Dec. 27, 1927. 1,654,419

A. E. GREENE

ELECTRIC FURNACE

Filed Nov. 23, 1922 2 Sheets-Sheet 1

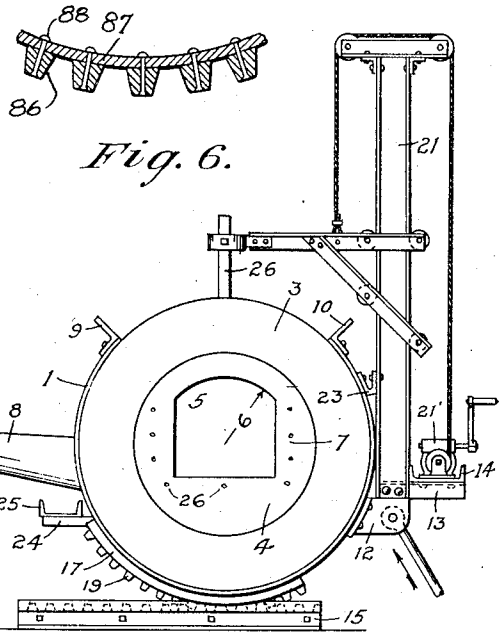



Fig. 6.

Fig. 1.

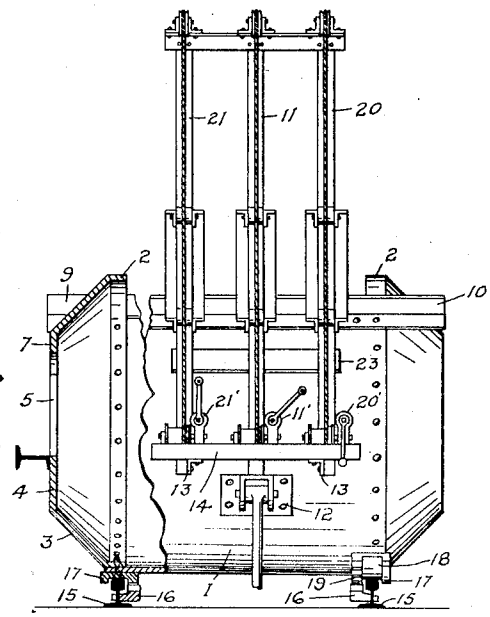



Fig. 2.

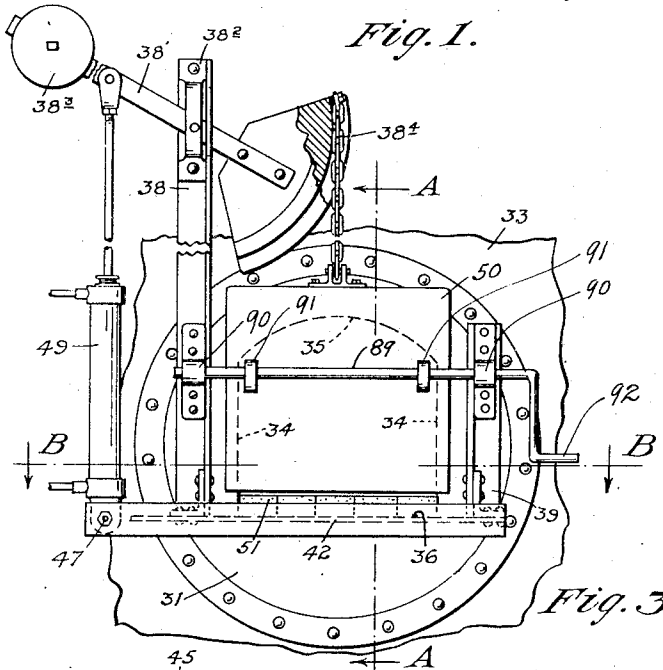



Fig. 3.

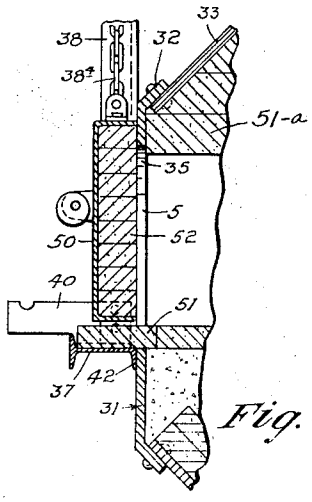



Fig. 4.

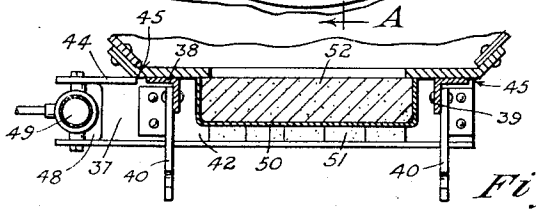



Fig. 5.

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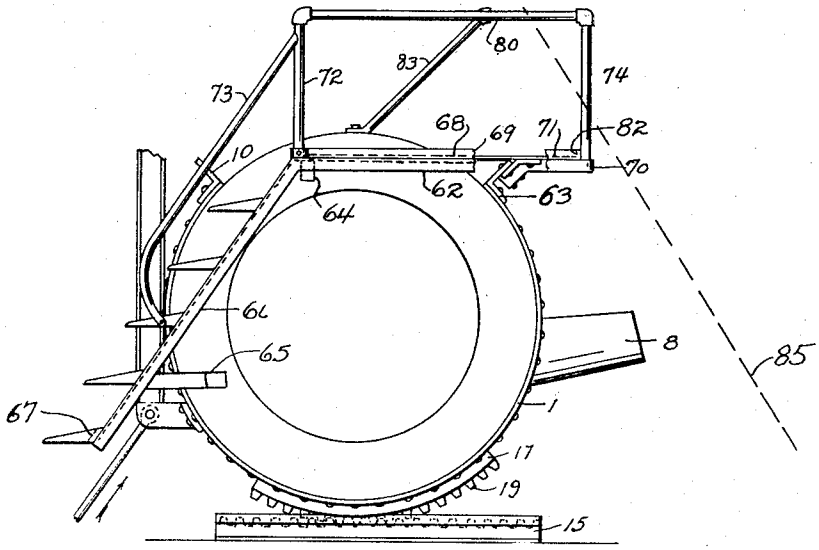



Fig. 7.

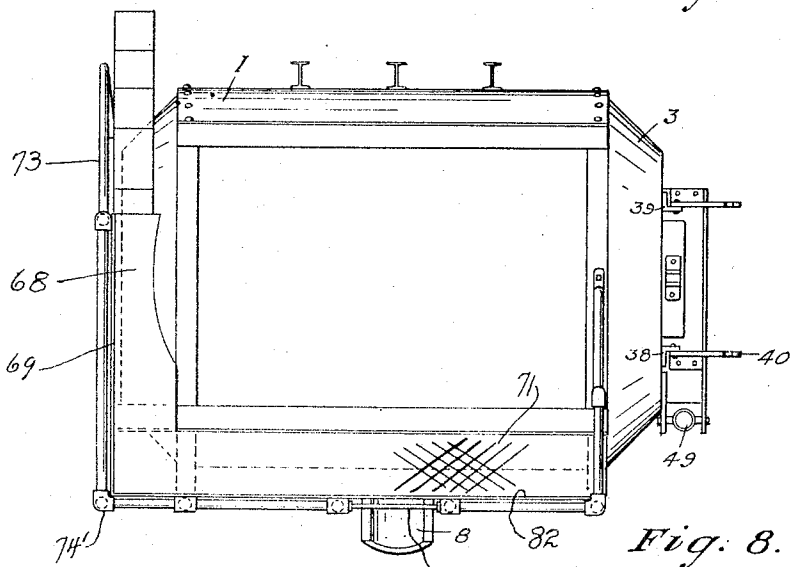



Fig. 8.

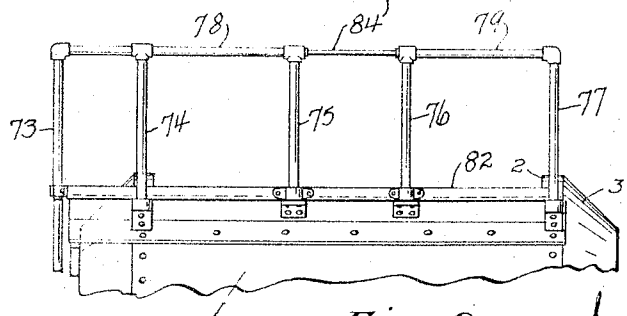



Fig. 9.

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Patented Dec. 27, 1927. 1,654,419

# UNITED STATES PATENT OFFICE.

ALBERT E. GREENE, OF MEDINA, WASHINGTON.

## ELECTRIC FURNACE.

Application filed November 23, 1922. Serial No. 602,813.

My present invention relates to improvements in electric furnaces and more particularly to the construction of the shell and the door parts, the method of tilting the furnace and to improvements in construction of the parts connected with the shell.

One object of my present invention is to provide a simplified construction of end for a cylindrical type of furnace mounted on an axis parallel to the axis of the cylindrical shell.

My present application is a continuation in part of my application for Patent Serial No. 279,776 filed Feb. 28, 1919.

In the construction of furnaces of the rolling cylinder type as described in my United States Patent No. 1,297,149 and in my copending application for patent Serial No. 279,776 I have described a furnace which has bulged ends and which is constructed to tilt about an axis parallel to the axis of the cylindrical part of the shell. My present application is a continuation in part of my application for Patent Sr. No. 279.776, filed Feb. 28, 1919. I have found that the use of a cone shaped head or end to a furnace of this type is a material improvement in certain instances and one feature of my present invention has to do with the construction and shape of such a cone head. In placing the refractory brick lining in the ends of the furnace the cone shaped metal head provides for a very simple arrangement of brick in the ends of the furnace and makes the construction of the brick arches over the doorway through the end of the furnace very simple.

One feature of my invention has to do with a provision of a doorway through the end of the cone shaped head of the furnace so as to provide a flat surface on the outside against which a metal door with refractory lining can abut.

Another feature of my invention has to do with the casting of the end of the furnace in a single piece to provide a flange for riveting or attaching the cylindrical shell plate to and providing also a conical surface and also providing a flat end surface for the door parts. I have found that in certain instances it is very much simpler to cast this shape of head in a single piece than it is to make it up out of steel plate which has to be bent in a number of ways.

Another feature of my invention relates to the construction of the door frame which has for its object the holding up of the refractory or brick sill of the door-way and also for mounting a door lever mechanism and for holding a movable door member in position. In one embodiment of my invention I have provided a door sill specially constructed to be attached to a flat end surface of the cone head or to some other flat surface of a furnace and this sill member may be made out of an I-beam and may provide a mounting for a door tilting cylinder operated by hydraulic means.

Another feature of my invention relates to the provision of gear teeth on a segment attached to the underpart of a cylindrical shell and forming a part of a member which engages a rail beneath, on which rail the furnace tilts or rolls over. Attached to the rail is a rack member with teeth to mesh with the teeth of the gear segment and thus prevent the furnace from slipping when it is rolled over on the rail tracks.

Still another feature of my invention relates to a means of balancing the shell by suitable weights on the spout side of the shell to counter-balance the weight of the electrode supporting structure on the opposite or back side of the shell.

Another feature of my invention relates to the provision of a safety platform and steps whereby a furnace operator can mount to the upper part of the furnace to get close to the electrode holders or the parts on the top of the furnace.

Still another feature of my invention relates to the construction of the I-beam frame work which serves as the electrode crane and this feature has to do more particularly with the mounting of the frame in connection with a bracket for holding the pin of a tilting cylinder and also has to do with the mounting of the structural or channel frame to hold the gear hoists which serve to operate the electrode holders up and down the I-beams.

These and other features will be more fully described and better understood by reference to the accompanying drawings which include the following figures:

Fig. 1 is an end view of a rolling cylinder furnace with cone head ends embodying my invention.

Fig. 2 is a side elevation view of the furnace showing Fig. 1 and is partly in section.

Fig. 3 is a detail view of one modification of my invention relating to the construction

of the end of a cone head type of rolling cylinder furnace.

Fig. 4 is a vertical sectional elevation through the line AA of Fig. 3.

Fig. 5 is a horizontal section through line BB of Fig. 3.

Fig. 6 is a sectional view of the teeth of a gear segment member attached to the cylindrical portion of the shell and showing the teeth held in place by means of rivets instead of being cast integral with the flange part of the casting.

Fig. 7 is an end elevation view of the rolling cylinder furnace shell showing the safety platform and railing and steps forming one feature of my invention.

Fig. 8 is a plan view of the furnace shown in Fig. 7.

Fig. 9 is a front view from the spout side of the furnace as shown in Fig. 7.

Referring now to the drawings and particularly to Fig. 1 and Fig. 2 which are different views of one modification of my invention, Fig. 1 is an end view looking at the outer surface of the cone head and Fig. 2 is an elevation view from the backside of the same furnace and partly in section showing the construction of the cone head. In these figures a cylindrical shell of the furnace is shown at 1. This shell may be made of steel plate and rolled to fit the outer surfaces of the flanges as shown at 2 in Fig. 2 of the cone heads, and the shell is riveted to these flanges. The conical surface of the head is shown in section at 3 and the flat surface of the outer end of the cone head is shown at 4. Fig. 2 shows these parts in section and Fig. 1 shows the elevation view. The attachments for the door parts are not shown in these Figures 1 and 2 but will be explained in reference to later figures. The door opening 5 is shown in Fig. 1 and in section in Fig. 2. The outer flat surface at 7 in these two figures is the surface against which the movable door member abuts to close the opening into the inside of the furnace. Both the shell and the movable door member are lined with refractory material as at $51^a$ and 52 for operation of the furnace. The door opening 5 through the cone head may be as indicated with the upper part of the opening arched-shaped to conform more or less closely to the ends of the arch brick shown at $51^a$ which make the doorway into the furnace chamber. In Fig. 1 the radius of the arc of the upper part of the door opening is at the center or axis of the cone head and is represented by the numeral 6 in Fig. 1. The inside portion of the flat surface above the top of the door opening abuts the arch brick $51^a$ over the doorway through the refractory lining into the inner chamber of the furnace. This construction makes a very simple one for installing the brick and for the attachment of the door parts more particularly referred to hereafter in this specification.

The cylindrical shell is provided with a top opening between the angles 9 and 10 in Fig. 1 and these angles serve to strengthen the cylindrical part of the shell so that the expansive pressure of the brick work inside the shell will not distort the steel plate. The spout is shown at 8. Opposite the spout is shown a structural frame which comprises vertical I-beams 11, 20 and 21 on each of which an electrode holder may operate. An electrode is shown at 26. The I-beams are attached to the cylindrical shell of the furnace by means of a bracket casting 23 which may be riveted to the I-beams and bolted to the shell so that it can be removed in case of necessity and the lower part of the I-beam frame may also be attached to the shell as for example, by means of a bracket casting 12. This bracket casting 12 shown in Fig. 1 also serves to hold the pin of a tilting mechanism which may be a hydraulic cylinder to roll the furnace over on the tracks for the purpose of pouring out the contents. A structural member 14 which may be a channel is attached to the lower parts of three I-beams by means of angles 13 and it may be riveted or otherwise fastened to the I-beams. This channel serves to hold the I-beams together in position and also serves as a support for worm gear hoists 21′ or other hoist mechanism which mechanism is used to raise and lower the electrode holders on the several I-beams.

The furnace is supported on rails 15 which may be ordinary railway rails or which may be I-beams or any other suitable kind of supporting member. In the figures shown the rail 15 has a rack member 16 attached to it by means of bolts and on the shell there is riveted a segment 18 which is provided with flanges as shown at 17 and also with teeth as shown at 19. These teeth mesh with the teeth 16 on the rack member which is attached to the rail. The furnace is therefore prevented from slipping out of alignment when it is rolled over on the rails by means of a tilting mechanism acting through the bracket 12 as previously referred to. Two rails are provided and the gear segments 17 may be riveted together with the shell plate 1 to the flange of the cone head at each end of the shell. There is thus provided quite a thickness of metal directly above each of the rail tracks including the thickness of the segment casting 18 and thickness of the plate 1 and the thickness of the cone head as shown at 2. The rivets through the flange of the head and through the plate and segment casting may be counter sunk and driven flush with the surface which engages the rail track so as not to interfere with the rolling of the shell.

In certain instances I may even use extra

large rivets and allow the head of the rivet to extend out from the outer side of the segment casting and I may provide suitable holes or openings in the rail member beneath for the rivet heads to mesh with and in such case do away with the teeth as shown in Fig. 1. I may even provide a special tooth held in place by driving the rivet through it. However, my preferred construction is that shown in Fig. 1. The gear segments 17 are shown extending approximately 60 degrees around the shell on the spout side and approximately 30 degrees on the back side of the furnace shell. It is ordinarily sufficient to provide for tilting the furnace 45 degrees forward and only slightly backward, the backward tilting being used at times when a larger charge is desired without getting into the tap hole or for slagging or other purposes.

On the front or spout side of the furnace is shown a bracket casting 24 with a channel 25 shown in section attached to it. In the channel weights may be placed for the purpose of counter-balancing the structural mounting on the back side opposite the spout so that the furnace will be easier to tilt or roll over on the supporting tracks.

The construction of the cone heads may be cast steel or other metal but cast steel is preferred because it does not crack under the expansion strain of the lining and the heat of the furnace. Furthermore, by casting the cone head with a conical surface the molding of the casting is materially simplified and the holes as shown at 26 may be cast in the head and thus labor and machine work is saved. However, the cone head may be made out of steel plate, for example, as indicated in the section in Fig. 4 and in such case the flat surface may be made out of plate metal or may be cast and may be provided with a flange 32 which is cone shaped for riveting or attaching to the conical surface 33 of the rest of the head. In such case the cone shaped steel head would be provided with a suitable flange similar to the flange 2 of Fig. 2. This cone head when made up of steel plate, especially if it is a large diameter head, may require a number of plates in which case they would be attached to each other by suitably riveting together.

In Fig. 3 I have aimed to show the door parts attached to the flat surface of a cone head. In Fig. 4 I have shown a vertical section through the center line of Fig. 3 and in these two Figures 3 and 4 the bottom of the door opening through the end plate of the head is shown at 36 and the side openings through the head at 34 and the top opening which may be an arc of a circle is shown at 35 in Fig. 3 and in section at 35 in Fig. 4. The outer flat piece 32 of the cone head is shown as separate from the main part of the cone indicated at 33 and riveted together as shown at 32. The outer surface of the flat piece is indicated at 31. Against this outer surface the door parts are attached or abut.

The door parts include a sill member 42 which may be an I-beam, and side members 38 and 39, the member 38 serving to support a lever $38^1$ for opening or closing the door. The door sill member 42 is shown in detail in Fig. 5 together with the parts which are attached to it including the angles 38 and 39 and other angle members 40 which serve to support bars used in working with tools through the furnace door. In Fig. 5, which is a plan view of the door sill, the upper flange on the side toward the head is removed for the distance between the points 45 on this figure. The bottom flange 42 may serve to rivet the sill to the flat outer surface 31 of the head. However, the upper flange is not removed for the entire length of the I-beam sill 37 but is left on for the space indicated at 44. Near the outer end of the I-beam sill at 47 a hole is made for a pin which may be used to support a door tilting cylinder 49. The main web of the I-beam 37 is cut away as shown at 48 so that this pin may extend through both flanges of the I-beam and so that the lower part of the tilting cylinder may be mounted on this pin. The part of the flange which is not cut away on the side toward the head is shown at 44.

The two members 38 and 39 may be of suitable structural material and are shown as angles which may be riveted or bolted to the head of the furnace. The angle 39 is shorter than the angle 38 and serves merely to keep the flame from going out of the side of the doors and also it is used to support a door closing bar 89. The angle 38 extends far enough up to support a pin for a door lever bar $38^1$ to operate on, the door lever bar having a suitable casting on it for connecting the tilting cylinder 49, and also a counter-weight $38^3$ and a chain casting $38^4$ which is connected by means of a chain to the door 50. The bar supporting members 40 may be angles cut to fit the other parts of the door fittings and these pieces 40 may be riveted to the angles 38 and 39 and also to the sill 37 thus making a substantial and strong supporting structure for the brick 51 in the door sill and for the movable parts of the door mechanism. The members 40 are shown with a slot in the outer end in which a bar may rest, this bar being used to support hooks or tools which are used to work the charge inside the furnace. The frame work comprising the side angles and door sill may be riveted together but may be bolted to the end plate 4 using the holes shown at 26 in Fig. 1.

The door is indicated at 50 and is preferably a steel casting which may be lined with

brick 52 and is in the nature of a steel box with the inner part open for lining the box with brick. The construction shown in Figs. 3, 4 and 5 provides a combined door sill and support for a tilting cylinder and also a support for the door lever and door closing mechanism. I have found it especially advantageous to use a door lever with a counter-weight attached and at the same time provide a small hydraulic cylinder operated by air or water whereby the movement of the door may be regulated. By having the counter-weight on the door lever it is not necessary to have a very powerful cylinder and thus the operating mechanism is materially simplified. The advantages of this construction of door mechanism are very material. The sill is very simple to make either out of a piece of structural steel I-beam or it may be cast in a single piece. Also the members 39 and 38 are of simple construction to mount on the flat outer surface of the cone head. It will be noted that the door 50 does not come close to the members 39 and 38 and these members 39 and 38 are purposely not built close to the door 50 because I have found that when side frame members are built close to the moving door member, the warping and dirt around an electric furnace tend to make the movable member like that at 50 bind or stick and it is a special feature of my invention to provide ample room between the side surfaces of the door 50 and the members 39 and 38. The door 50 is kept in alignment by its support on the chain from the door lever above. Then the closing of the opening into the furnace is by pressure against the outer surface of the door so as to push it or the brick lining inside it against the steel or metal outer flat surface of the head. There is often a tendency of flame coming out of the door especially when material is heated in the furnace which causes the emission of considerable gas and when this gas comes out the members 38 and 39 direct it so that it will not do any damage to the door cylinder or to an operator who might be standing in line with the flat surface of the head. Another purpose of providing space between the sides of the door 50 and members 38 and 39 is so that when desired wet sand or mud can be thrown into this space and so seal the openings which might still remain into the furnace chamber. The small hydraulic tilting cylinder may be operated by a 4-way valve and is made double acting and direct connected to the door lever so that with hydraulic pressure on both sides of the piston in the hydraulic cylinder the admission of air or water on one side of the piston can be controlled and the door can be raised to any desired level within the limits of its movement merely by a movement of the 4-way valve. This valve may be located at any convenient place as for example, it may be mounted on the end of the door sill 37.

Referring now to Figs. 7, 8 and 9, these figures illustrate the construction of the safety platform and railing for the same type of rolling cylinder furnace shown in Figs. 1 and 2. Fig. 6 is an end view of the furnace showing the steps leading up to the platform and the railing. The structural frame which supports the steps may consist of a channel 61 with an extension 62 which is supported on extensions of the shell angle 63. A bracket 65 connected with the shell supports the lower end of the channel member 61. The channel parts 61 and 62 may be formed by bending a single piece of channel iron or by suitably connecting two pieces of channel iron together at the proper angle. The angle of the member 61 is approximately 35 degrees from the vertical. Mounted on the member 61 are steps which may be made of steel castings bolted or riveted to the web of the channel through the back flange of the step casting 67. It is understood that the structural member supporting the steps may be made of any suitable material such as angles or other metal members to support the steps. Between the angle 63 and bracket member 64 and on top of the channel member 62 is placed a piece of platform plate 68 having its outer edge bent upwardly for a suitable distance, perhaps two inches, so that one's foot will not slip off the plate. This flange is shown at 69. Attached to the front side of the shell in Fig. 7 are bracket members 70 which may be steel castings and these members serve to support another piece of floor plate 71 extending across the front of the furnace as is further illustrated in the plan view in Fig. 7. These brackets 70 may have holes in the outer ends of the brackets which holes may be tapped to take pipes extending upwardly and forming the safety railing members around this platform. I have shown a vertical pipe member 72 in Fig. 7 to which may be connected a slanting pipe rail member 73 leading from one of the steps up to a point near the top of the pipe 72. In these figures there are four vertical pipe members 74, 75, 76 and 77 which serve to support the horizontal railing or pipe members 78 and 79 forming a safety railing around the front part of the platform. Then another member 80 joins the vertical member 72 with the vertical member 74 and may have a bend $74^1$ or elbow in it to provide for the curvature from the front platform around the side portions of the platform. The platform plate in front is shown at 71 and has a flange extension 82 to prevent slipping of a man's foot especially when the furnace happens to be tilted over in the direction of the front platform.

Another pipe member 83 serves to complete the safety railing to the end of the furnace opposite the steps and the railing members would be joined by suitable pipe fittings for that purpose.

The platform plates may be made in the usual manner with cross ridges as indicated in the plan view in Fig. 8 to prevent one's foot from slipping. It is understood that this same construction of platform and safety rail may be extended completely around the furnace or it may be used on a furnace of different shape from the rolling cylinder type furnace shown; for example, it may be used on a round shell type of furnace with cylindrical shell of vertical axis.

In the front middle section of the railing I have shown a member 84 which serves to join the rail members 78 and 79, but this member 84 is made preferably to slide in and out of one of the pipes like 78 so that when desired an opening may be provided between the two upright members 75 and 76. The purpose of this opening is to permit the supporting cables from an overhead crane to be moved in close proximity to the furnace shell when the latter is tipped over for pouring the metal from the spout of the furnace into a ladle. The position which the crane cables might assume in such instance is indicated by the dotted line 85 in Fig. 7.

Referring now to Fig. 6, instead of a casting which may be riveted or attached to the cylindrical shell plate as shown in Figs. 1 and 2, I may rivet cone shaped members 86 to the plate 87 by means of rivets 88 so that the cone shaped members will serve as teeth to mesh with teeth on the rack member 16 in Fig. 2. Or I may provide holes in the rack member or even in the rail itself into which the cone shaped teeth will extend for the purpose of keeping the furnace shell from slipping. In Fig. 6 I have shown the rivets as counter sunk on the outer ends of the cone shaped teeth so that the rivet will not extend beyond the outer surface of the cone shaped teeth.

It is pointed out that the door opening may be in one end only of the furnace as indicated in Fig. 1 and the other end may be closed.

In further reference to the movable parts illustrated in Figs. 3, 4 and 5 I have shown a door closing mechanism comprising a bar 89 mounted in brackets 90, these brackets being in turn attached to the door frame members 38 and 39 or otherwise attached to the end of the furnace. On the bar 89 are mounted one or more eccentric discs, these being mounted in such a manner that when the bar 89 is revolved in the bearings 90 the discs which are eccentrically mounted on it will engage the adjacent surface of the door 50 so as to push it against the flat surface of the end of the cone head or else to push the brick against this flat surface in case the brick extend beyond the door casing. A lever and handle 92 serve to revolve this bar 89 for the purpose of opening or closing the door.

It is pointed out that the rail guide members 18 shown in Fig. 2 are located so that the rivets through these may also serve to rivet the cylindrical shell plate to the flanges on the cone heads, but these rail guide members may be placed nearer together and independent of the rivets through the flanges of the heads. The flanges 17 on these rail guide members may be increased in size so as to serve to strengthen the cylindrical portion of the shell and the rail guide members may also be extended around the shell as far as may be desired for further movement of the shell.

It is further pointed out that the end member 32 shown in Figs. 3 and 4 may have its flange 32 designed so that it can be mounted either on a cone shaped head or on a dished head like a boiler head and at the same time the structure illustrated in Figs. 3, 4 and 5 can be attached to the end piece 32 as already described. In other words, my invention as it relates to the improvements in the door frame structure and door parts is not limited to use on a cone head but may be used on a dished head or may even be attached to any suitable flat surface in connection with a furnace.

An important feature of my invention is the improved construction of electrode crane illustrated in Figs. 1 and 2. This consists of upright I-beams which serve as guide beams for the electrode holders. At the top of these beams is an angle structure which connects the tops of the beams and also supports cable sheave wheels. At the lower ends of the beams is mounted a channel 14 resting on angles 13 which latter angles are riveted or attached to the lower ends of the I-beams. This channel 14 serves as a support for three worm gear hoists like that at $21^1$. This crane structure comprising the upright beams connected together at the top and bottom is mounted on the furnace shell by means of the angle bracket 23 and by means of a connection to the cylinder pin bracket 12, the latter bracket supporting the center I-beam of the crane structure. The connecting angles at the top of the beams may be bolted together so that they can be removed for installing the electrode holders when the furnace is assembled after shipment.

What I claim is:

1. An electric furnace comprising a horizontal cylindrical shell, outwardly bulged, cone shaped metal ends for said shell, a refractory lining within, and a flat end surface on one cone shaped end against which a movable door member can abut, and a door open-

ing through said end and through the refractory lining within forming a doorway.

2. An end for an electric furnace, said end comprising an outwardly bulged cone shaped head having a flat outer end surface, a door opening through said flat surface and a structural frame attached to said flat outer surface comprising a sill and side members for supporting a refractory lining in the sill and for supporting movable door parts.

3. In combination with an electric furnace, an electrode crane structure comprising a plurality of vertical beams along which electrode supporting trolleys may operate, means of supporting said upright beams in proper position with respect to the furnace chamber, a structural frame connecting the upper ends of the beams and carrying sheave wheels for cable to raise and lower the electrode holders, and a structural member connecting the lower ends of the upright beams and adapted to support hoisting mechanism for the cables of each electrode holder.

4. An electrode crane structure for a three electrode furnace, said structure comprising three vertical I-beams properly spaced apart for carrying electrode holders, an angle structure connecting the tops of the I-beams and carrying cable sheave wheel and a structural frame connecting the bottoms of the I-beams adapted to support cable winding mechanism.

5. An electric melting furnace comprising a furnace shell, a metal door frame member attached thereto, said door frame casting having an outer flat surface against which a door closing member abuts, and a sill on which said door member rests when in closed position.

6. The combination of claim 5 together with means for holding said door in closed position, said means comprising a bar placed outside the door in supports attached to said door frame, and means for pressing said door against the door frame by wedging it against said bar.

7. The combination of claim 5 and means for closing said door member against the door frame comprising an eccentric mechanism.

8. In combination an electric melting furnace having a curved shell, a door frame member having a flanged portion conforming to and for attaching to said curved shell and having a flat outer surface against which a door member abuts, a sill attached to said frame member refractory material on said sill, and means for holding a door in closed position against said frame member.

9. In combination in an electric furnace, a furnace shell, a metal door frame member attached to said shell and having a flat outer surface, a door member movable vertically abutting said flat surface in such manner that the joints of abutment at the sides of the movable door are exposed when the door is in closed position so that they may be sealed by mud or clay material.

10. An electric furnace comprising a cylindrical shell of substantially horizontal axis supported from beneath and having means for tilting said shell about its horizontal axis, a refractory lining within said shell, forming a heating chamber, an open top portion of the cylindrical shell closed by a refractory arch, holes for electrodes thru said arch, and a door way at the end of the cylindrical furnace shell with a door member abutting a flat end surface of the shell structure.

11. An electric furnace as claimed in claim 10 with the further detail of bulged ends to said shell, bulging outwardly from the cylindrical shell and having a door frame member attached to one of said bulged ends.

12. In combination an electric arc furnace comprising a curved metal plate shell, a door frame member comprising a flange fitting the outer surface of said shell and having a flat outer surface away from said shell plate against which a door member abuts, said outer flat surface extending out away from said shell to allow for brick to abut this flat part of the door frame on its inside.

13. An electric melting or heating furnace, comprising in combination, a shell lined with refractory material forming a chamber within, a door frame attached to said shell, said door frame comprising an outer flat plate thru which a door opening is provided and structural strengthening members attached to said flat plate on the outside thereof with space between for a vertically movable door, a sill at the lower part of the door way, a vertically movable door lined with refractory material, the lining of which abuts the flat plate of the door frame when the door is in closed position, and means for raising the door member to open the door way.

14. In an electric metallurgical furnace having a metal shell, a door frame attached to said shell having a flat outer surface against which a door member slides, this flat plate surface being spaced away from the shell proper whereby room is provided for a reinforcing portion of the door frame between the flat surface and the shell proper.

In witness whereof, I hereunto subscribe my name this 17 day of November A. D. 1922.

ALBERT E. GREENE.