIG. VI.

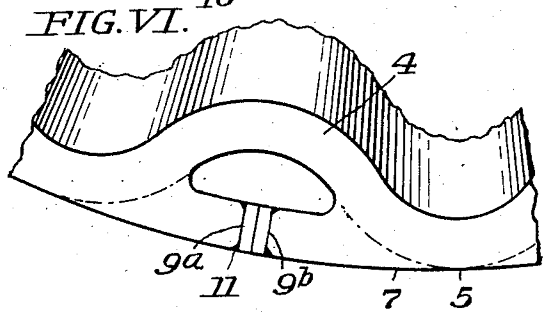
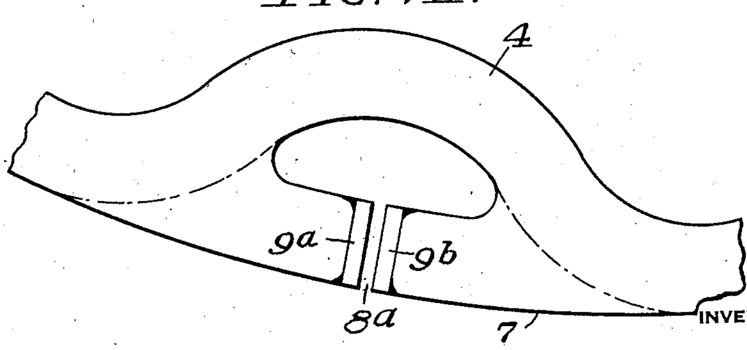


FIG. VII.



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UNITED STATES PATENT OFFICE

2,301,880

REINFORCED CINDER POT

William Johnston, Jr., Wilkinsburg, Pa.

Application July 25, 1942, Serial No. 452,265

2 Claims. (Cl. 266—39)

This invention relates to cinder pots; that is to the large vessels of cast iron and steel which are used to receive and convey slag and cinder from metal reducing and treating furnaces, and particularly from open-hearth steel-making furnaces. The cinder pots themselves are ferrous, and desirably steel, castings.

In service of the cinder pots slag is poured from the surface of the molten metal in a furnace or ladle, and the cinder pots are then lifted by a crane and placed aside for gradual cooling of the slag. At some period after they have been filled, the cinder pots are lifted, and usually are conveyed to a slag disposal yard. In any event, cinder pots are lifted and moved by a crane while the cinder pot is highly heated from the hot slag which it contains.

It is recognized that the best equipment associated with cinder pots for their lifting is a lifting, or trunion ring in which the cinder pot is set, and which ring rather than the cinder pot itself is engaged by the crane hooks or bars when the cinder pot is lifted. For one reason or another all steel-making plants have not been able to adopt lifting rings for their entire cinder pot practice, and therefore many cinder pots, and particularly those of the larger sizes, are lifted by a direct engagement with trunnions or feet carried by the cinder pot wall.

The cinder pots which are most widely used, and in which the benefits derived from my invention are most strikingly present are of the conical type, that is they are formed of conical shape and are used with their larger and open ends upwardly presented. This is a well-known type of cinder pot, and such cinder pots will be referred to hereinafter as "conical" cinder pots. In order that such cinder pots, when filled, may be lifted in balance the trunnions or lugs by which they are engaged for lifting are placed in an upper region of the cinder pot. In conical cinder pots slag freezes most rapidly at the upper and open end of the cinder pot where the slag is exposed to the atmosphere, and at the lower end of the cinder pot where the area of the wall available for heat dissipation is relatively great with respect to the volume of the hot slag which is there confined. In an intermediate region, which lies irregularly about two-thirds of the way up from the cinder pot bottom, the slag is confined between the bodies of frozen slag, or "skulls," which overlie and underlie it as well as by the cinder pot wall, and in that region the volume of hot slag confined is relatively great with respect to the area of the cinder pot wall. In practical effect heat dissipation in that zone is limited to transfer through the cinder pot wall, and the volume of slag being great with respect to the wall area it is here that the cinder pot wall is raised to its highest temperature.

The lifting trunnions or lugs are thus carried by the cinder pot in its zone of highest temperature, and because of its relatively high temperature that is the cinder pot region which is most susceptible of distortion under applied forces. When therefore the cinder pot is engaged with a crane at two or more points by attachment of the chains or hooks of the crane to the trunnions or lifting lugs of the cinder pot, the opposition of forces produced between the points of engagement and by the weight of the cinder pot tend to cause cross-sectional distortion of the cinder pot wall in this highly heated region, or zone. If the cinder pot is suspended from two opposite points the effect is to crush the cinder pot into an oval contour, and if it is suspended from a greater number of points the effect is to produce cross-sectional distortion corresponding to the pattern in which the points of engagement are arranged. Distortion destroys the balance of the cinder pot, and increases the difficulty of removing solidified slag from it. It greatly decreases the useful life of the cinder pot.

The problem presented by the cross-sectional distortion due to lifting may in great measure be obviated by forming a substantial rim around the extreme upper edge of the cinder pot wall. Such rim, stiffens the cinder pot so greatly against the distorting effects caused by lifting as to minimize cross-sectional distortion.

Another problem met in cinder pot practice results from unequal expansion and contraction of the cinder pot wall, which expedites destruction of the cinder pot by cracking and checking of its walls. This difficulty is overcome by corrugating the wall of the cinder pot, as in my prior Patents No. 2,057,528, issued October 13, 1936, and No. 2,181,331, issued November 28, 1939. If, however, a stiffening rim is applied to a cinder pot of the corrugate species, it so binds the cinder pot wall that benefit of the corrugations in facilitating expansion and contraction is lost and the cinder pot wall cracks and checks as if it were throughout of simple circular section. This disadvantage substantially outweights the advantage of preventing cross-sectional distortion in lifting the cinder pot.

As hereinabove specifically discussed, and as specifically as shown herein, the cinder pots in which my invention is incorporated are of the conical type, and the corrugations of the cinder pot wall are formed as smoothly curved inward and outward bows. It is to be understood, however, that cinder pots shaped other than conically, such for example as cinder pots which are primarily oval and primarily rectangular in cross-section, are also in measure susceptible to distortion under lifting forces. Also cinder pots have been made in which the effect of curved corrugations is in part obtained by forming the cinder pot wall with inward and outward bows recurrent around the cinder pot, but which are formed on relatively straight lines instead of regularly curved lines. To all of such cinder pots my invention applies.

It is the object of my invention to provide cinder pots formed for facilitated expansion and contraction with reinforcing means arranged at the upper end of the cinder pot which is of such sort as effectively to stiffen the cinder pot against forces tending cross-sectionally to distort it, without preventing or substantially limiting free expansion and contraction of the cinder pot wall.

In the accompanying drawings illustrating an exemplary embodiment of my invention:

Fig. I is a plan view of a cinder pot of the conical type and corrugated species which embodies the novel features of my invention.

Fig. II is an elevational view of the cinder pot shown in Fig. I.

Fig. III is a detail vertical sectional view on an enlarged scale, taken in the plane of the section line III—III of Fig. I, at one of the outward bows of the corrugated cinder pot wall.

Fig. IV is a detail vertical sectional view on an enlarged scale, taken in the plane of the section line IV—IV of Fig. I, at one of the inward bows of the corrugated cinder pot wall.

Fig. V is a detail plan view on an enlarged scale, taken at one of the inward bows of the corrugated cinder pot wall, and illustrating a preferred method of embodying the principles of my invention in the general physical structure of a cinder pot, an intermediate stage in the process being illustrated.

Fig. VI is a detail plan view similar to Fig. V but illustrating the completion of the preferred process of embodying my invention in the cinder pot.

Fig. VII is a detail plan view, generally, similar to Fig. VI but still further enlarged, illustrating the condition of the structure shown in Fig. VI when the cinder pot wall has been heated to a high temperature.

Referring now particularly to Figs. I and II of the drawings, the cinder pot designated generally by reference numeral 1 is shown as a one-piece casting, which is primarily of conical shape and which is composed of iron or steel, preferably the latter. The curved bottom 2 of the cinder pot merges with the bounding side wall 3, which is corrugated. As shown, the corrugations of the bounding side wall of the cinder pot are composed, as is preferable, of smoothly curved bows, 4 and 5, extended alternatively inward and outward from a common base line. These corrugations as shown extend downwardly from the upper end of the cinder pot, gradually decreasing in depth downwardly finally to merge into a true circular wall of the cinder pot. If desired, however, they may be continued around the bottom 2 finally merging, or blending adjacent the vertical axis of the cinder pot. As above indicated, the corrugations may be made more abrupt by resolving their curves into straight or approximately straight lines. Projectant from the outer surface of the cinder pot wall there are four equally spaced lifting lugs 6, by two or more of which the cinder pot is engaged for lifting.

In this corrugated species of cinder pot, the cinder pot wall is able to expand radially of the cinder pot, with an accompanying straightening tendency of its wall, so that the binding effect of a true circle is obviated, and destructive stresses attendant upon a high temperature of the cinder pot wall are avoided.

The cinder pot is, however, subject to distortion between lifting lugs 6 when it is lifted at high temperature of the cinder pot wall. As the cinder pot and its contents may in the larger sizes weigh as much as 60 tons, it will readily be seen that the crushing forces tending to produce distortion are very great. As noted above it has previously been proposed to resist such crushing forces tending to produce distortion of the cinder pot wall, by applying a heavy rim completely circling the upper edge of the wall. That practice I have found to be impractical, because the heavy rim by binding the corrugations prevents what may be called the "accordion" movement of the cinder pot wall. The cinder pot thus has again the inability of a structure formed on a true circle to accommodate itself to thermal expansion; and, so far as the avoidance of destructive thermal stresses is concerned the benefits of corrugation are lost.

I have, however, discovered a way by which I obtain the advantage in preventing distortion which is provided by a heavy rim without sacrificing the advantage in preventing thermal stresses afforded by a corrugated structure of the cinder pot wall. This I do by making of one-piece with the cinder pot wall, near the upper end of the cinder pot, an element analogous to a rim in the form of a heavy reinforcing ring 7. This ring 7 merges with the surface of the outward bows 5 at their extreme outward extent, and bridges across the inward bows 4. If the ring 7 were continuous, it would act as above described so to bind the corrugations that the desired "accordion" effect of the corrugations in accommodation to thermal expansion in the cinder pot wall would not be obtained. This, however, I prevent by making the ring discontinuous so that its segments being carried by the outward bows, may move with the corrugations as they straighten out under thermal expansion regionally to increase the overall diameter of the cinder pot.

By reference to Fig. I of the drawings it will be seen that reinforcing ring 7 is divided opposite each of the inward bows 4 of the cinder pot wall, except at those points in which the lifting lugs 6 merge with the ring 7, into a plurality of segments which are connected with each other only through the main body of the cinder pot wall. When the cinder pot wall is subjected to thermal expansion, and the corrugations tend to straighten in accommodation to increase in the overall diameter of the cinder pot, the opposed edges of the ring segments move apart to cause or increase gaps between them. Being thus segmentally carried solely by the outward bows of the corrugated cinder pot wall, the reinforcing ring does not inhibit movement of the wall corrugations in accommodation to thermal expansion. The division of the reinforcing ring into a plurality of segments is necessary. As to the number of segments into which the ring is divided, I have found that when a cinder pot has a number of corrugations as great as the cinder pot shown, free expansion is not limited by omitting division at points where the lifting lugs **6** join the ring. If substantially fewer corrugations are formed, the additional reinforcement provided by the organization of the feet may be dispensed with in the interest of free movement in the cinder pot wall, and the lifting lugs may be made independent of the ring. Decrease in the number of segments into which the reinforcing ring is divided merely tends to decrease the benefit derived from my invention by retarding in measure free expansion in the cinder pot wall.

The function of a reinforcing ring so divided in preventing distortion of the cinder pot wall now should be explained. As noted above the opposed edges of the reinforcing ring segments spread apart from each other as expansion takes place in the cinder pot wall. This is substantially uniform, so that the reinforcing ring remains as an approximately true circle in which there are a plurality of gaps. Incipient distortion when the cinder pot is lifted brings the opposed edges of the ring segments into physical contact, so that the stiffening effect of the ring is restored. It has been explained that the segments of ring **7** are carried above the hottest region of the cinder pot wall, and are connected with the wall by that portion of each segment which merges with an outward bow. The ring segments therefore remain relatively cool and capable of acting positively as "compression members" to resist distortion of the cinder pot wall.

This effect may occur so closely as to render distortion imperceptible. I so divide the reinforcing ring that the opposed edges of its segments lie close together; thus to minimize the measure of distortion which serves to bring the segments into metal-to-metal contact around the wall. No critical numerical value can be assigned to the word "close," for the reason that the less the width of the gaps between the ring segments when the cinder pot is cold, the less will be their separation at the maximum temperature of the cinder pot wall and the less will be the distortion which brings them into metal-to-metal contact. If the cinder pot is lifted after it has passed through its period of maximum temperature, the permitted distortion is of course decreased.

Since closeness of the reinforcing ring segments is desirable, and since a mere interruption of complete continuity in the ring is adequate to free the wall in expansion, the optimum embodiment of my invention is one in which the segments are as close as is practical in manufacture of the cinder pot. The several interruptions **8** in reinforcing ring **7** may be made in various ways. One such way is to cut through the metal of the ring with a saw having a thin blade, such as a saw blade no more than $\frac{1}{16}$ inch in thickness. It is also possible in several ways so to divide the reinforcing ring that the edges of its segments are in actual metal-to-metal contact when the cinder pot is cold.

My preferred procedure illustrated in Figs. V and VI, is to cast the reinforcing ring **7** integrally with the wall **3** of the cinder pot as shown, and then to saw, or burn substantial bodies of metal from the ring in the regions where division is to be made. In the relatively wide gaps in the ring there are welded inserts **9**. These inserts each comprises two plates **9a** and **9b** which equal the height of the ring **7**, and project laterally beyond it both inwardly and outwardly of the cinder pot. The plates **9a** and **9b** lie face-to-face and are welded together at V-notches **10** along their vertical edges, as is shown in Fig. V. These composite inserts **9** are welded in the relatively wide gaps between adjacent segments of the ring **7**. As shown in Figs. V and VI this welded bond includes V-notch welds **11** extended vertically of the reinforcing ring. When the inward and outward extensions of the insert are cut or burned off to leave the structure shown in Fig. VI, the two plates **9a** and **9b** remain in welded bond with the ends of the adjacent ring structure, with the opposed faces of the plates **9a** and **9b** in metal-to-metal contact with each other but unbonded.

When the adjacent faces of plates **9a** and **9b**, now the end edges of the ring segments, separate under thermal expansion in the cinder pot wall, they therefore start from zero and the maximum width of the gap between them is minimized. The effect of such separation is shown in Fig. VII, in which a gap **8a** appears between the opposed faces at the ends of two of the ring segments. It is to be understood that gaps similar to the gap **8a** will occur at every point of division around the ring. In the structure specifically as shown, having a maximum diameter of about 12½ feet and 16 outward bows, each of the gaps **8a** will not, at the maximum temperature of the cinder pot wall, exceed ⅛ inch in width; if the edges of the adjacent ring segments are initially in metal-to-metal contact. Usually the gaps are below $\frac{3}{32}$ inch in width. The gaps between adjacent ring segments being so narrow, the edges come together upon and almost imperceptible distortion. If there is an initial physical spacing, as by a thin saw cut, the separation at maximum expansion of the cinder pot wall is no more than additively greater.

This gives specific meaning to the words "close" and "closely spaced" as used to define the relation between opposed edges of the reinforcing ring segments at the points in which the ring is divided. Thus "close" spacing of those edges, the cinder pot being cold, means a spacing so close that when the cinder pot wall expands at the maximum temperature to which it is brought, distortion of negligible order serves to bring the edges of the ring segments or "compression members" into contact functionally to complete the ring.

It has been explained above that my invention is applicable to cinder pots having corrugated walls, whatever the specific form of the corrugations may be, and that my invention is applicable to cinder pots having corrugated walls which are not of the conical type herein illustrated. It may further be explained that it also is applicable to open-bottom cinder pots consisting primarily merely of a bounding wall, and which are open downwardly for positioning on a separable base, as well as upwardly open. Such open-bottom cinder pots, if corrugated may desirably be equipped with reinforcing rings, organized in accordance with my invention to preserve the effect of the corrugations. It will be understood also, that the term "reinforcing ring" as herein used is not a term of limitation but is a term of description applicable to a plurality of compression members closely organized in end-to-end relation around the cinder pot wall and carried by the outward bows of the wall corrugations to lie outwardly of the cinder pot wall in regions opposite the inward bows of the side wall corrugations.

In general many changes in the structural form and arrangement of the cinder pots embodying the principle of my invention may be made without going beyond the bounds of my invention as defined in the appended claims.

I claim as my invention:

1. In a cinder pot having an integrally cast thermally expansible corrugated side wall, a segmental ring expansible with the cinder pot side wall reinforcing the said side wall against cross-sectional distortion including a plurality of segments carried by the outward bows of the side wall corrugations near the upper end of the cinder pot and having opposed edges close together in regions around the cinder pot lying outwardly of and opposite the inward bows of the side wall corrugations.

2. In a cinder pot having an integrally cast thermally expansible corrugated side wall, a segmental ring expansible with the cinder pot side wall reinforcing the said side wall against cross-sectional distortion including a plurality of segments carried by the outward bows of the side wall corrugations near the upper end of the cinder pot and having opposed edges in regions around the cinder pot lying outwardly of and opposite the inward bows of the side wall corrugations which are in metal-to-metal contact with each other in thermally contracted condition of the said cinder pot side wall.

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