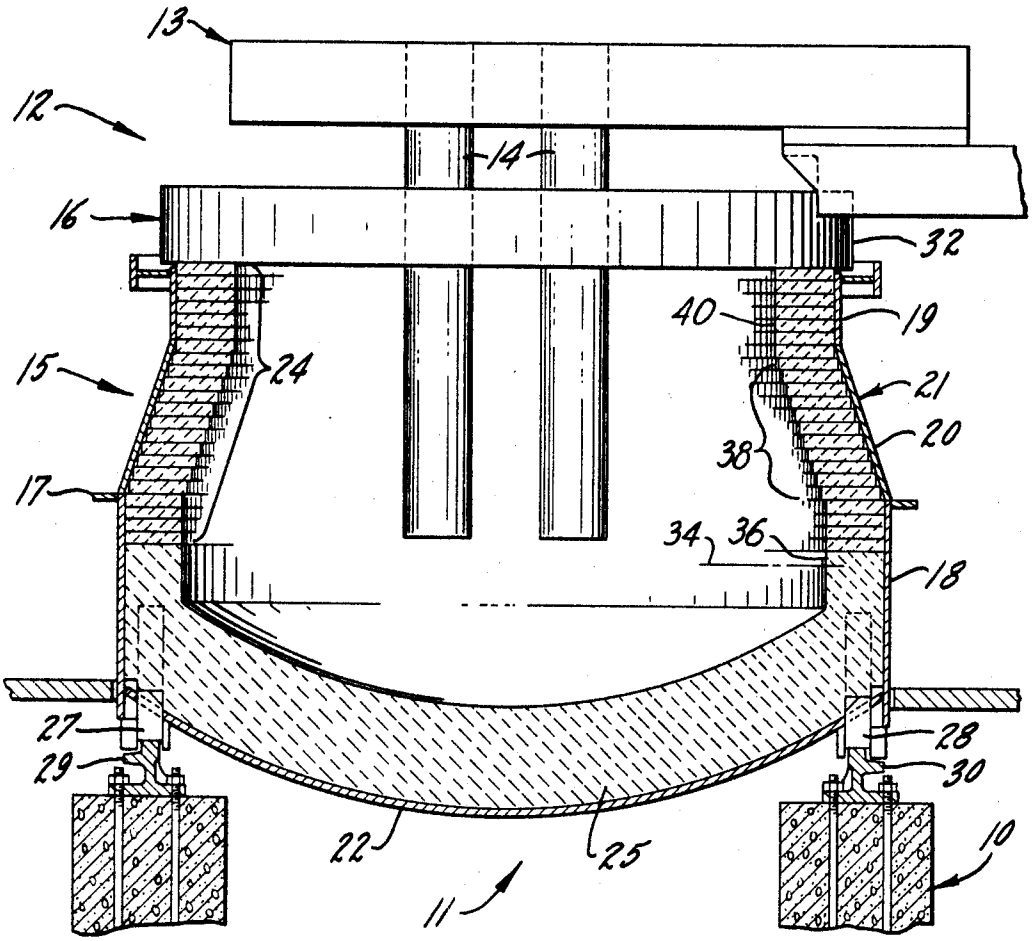
Sept. 3, 1968 E. F. FRANZEN 3,400,208

TAPERED SHELL ELECTRIC FURNACE

Filed Sept. 2, 1964



INVENTOR.
Erwin F. Franzen,
BY
Parker & Carter
Attorneys.

United States Patent Office 3,400,208
Patented Sept. 3, 1968

3,400,208

TAPERED SHELL ELECTRIC FURNACE

Erwin F. Franzen, 3718 176th Place,
Lansing, Ill. 60438

Filed Sept. 2, 1964, Ser. No. 393,871
3 Claims. (Cl. 13—35)

ABSTRACT OF THE DISCLOSURE

An electric furnace of the type having an arc which operates under substantially atmospheric environmental conditions in which interior wall configuration tapers inwardly in an upward direction from the sill level at which the maximum internal dimension occurs, whereby lining erosion due to refractory drippings is minimized, and the furnace capacity is maximized for a given sized cover.

This invention relates generally to vessels for treating molten metal and specifically to a uniquely internally contoured electric furnace.

Present electric furnaces are nearly invariably cylindrical in shape. These furnaces have several disadvantages, among which are a rather rapid rate of refractory erosion at the sill level, and an undesirably high furnace refractory cost per ton of steel. The art is well aware that it is more economical to make large batches of steel than small batches and accordingly attempts have been made to increase the present size of furnaces. It has been found, generally speaking, that there is a limiting size above which it is simply not feasible to enlarge the furnace.

Because of the cylindrical design, the roof diameter must be approximately the same diameter as the diameter at the hearth or sill level. In a top charge furnace, it is necessary to raise the roof and swing it aside, or perhaps remove it altogether by a gantry, in order to open the furnace for charging. As the shell diameter increases, the size and weight of the roof becomes quite great thus necessitating powerful superstructures and raising apparatus, including larger motors.

The roof itself tends to flex as it becomes larger and it becomes difficult to maintain the roof mechanically due to its great breadth. Further, the roof refractory life is reduced. The result has been to effectively limit the size of furnaces to approximately a 26 foot diameter and accordingly limit the batch size of molten metal able to be treated at one time since there are well known practical limits to the depth of bath for any given diameter.

Accordingly, it is a primary object of this invention to provide apparatus for making larger batches of steel than are now conventional and at a significantly lower cost per ton.

Another object is to provide means for converting existing furnaces to handle larger size batches than are now handled at a small fraction of the cost of purchase of a new furnace of conventional design of equal capacity.

Yet another object is to provide an electric furnace of substantially greater capacity for a given roof size as contrasted with existing furnaces whereby mechanical and refractory maintenance and equipment costs of the roof are not increased, thereby lowering the cost per ton of steel treated.

Another object is to provide a measn for converting

existing furnaces which requires only minor modifications to foundations, roof, superstructure and tilting mechanisms, and to make the modifications in a minimum time.

A further object is to provide, in a new electric furnace having the same capacity as a conventional existing furnace, smaller raising motors and equipment which thereby provide less maintenance problems and lower operating costs.

Yet another object is to provide an electric furnace having a greater refractory life for both roof and lining than can be achieved in conventional furnaces, and particularly at the sill level.

Yet another object is to provide a method and means for melting materials charged into an electric furnace at a faster rate than now possible whereby faster metallurgical reactions may be accomplished with lower electrode breakage.

Other objects and advantages of the invention will become apparent upon reading the following description of the invention.

The invention is illustrated more or less diagramatically in the accompanying figure which is a cross-section through a furnace constructed in accordance with the principles of this invention.

Like reference numerals will be used to refer to like parts from one portion of the disclosure to the other.

A concrete foundation is indicated generally at **10** in the figure. The foundation may be of any desired configuration. It forms a pit area, generally indicated at **11** which is conventional in the industry.

An electric furnace is indicated generally at **12**. The furnace consists essentially of an electrode support structure **13** having a plurality of electrodes, indicated in outline at **14**, with a charge holding vessel **15** and a roof **16**. The roof is suitably apertured to receive electrodes **14** which are raised and lowered by any suitable mechanism, a description of which is not essential to an understanding of the invention.

The charge holding vessel **15** is composed of an outer steel shell **16** which may have reinforcing ribs **17** disposed thereabout to form a rigid shell structure. The lower portion of the shell, indicated at **18**, is substantially cylindrical in shape and is of a maximum diameter. The upper portion **19** is likewise cylindrical in shape and has a minimum diameter. The mid-section **20** is formed as a frustrum of a cone connecting the upper and lower portions of the shell. A bottom shell **22** is welded to the lower end of the bottom portion **18** of the outer shell. Preferably, the ratio of the area of the upper end portion of the side wall means to the cross-sectional area of the furnace at the sill level is approximately on the order of about 1 to 1.3.

Courses of bricks are indicated at **24**. Each course is layed with its longest axis horizontal and, in this instance, its widest plane is similarly laid horizontal. The courses are offset slightly from one to the next along the mid-portion **20** of the shell. The bottom **22** has a lining of refractory material **25** which may, within the scope of the invention, be composed of courses of bricks.

The sill level is indicated at **34**. It will be noted that the interior of the side wall extends vertically upwardly from the sill level for a short distance as indicated at **36**. The side wall above portion **36** then tapers inwardly in an up-

ward direction, this tapered portion being indicated at **38**. The upper portion **40** of the interior side wall is vertical as indicated at **42**.

The vessel is supported for tilting on a pair of trunnions **27, 28** which rock about trunnion support structure **29, 30**. Any suitable tilting mechanism may be employed, the specific details of which are not essential to an understanding of the invention. Any suitable molten metal outlet may be employed.

Roof **16** consists essentially of a roof ring **32** which forms the outermost periphery for a plurality of concentric course of bricks, not shown. In this instance, the refractory roof is substantially planar although it may have a slight arch. In any event the roof, which may be on the order of about **13** feet in diameter, slightly overlies the opening at the upper end of the vessel.

Electrodes **14** are supported by any suitable means from the supporting bracket structure **13**.

The use and operation of the invention are as follows:

Charge material is charged into the vessel **15** with the electrodes **14** and the roof **16** swung out of the way. Once a sufficient charge has been admitted to the furnace, the roof **16** is positioned in place and electrodes **14** inserted through the electrode apertures of the roof. Electric current is turned on and the melting process begins.

Melting occurs from a location directly beneath the electrodes. There will be a considerable period of time in which a pool of metal is formed beneath the electrodes while many pieces of the charge material are still in solid, unmelted condition. As the pool expands these solid pieces of charge material will tumble into the pool. In previous vessels, these pieces that tumbled in from the edges of the vessel frequently struck against the electrodes and broke them. With the illustrated construction, the charge material can be spread initially in such a thin layer that the individual pieces of charge material will travel only a relatively short distance in a horizontal plane as they fall into the bath.

As the melting commences drippings from the roof refractories will drop downwardly towards the melt. In prior constructions these drippings splashed against the side walls creating considerable damage to the linings. In this vessel the drippings drop directly onto the melt where they float on the surface since they are lighter than the melt. This occurs because the center and lower portions **36** and **34** of the side walls are displaced outwardly with respect to the periphery of the melt which is exposed to the radiant heat. That is, since the maximum internal horizontal dimension of the furnace occurs at the sill level when the furnace is disposed in a vertical position, and since the internal configuration of the furnace gradually narrows from the sill level area **34** to the uppermost end of the upper portion **40**, refractory erosion by reason of refractory drippings is minimized.

The lining life will also be improved because the area immediately above the slag line is substantially regressed away from the arc heat. As is well known, this is the area of greatest wear and requires the most maintenance and the bulk of patching and refractory gunning is done in this area. Further, since the effect of the radiant heat from the electrodes decreases roughly with the square of the distance of the receiving surface from the source, it can be readily appreciated that a relatively small increase in distance between the arc and the wall will result in a relatively great decrease in erosive effect of the heat.

Another great advantage of the present construction is that smaller roofs may be used for melts of a size comparable to those now melted, or roofs of a size equal to those now employed may be used for heats of considerably greater size than are now melted. These smaller roofs have a longer refractory life than larger ones due to greater rigidity, better cooling and less need for a heavily sprung arch with its concomitant high bearing pressures. Smaller roof rings hold their shape better and consequently reduce flexing of the refractories as the roof is raised and lowered. Furthermore, water leaks in the roof ring are less common the smaller the roof ring.

In addition, scrap will not tend to cling to the walls as much as with conventional contours. Further, the furnace will hold more scrap per charge since it has a greater volume as contrasted to present furnaces of the same roof diameter.

One of the most unique features of the present invention is that it is equally applicable to existing installations as well as new furnaces. In either event, the construction provides a flatter bath which enables faster melting because of the larger area-to-depth ratio of the hearth than in present vessels. The slag area per cubic foot of metal can also be increased, thus speeding up metallurgical reactions such as carbon, sulphur and phosphorus reduction. As already mentioned, the electrode breakage will be less frequent because of the greater melting area since the charge will spread over a greater area and be less apt to tumble against the electrodes during the melting process.

When an existing electric furnace is converted, only the shell of the furnace need be changed. The foundation, roof, superstructure and raising and tilting mechanism would require only minor changes and the electrodes will be positioned close together which is desirable. The cost of conversion will be about 25 percent or less than the cost of a complete new, larger furnace. Furthermore, the time involved in making the conversion is minimal as contrasted to building a new furnace. In addition, the tapered configuration facilitates the addition of charge materials or the injection of oxygen. Finally, a new furnace embodying the aforementioned concepts will cost less than a conventionally designed furnace of equal capacity due to several factors, among which is the lighter roof as contrasted to existing designs. The use of a smaller roof enables smaller raising motors and equipment and lighter structural components to be used. These in turn reduce the maintenance problems and provide minimum operating costs.

Although the invention has been illustrated and described in a specific manner, it will at once be apparent to those skilled in the art that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, it is the intention that the scope of the invention be limited not by the scope of the foregoing exemplary description, but solely by the scope of the hereinafter appended claims when interpreted in light of the pertinent prior art of date.

I claim:

1. In an electric furnace of the type in which charge materail is subjected to an arc under substantially atmospheric pressure and environmental conditions, the combination of

side wall means,

said side wall means comprising a lower portion which extends vertically upwardly from the sill level,

a generally upwardly tapering intermediate portion, and a vertical upper portion,

the maximum internal, horizontal dimension of the furnace occurring at the sill level when the furnace is disposed in a vertical position,

the cross-sectional area at the upper end of the upper portion being smaller than the cross-sectional area at the sill level of the furnace whereby the internal configuration of the furnace gradually narrows from the sill level area to the uppermost end of the upper portion of the side wall means and

bottom means,

said bottom means being dished throughout substantially the entire bottom area to thereby provide a relatively shallow, dished configuration.

2. The electric furnace of claim **1** further characterized in that

the side wall means and the bottom means are lined with refractory material,

the innermost portion of the side wall means being re-

fractory lining material consisting of refractory bricks disposed with their longest axis substantially perpendicular to the vertical axis of the furnace.

3. The electric furnace of claim 1 further characterized in that

the ratio of the area of the upper end portion of the side wall means to the cross-sectional area of the furnace at the sill level is approximately on the order of about 1 to 1.3, the upper end portion of the side wall means having a maximum diameter of about 26 feet.

References Cited

UNITED STATES PATENTS

1,242,275	10/1917	Valentine	13—9
2,159,286	5/1939	Moore	13—9

FOREIGN PATENTS

654,213	12/1962	Canada.

BERNARD A. GILHEANY, *Primary Examiner.*

R. N. ENVALL, JR., *Assistant Examiner.*