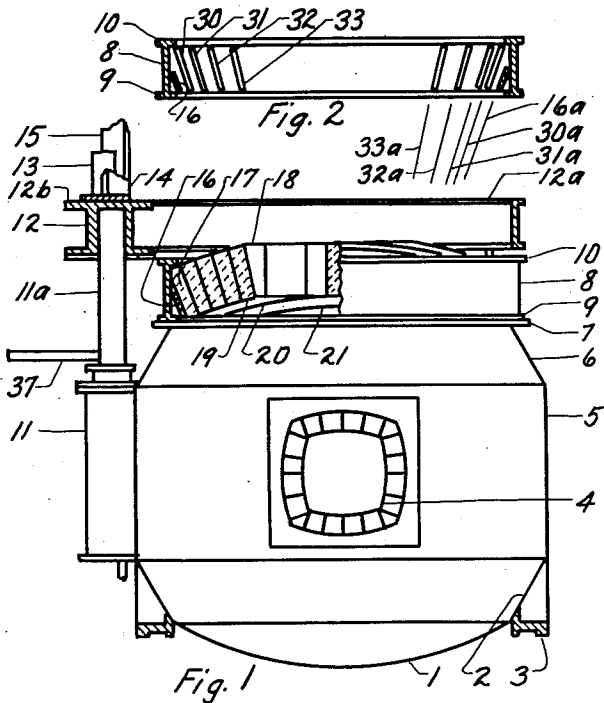
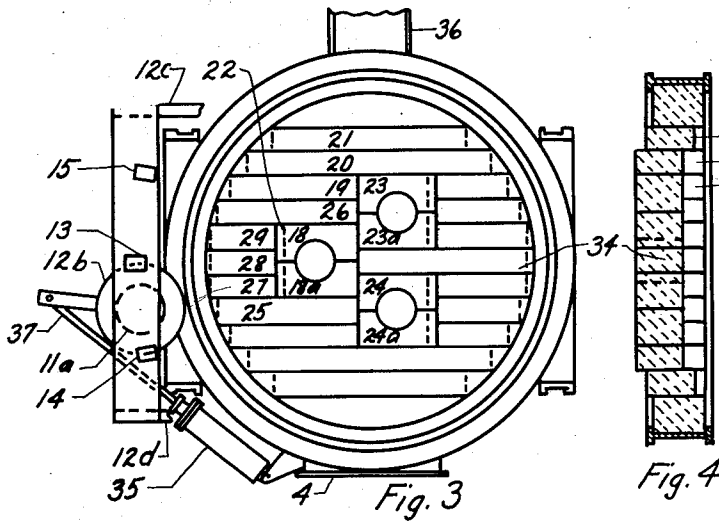


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TILTING FURNACE ROOF

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TILTING FURNACE ROOF

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My present invention relates to electric arc furnaces and furnace roofs and particularly to such furnaces having steel shells of normally cylindrical shape of vertical axis; and also to improvements in roofs for such furnaces.

Electric arc steel melting furnaces have been built with cylindrical shells of normally vertical axis, lined with refractory and having refractory roofs in which the roof brick are held in rings called roof rings. The shells for these furnaces have usually been of medium height and reinforced at the top with an outwardly extending angle or channel member to reinforce the shell against warping under tilting and heating. The doors have usually been opposite the spout and reinforced outside the door proper. The roofs for such furnaces were usually held in rings which rings were smaller than the inside diameter of the shell so that the roof ring rested on the top of the refractory wall lining the vertical cylindrical shell. To prevent rapid melting of the roof ring when the refractory wall melted, roof rings were made water-cooled but still mounted inside the shell top. These furnaces had refractory skew blocks which abutted the water-cooled ring or abutted the ring itself. These rings were heavy because of the weight of the skew blocks, and particularly where the roof ring was of the approximate diameter of the shell inside. Also the water-cooled rings had the objection of using much water when the refractory wall became melted and of even melting the roof ring itself. Furthermore, the shells which were usually low brought the roof ring close to the arcs and had the further objection of inability to take a large cold charge.

My present invention avoids the above objections both in the shell construction and roof construction. Arc furnace shells are subject to strains due to the intense heat of the arcs and steel where the shell top is close to the bath level. Also, tilting puts a further strain on such shells, even when heavily reinforced at the top.

My present invention has for one object the provision of a higher shell with a smaller top of special design, namely a relatively low steel cone on the top of the cylindrical part of the shell, the cone extending in and with an outwardly extending flange welded to the top of the cone section. The cone gives extra strength to the shell against warpage under the conditions such a shell is normally subjected to. Then furthermore, the higher shell places the upper refractories farther from the bath and arcs and yet, at the same time reduces the roof surface by using a smaller roof

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ring. Another advantage in my construction of this invention is the location of the roof ring on top of the reinforcing plate or flange around the cone top of the shell, whereby the ring is not subjected to the intense heat of the arcs when the wall melts away, for then it is time to replace the wall; and the roof ring need not in my construction be water-cooled. The ring is lighter and also the refractory inside the ring is much less than for a roof as great in diameter as the normally cylindrical part of the shell below the cone top I use.

A further advantage in my roof construction is that no refractory skew blocks are needed. I replace the previously used skew blocks with a steel skew welded inside the roof ring to abut the standard shapes of arched roof brick. In this improved roof, I replace the formerly used radial roofs with a series of parallel arches extending one way across the furnace chamber, that is, from one side of the roof ring to the other. The central rows are of the desired rise and the outer parallel rows which are farther from the center of the roof are of lower rise. The central rows, two, three or even four, can be sprung from a steel skew back welded inside the roof ring at one end of these rows to a corresponding and approximately equal sized steel skew plate at the other side of the ring abutting the other ends of these parallel rows. When next to the outer of these parallel rows on either side of them will be first a shorter and slightly lower rise arch, and next to this row will be another parallel and still shorter row. These parallel rows will be sprung from steel skew plates at one end of each such single row to corresponding plates at the other ends of such rows. That is to say—each single parallel row outside the center rows has a steel skew back member at each end. Then these skew plates for single parallel rows are spaced apart so that their center lines correspond to the center plane thru the given arch and these skew plates are made slightly less in width than the width of the standard brick forming the single parallel arches. Thus, where standard 9" series brick are used to form the arch, the skew plate would be slightly narrower, or about 4" instead of 4½" for the 9" series brick. Also I space the skews laterally so as to allow for slight discrepancies in the standard brick width, for example 4⅞" instead of 4½". The outer parallel rows have their ends closer together than the center rows and the skew plates which abut the ends of a short row are more nearly vertical than the plates for the center rows.

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Heretofore, in roofs for electric arc furnaces which are round, it has been customary to have very special radial shapes of refractory brick made, so as to provide, first a skew back brick next to the roof ring, and then circles of special radial brick, often quite large, and such as must be made by hand, and then inside where the electrode holes are located, further very special shapes to match those outside have been used. Such roofs are costly in first cost of the brick and they are not nearly so easy to lay as a roof such as my present improvement contemplates, which is made of very simple and standard shapes of brick with only a very few special shapes. These special shapes are constructed to match the standard arches so that practically no cutting of brick in such a roof is necessary. My improved roof construction has the further advantage of ability to use standard brick which are usually kept in stock, whereas the special shapes are not usually kept in stock.

My present invention contemplates doing without the usual outside skew-back brick needed for the round special roofs, whether the radial shapes are used or whether the roof is made up of circles of standard shapes with more or less cutting. In my present improvement, I use a one-way-arched roof. To do this in a round roof ring, it is seen that the one-way-arch rows farther away from the center of the roof and nearer the roof ring, get shorter as they are located nearer the ring and away from the center. Therefore, the skews which abut the ends of the different rows of one-way-arches, must be located at different positions inside the roof ring. The roof ring of my present improvement is round and preferably reinforced with a flange at the bottom if not at both bottom and top. Inside this ring I mount metal skew plates, preferably using steel plates and welding these inside the ring at the proper locations. The center rows which are sprung across the roof and which are the long rows, may have their ends approximately in line, so that a single skew plate will serve for several rows in this center part of the roof. Then adjoining the outer of these center rows the arch is shorter so that the skew plate must be located nearer the centerline which center line is at right angles to the direction of the one-way-arches. And the next farther out row of one-way-arched brick will require its skew plates to be still closer to each other and farther around the inner circumference of the ring. These outer skew plates are preferably made slightly narrower than the width of the row of one-way arch brick. Thus with standard 9" series shapes of brick which are $4\frac{1}{2}$ " wide, I make the steel skews slightly less in width than the brick, for example I make the steel skew plates about 4" wide. These plates may be made, for example of $\frac{1}{2}$ " thick steel, and they are welded in the ring to have their surface which abuts the first brick of the arch, parallel to the surface of that first brick. The skew for a row farther out will of course be more nearly vertical, since the brick nearer the center of the arch are more nearly vertical. Then when I insert in the roof a special shape or two or more special shapes to form a hole, for example an electrode hole in the central part of the roof, I make the end surface or surfaces wedge shaped, at one end any way, but I make the side surfaces of a dimension which will make that side surface conform to the side surface of the row of arch brick against which the special shape abuts. Thus the width across one or more of the special shapes is a

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multiple of the width of the standard series width. This special construction of roof is far simpler to lay up and without nearly so much time required as for the roofs heretofore used. I have made one way arched roofs before but heretofore, I have rammed plastic firebrick in behind the last or end brick of each single row of one-way-arched brick. My present use of a steel skew instead of the plastic saves much time and makes each relining simpler in that it is not necessary to set the arch in and then ram plastic back of the end brick, between the brick and the ring; but in my improved construction of this present invention, once the steel skews are welded in the ring or otherwise held in it, then it is necessary only to drop the brick in place with or without spacers to allow for expansion.

Standard series of brick, including straights, such as the $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$ inch brick, and the wedge brick which are 9" long and $4\frac{1}{2}$ " wide but smaller at one end to permit the arch construction, such brick made by one maker may be very close to $4\frac{1}{2}$ " wide but those of another maker may be a full sixteenth of an inch wider. To permit use of such a range in size, I make the steel skew plates preferably about 4" wide and I space them so that even tho the brick vary in width, still as they are farther apart they do not extend far enough to avoid use of the 4" skew plate, or, in other words, the different widths still make possible a joint within the $\frac{1}{2}$ " between the adjoining ends of the adjoining skew plates.

Altho there is a special advantage in the roofs where the electrode shapes are used, there is, none the less, a great advantage in any round roof, whether it has holes for electrodes or not; because of the simplicity of laying up these improved one-way-arch roofs of standard brick practically without any cutting of the brick.

My invention in its several modifications and aspects will be better understood by reference to the annexed drawings in which Fig. 1 is an elevation view partly in section of one modification of my invention. Fig. 2 is a sectional elevation view of the roof ring shown in Fig. 1. Fig. 3 is a plan view of the furnace of Fig. 1 and Fig. 4 is a sectional elevation view taken along the center line thru Figs. 1, 2 and 3. This Fig. 4 shows the relative elevations of the separately sprung arches, the three center rows being sprung from one skew plate at one end to a corresponding skew plate at the other end; and the outer separate arch rows being sprung from separate skews spaced so as to abut approximately the center of each one-way-arch row of standard brick, and also this Fig. 4 shows the electrode shapes in section, embodied in my invention.

Referring now to the drawings and particularly Fig. 1 and also the other figures the different parts are numbered as follows. The main vertical axis cylindrical part of the shell is marked 5 with a cone section welded to it beneath marked 2 and welded to the bottom of cone 2 is a bottom dished head, 1. The shell has a charge door indicated at 4 and a tapping spout 36 in Fig. 3. The shell is mounted on steel rockers attached to the cone 2. An upper cone section of shell 6 is welded to the top of part 5 and has a reinforcing flange 7 welded to the top of cone 6 and provides a rest for the roof ring which carries the roof brick. The main roof ring band is 8 and a bottom flange 9 is welded to 8 and a top flange 10 also, strengthening the roof ring to hold the arched brick.

At the left of the shell in Fig. 1 is shown a lift

cylinder 11 with plunger 11a entering a plunger member 12—a socket or cap—which is attached to and carries a frame 12a for carrying the roof ring proper. The roof frame 12—a is shown in Fig. 1 in section and also partly in Fig. 3 at 12c and 12d. The flanges of the plunger cap 12 are shown at 12—b. Then a crank arm 37 in Fig. 1 is provided for attaching a swing cylinder piston rod of the swing cylinder 35 so that after the roof frame and roof are lifted then the roof can be swung aside by movement of the crank arm 37 by the swing cylinder rod, so that a charge can be put into the furnace chamber to be melted. Electrode masts, which carry cross heads and electrode holders not shown, are marked indicating the center mast at 13, and the outer masts at 14 and 15. The masts are attached to the frame 12a so as to swing out with the roof ring.

In Fig. 1 the left hand half of the roof is shown in section thru the centerline of Fig. 3. This section shows the main roof ring band 8 and bottom and top flanges 9 and 10 in section; and also the steel skew back plate or skew proper at 16, attached, preferably by welding to the ring and flange 9 inside the ring, and at the proper angle for springing the center rows of one-way-arch roof brick. These three center rows are marked 27, 28 and 29 in Fig. 3 and the brick which abuts the skew 16 in Fig. 1 is marked 17. The special electrode brick which is shown in the section in Fig. 1 is marked 18 and is shown also in Fig. 3. The other special brick shape forming the electrode hole with 18 is marked 18a in Fig. 3. It will be noted that brick shape 18 and also the standard brick row marked 29 abut the row marked 26 in Fig. 3; and the side of brick 18a as well as the side of the row marked 27 abut the next row marked 25. The shapes 18 and 18a are wedge shaped as indicated by the dotted line 22 so that they abut the next wedge brick on the left. The under surfaces of rows 19, 20 and 21 are shown in Figs. 1, and 4, and these same rows are marked with the same numbers in Fig. 3.

In Fig. 2 a sectional elevation view of the roof ring is shown thru the center line of Fig. 3. The steel or metal skew 16 is attached to the inside of the roof band 8 and to the bottom flange 9. The other skews are shown at 30, 31, 32 and 33 for the left end of the one-way-arches; the skew 16 abutting the arch comprising the three one-way arch rows marked 27, 28 and 29 in Fig. 3. Then the next skew is indicated at 30 in Fig. 2 and abuts the row of arched or wedge brick 26 in Fig. 3 at the left end of this arch. A corresponding skew for the row marked 25 is mounted in the ring. The skews at the other ends of the rows are shown at the right hand side of Fig. 2 and the faces of these skews and the skews at the left or opposite side of the ring all have a slope corresponding to the lines shown at the right under Fig. 3 namely 16, 16a, 30a, 31a, 32a and 33a. It will also be noted that in Fig. 4, row marked 34 is a continuation of row 28 and is placed between the special electrode shapes marked 23 and 23a and 24 and 24a in this figure. Now altho the outside edges or sides of 23 and 24a are farther apart than the rows 27 and 29, yet they match with the arched brick in rows 20 and the row adjoining 24a. In other words, the special shapes are so made as to be equal to a multiple of the width of the standard arch brick rows. This construction is a special advantage because these special shapes fit in with the rows and permit use of the steel skews for the rows of arch brick outside rows 27, 28 and 29. The width

of the metal plate forming the skew for a single one-way-arch row of standard brick, such as a standard 9" series wedge brick which is $4\frac{1}{2}$ " wide, should be slightly less than the $4\frac{1}{2}$ inches and it can be about 4", thus leaving about $\frac{1}{4}$ " for unevenness or for slight differences in the $4\frac{1}{2}$ " brick dimension. Thus it happens that some kinds of these standard brick which are supposed to be $4\frac{1}{2}$ " in width are $\frac{1}{8}$ " thicker. In such cases, the skew plates must be mounted in the roof ring far enough spaced apart in their center lines thru the skews at both ends of the one-way arch row, to allow for such discrepancies in the widths of brick as may occur.

I have shown and described my present invention in its several modifications shown to bring out the special advantages, both in the shell construction to conserve heat by less outside radiation surface, and to provide a simpler furnace shell construction both to the above end and to make possible the use of smaller and lighter roofs, whether mounted with or without top charge roof and electrode crane mechanism, but especially where such lift cylinder construction is used. And I have shown the advantage of my one-way-arch improvement, comprising the metal or steel skews to replace the costly and heavy skew-back brick heretofore used; or the rammed plastic to form a skew back brick; and the further special advantage where electrode hole shapes are used in the roof. Altho I have shown electrode hole shapes comprising only two halves, it is understood that I may make these shapes in more than two halves and in as many parts as may be required for very large electrodes, so long as I make these shapes to have their outside lines or joints where they join the next row of standard brick, such that no cutting is necessary.

What I claim is:

1. An electric arc steel melting furnace comprising a steel shell having a normally vertical cylindrical section, dished bottom welded to the lower part of said cylindrical section, and steel cone, relatively short and small end up, welded to the top of said cylindrical section with a steel flange welded to the top of said cone extending out horizontally, when the shell is in the normal upright position to about the outside diameter of the cylindrical part of the shell; a spout attached to one side of said shell and a charge door opposite and rockers for tilting the shell in the direction of the spout; a refractory lining in said shell up to the top flange of the cone section; a roof ring comprising a channel of steel having its flanges extending in and of the same approximate diameter inside as that of the top flange of the cone and of the same approximate outside diameter as the outside diameter of said top flange; steel skew plates welded inside said channel to abut the ends of parallel rows of arched brick, said skew plates being of slightly less width than the width of the arches sprung from given opposite skew plates and located approximately in the central planes of the parallel rows, the central rows being sprung from skew plates which are of the approximate width of the several central rows which have the same approximate rise; the arched rows supporting special blocks which form the holes for the electrodes thru the roof; means for tilting said furnace; and means attached to the side of the shell for lifting and swinging the roof, for charging thru the top of the furnace.

2. An electric furnace roof comprising a chan-

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nel shaped steel ring, the top and bottom flanges of said ring extending in; refractory brick of approximately equal width mounted in said ring in parallel arches across the ring, said arches including blocks which form the holes for electrodes to enter thru said roof; steel skew plates replacing the usual refractory skew blocks, to abut the two ends of the several central rows which are of approximately equal length; and outside these central rows, skew plates of steel welded inside the channel to abut the ends of the shorter parallel rows of arches, said steel skew plates for these outer and shorter rows being spaced laterally with their centers conforming approximately to the center plane of the given arch and being slightly less in width than the width of the brick of the parallel arches.

3. A roof ring for a circular furnace of normally vertical axis, said ring comprising a structural steel channel shaped member having bottom and top flanges extending in, and steel skew plates welded inside the channel member so as to abut the ends of the rows of parallel arches,

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said skew plates being narrower than the separate parallel arches and spaced laterally apart on centers which centers are themselves spaced apart a distance equal to the width of the corresponding arch.

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