Feb. 26, 1935. G. E. BLAGG 1,992,465

ELECTRIC FURNACE

Filed July 25, 1934 2 Sheets-Sheet 1

Fig. 1.

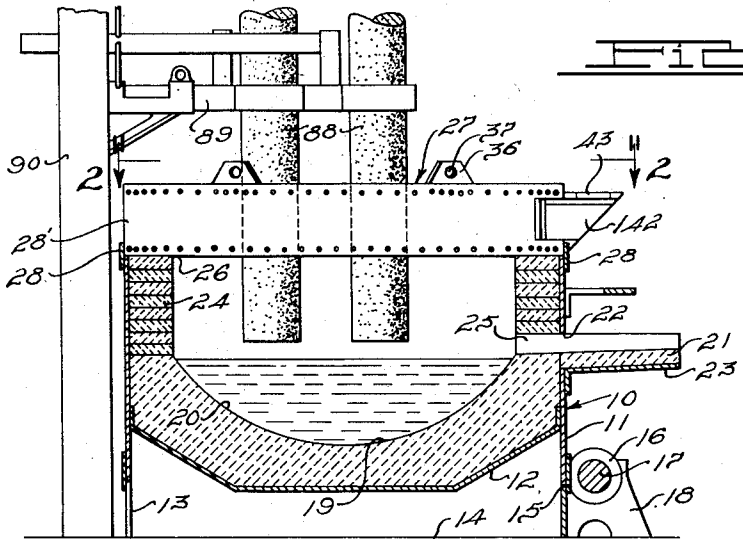
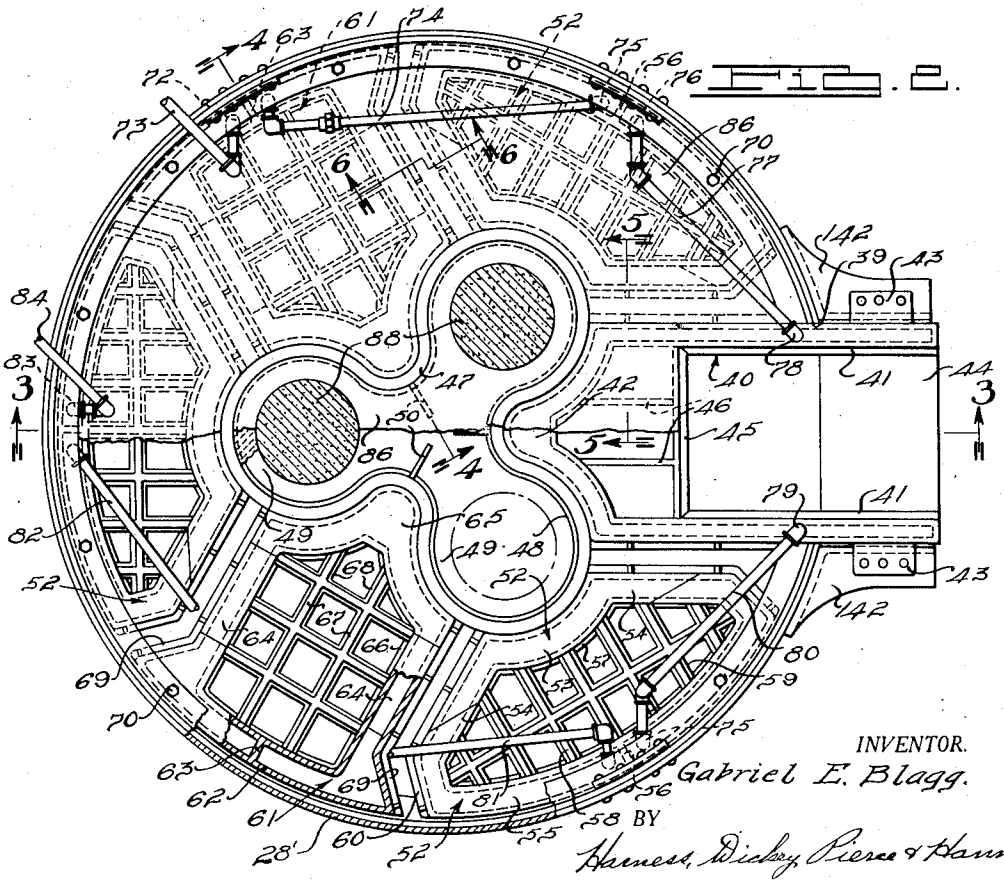



Fig. 2.

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ELECTRIC FURNACE

Filed July 25, 1934 2 Sheets-Sheet 2

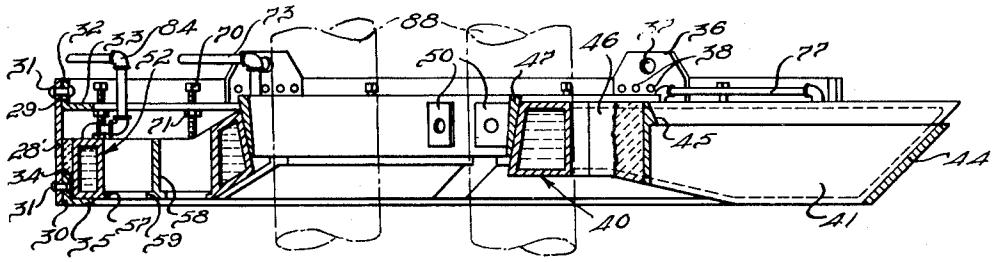

FIG. 3.

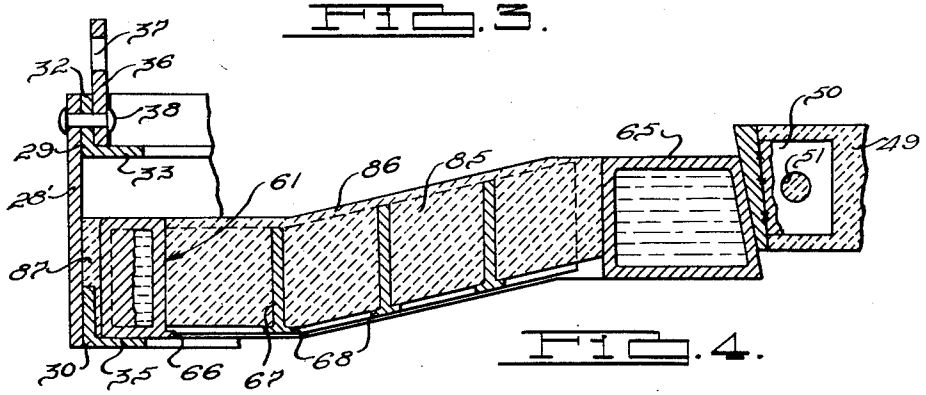

FIG. 4.

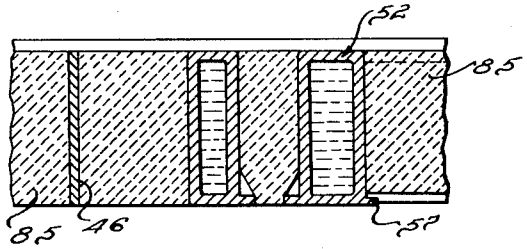

FIG. 5.

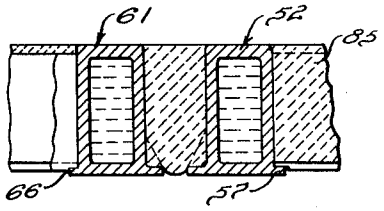

FIG. 6.

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# UNITED STATES PATENT OFFICE

1,992,465

## ELECTRIC FURNACE

Gabriel E. Blagg, Detroit, Mich.

Application July 25, 1934, Serial No. 736,883

18 Claims. (Cl. 122—6)

This invention relates to a furnace roof construction.

More specifically, the invention pertains to the provision of a cooled, electric furnace roof.

One of the main objects of the invention is to provide an improved furnace roof, of which substantially all portions thereof are maintained at a comparatively low and relatively uniform temperature during operation of the furnace.

Another object of the invention is to provide a cooling system in a roof of this character, which has cooling medium passages disposed in close proximity to those portions of the roof which contact with, or are adjacent to, the side walls of the furnace, so as to guard against destructive heating of the material of the adjacent side wall and roof portion, and to prevent burning of flames and escapement of gases through the junction of the side wall and roof of the furnace.

A still further object of the invention is to provide a furnace roof having refractory material structurally supported and held from falling into the interior of the furnace.

Another object of the invention is to provide, in a furnace roof having centrally located apertures for accommodating electrodes, means for maintaining the temperature of the walls of such apertures sufficiently low to allow operation of the furnace with only a slight clearance between the electrodes and the walls of the apertures.

Other objects of the invention are to provide a cooling system in a roof of the foregoing character which prevents excessive heating of the roof portions in the vicinity of the electrodes and eliminates binding and sticking of the electrodes; to provide a roof which is maintained at a low enough temperature to permit attendants to stand on the top thereof for the purpose of adjusting the electrodes while the furnace is in operation; to provide a cooled furnace roof which permits of accurate control of the electrodes at all times in such a manner as to maintain highly efficient operation of the furnace and to guard against unintended and undesirable additions of carbon to the batch of metal under treatment which has heretofore been occasioned by improper electrode adjustment but more particularly because of breakage of the electrode due to warpage of its guiding ring, and to provide means for cooling a furnace roof which is also adapted to reduce the temperatures to which the materials of the side walls of the furnace adjacent the roof are subjected, and to thereby materially increase the length of life of such side wall structures.

Additional objects of the invention are to provide, in a furnace roof having centrally located apertures for accommodating electrodes, a plurality of inwardly extending cooling medium units which substantially conform in contour with and border the major portions of the perimeters of such apertures, so as to to maintain the surrounding wall temperature at a comparatively low value; to provide separate and independent conveniently formable cooling medium sectors having outer extremities conforming with the shape of the outer edge contour of the roof and having inner edge portions conforming with the contour of the electrodes and their apertures; to provide frame-like cooling units of this character having hollow central portions and tubular side and end extremities between which grids are receivable for conducting heat from substantially large areas of the roof directly to the cooling medium passages of the cooling unit; to provide means on cooling units of this character for supporting the grids in metal to metal contact therewith; to provide grids in the hollow central portions of the cooling units which have means thereon for supporting refractory material, such as ganister; to provide refractory material in the openings of the grids and between the cooling units which may be relied upon, in conjunction with an external layer of refractory material disposed on the upper side of the roof, to fill a desired portion of the space within the side walls of the roof; to provide a cooling unit having tubular sides for accommodating the flow of a cooling medium along the sides and end of a charging opening formed in the roof; and to provide cooling medium units of the foregoing character which are preferably constructed in the form of sectors and adapted to be assembled within the roof ring in an arcuate arrangement so as to substantially uniformly distribute the cooling medium passages of the units throughout the entire cross-sectional area of the roof.

Still further objects of the invention are to provide improved means for supporting the sector-like cooling unit and maintain the latter in fixed relation; to provide means of this character which is carried by the outer metal edge embracing shell or ring with which furnace roofs of this type are conventionally provided; to provide an inwardly extending radial flange on a roof ring of this character for contacting with and supporting the outer extremities of the sector-like cooling units and which is adapted to seat directly upon the upper edge portions of the side wall of a furnace so as to maintain the temperature at

such upper edge portion at a comparatively low value.

Additional objects of the invention are to provide means at the central portion of the roof for establishing the contour and arrangement of passages for receiving electrodes; to provide means of this character which contact with the inner extremities of the sector-like cooling units and hold the latter against inward displacement from the roof rings; to provide cooperating and inclined surfaces on the inner extremities of the cooling units and the electrode passage forming means so as to maintain a wedge-like engagement between such surfaces whereby the latter member is supported and the cooling units are cammed outwardly toward the roof ring; to provide sector-like cooling units of this kind which have inner and intermediate portions that are inclined upwardly from the plane of the lower edge of the roof ring in such a manner as to form a roof of arched contour; and to provide inner extremities on the cooling unit which conform in curvature and contact with substantially the entire outer surface of the band or loop defining the electrode passages and their locations.

Still further objects of the invention are, to provide means for connecting the interiors of the cooling units in a series relationship and to provide for the circulation of a cooling medium through such unit.

The above being among the objects of the present invention, the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

An illustrative embodiment of the invention is shown in the accompanying drawings, in which:

Fig. 1 is a vertical, sectional view taken centrally through an electric furnace having a roof which embodies the invention, the roof being shown in full side elevation.

Fig. 2 is a partially broken, partially sectioned plan view taken on the line 2—2 of Fig. 1.

Fig. 3 is a transverse, vertical, sectional view of the roof taken on the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary, vertical, sectional view of the roof taken on the line 4—4 of Fig. 2.

Fig. 5 is a fragmentary, vertical, sectional view of the roof taken on the line 5—5 of Fig. 2, and

Fig. 6 is a fragmentary, vertical, sectional view of the roof taken on the line 6—6 of Fig. 2.

In the form shown in the drawings, my improved furnace roof is illustrated in conjunction with an electric furnace, generally designated by the numeral 10, which is constructed in accordance with conventional practice. The furnace 10 includes an outer cylindrical metal shell 11 to which a concave bottom plate 12 is welded or otherwise suitably secured as, illustrated in Fig. 1. The outer metal shell 11 is provided with a lower skirt portion 13, by which the furnace is normally supported in a vertical, upright position with the bottom plate 12 spaced from the floor 14 which preferably comprises brick or other refractory material. Mounted on the skirt portion 13 of the furnace are brackets, one of which is illustrated in Fig. 1 and designated by the numeral 15, each having a bearing 16 for receiving a fulcrum shaft 17 carried by a standard 18 which is mounted on the floor 14. The shaft 17 provides a fulcrum about which the furnace may be pivoted in a clockwise direction, as viewed in Fig. 1, during discharging of molten metal therefrom.

Provided in the shell 11 is a hearth 19 having a concaved upper side 20. The hearth 19 preferably comprises refractory material, such as ganister, and it is provided with an outwardly extending trough-shaped flange or spout 21, which projects through a molten metal discharge opening 22 in the shell 11. The spout 21 is supported by a correspondingly trough-shaped metal plate 23, which is welded or otherwise suitably secured, to the shell 11. This discharge spout is located directly above the fulcrum shaft 17 about which it is rotated downwardly in a clockwise direction, as viewed in Fig. 1, during discharging of molten metal from the furnace.

The hearth 19 terminates at a substantial distance from the upper extremity of the outer cylindrical metal shell 11, and that portion of the latter which extends above the hearth is provided with a lining 24 comprising refractory material. In the form shown, the lining 24 consists of layers of fire brick, but it may also be formed of ganister or combinations of ganister and brick or other suitable refractory compositions. An opening 25 is provided in the lining 24 in registration with the opening 22 in the outer shell 11 for permitting the discharge of molten metal from the interior of the furnace.

The refractory lining 24 has an upper substantially horizontal extremity 26, which is substantially flush with the upper extremity of the outer shell 11, and upon which my improved furnace roof, generally designated by the numeral 27, is adapted to rest. The roof 27 is preferably held against lateral displacement by a metal band 28 which surrounds and projects above the upper edge portions of the outer shell 11 and which is preferably welded, or otherwise suitably secured thereto. The band 28 is slightly larger in diameter than the outer shell 11 and it therefore serves as a pilot in bringing the roof into concentric relationship with the furnace during placement of the roof thereon.

The roof 27 includes an outer metal roof ring 28′ of substantially cylindrical shape in which upper and lower metal rings 29 and 30, respectively, of angular cross-section are concentrically mounted. The ring 29 has a vertically extending cylindrical side portion 32 disposed adjacent the roof ring 28′ and secured thereto by rivets 31, and it is provided with an inwardly extending substantially horizontal flange 33, which is located in downwardly spaced relation from the upper edge portion of the roof ring 28′. The lower angle ring 30 has a vertically extending cylindrical side 34 secured by rivets 31 to the roof ring 28′ and an inwardly extending substantially horizontal flange 35 which is located in the plane of the lower extremities of the roof ring 28′.

Provided at the upper edge portion of the roof ring 28′ are arcuately spaced brackets 36 having apertures 37 therein for receiving hooks of overhead cranes (not shown) by which the roof may be removed from and placed upon the furnace. The brackets 36 are preferably secured to the inner periphery of the cylindrical side 28′ of the upper angular ring 29 and to the adjacent portions of the roof ring 28 by rivets 38, as illustrated in Fig. 4.

Formed in the roof ring 28′ is a charging opening or slot 39 in which a yoke-shaped cooling unit, generally designated by the numeral 40, is disposed. All electric furnaces do not have charging doors in the roof thereof, it being shown herein particularly to illustrate the application of the present invention thereto when employed, and in event it is not employed the necessary

modification of the structure shown and described will be readily recognized by those skilled in the art. The cooling unit 40 where employed preferably comprises a casting having opposite, parallel, tubular sides 41, and a tapered extremity 42 having a cooling medium passage therein communicating with the inner end of the cooling medium passages of the side 41 of the cooling unit. The sides 41 of the cooling unit 40 project beyond the roof ring 28 and they are supported by gusset plate 142, mounted on the external side of the roof ring and attached to the cooling medium unit by brackets 43. The inner end portions of the cooling unit 40 are so inclined upwardly toward the center of the roof as to conform to and provide the roof with a desired arched contour. The external end portions of the parallel sides of the cooling unit 40 are connected together by an inclined plate or wall 44 which slopes upwardly and outwardly from the location of the roof ring 28', and serves as a slide for the charges of metal fed to the furnace. The entire cooling unit 40 may comprise a central integral casting in which the wall 44 is an integral part, and it is preferably provided with a partition 45 extending between the inner end portion of the side 41 of the cooling unit, the space between the wall 44 and partition 45 being open during charging of the furnace to permit the passage of the charge into the latter. Extending inwardly from the partition 45 to the inner extremity 42 of the cooling unit 40 are plates 46 which are either welded to, or formed integral with, the partition and the inner extremity of the cooling unit. These plates divide the space between the inner extremity of the cooling unit 40 and the partition 45 into relatively small compartments in which refractory material, such as ganister, may be conveniently held. A door (not shown) is provided for closing the opening in the unit 40, this door comprising a metallic frame and enclosed grids which serve to support ganister or the like which is packed therein to complete the structure.

Arcuately arranged around the interior of the roof ring 28 between the opposite sides of the yoke-shaped cooling unit 41 are a plurality of sector-like cooling units of frame-like construction which preferably comprise hollow castings having tubular side and end extremities. It is to be understood that the number of such units employed in a particular furnace will depend upon its size and/or other considerations, the number shown in the drawings being by way of illustration only. All of the outer extremities of the frame-like cooling unit have substantially the same arcuate curvature which conforms with the contour of the roof ring 28, and the innermost portions thereof are inclined upwardly toward the center of the roof in conformity with the inclination of the corresponding parts of the cooling unit 40 and with the desired arched contour of the roof. The inner extremities of the various frame-like cooling units differ materially in contour for they are shaped to conform to the contour of a centrally located clover-leaf shaped band or loop 47, illustrated in Fig. 2. The clover-leaf shaped band 47 has three lobes, each of which defines the location of an electrode passage 48 which is provided with a lining 49 of refractory material such as ganister. The refractory material 49 extends into and substantially fills the interior of the loop 47, with the exception of the electrode passages 45 which are retained open by cores (not shown) during molding or other formation of the refractory material in the loop. Provided at the junctions of the loops of the band 47 are inwardly extending radial fins 50, which are fixed to the innermost extremities of the loop 47, and which terminate in close proximity to the central axis of the roof. The fins 50 are provided with apertures 51 through which the refractory material 49 of the central portion of the loop 47 extends and by means of which it is in part supported.

There are two distinct types of frame-like cooling units employed in the construction shown, one designated generally by the numeral 52, in Fig. 2, having a substantially greater length than radial dimension, and being provided with a concaved inner extremity 53 and converging inclined tubular sides 54. The inner extremity 53 of the frame-like cooling unit 52 conforms in curvature with the outermost portion of one of the lobes of the band or loop 47, and the outer extremity 55 of this cooling unit conforms, as above set forth, with the curvature of the roof ring 28 adjacent which it is disposed. The outer tubular extremity 55 is provided with an internal partition wall 56 which prevents continued recirculation of cooling medium through the passage of the cooling unit after it has once travelled therethrough. Formed on the sides and ends of the cooling unit 55 are inwardly extending flanges 57 which are located at the lower extremity of the cooling unit as illustrated in Fig. 3, and upon which are supported grids 58 comprising substantially vertical, intersecting walls having webs 59 along their lower extremities. The lower extremities of the inclined sides 54 of the cooling units 52 are provided with outwardly extending flanges 60, which protrude into the spaces between adjacent cooling units.

There are three arcuately spaced cooling units 52 each of which is aligned with the outer extremity of one of the lobes of the loop 47 and between which are disposed frame-like cooling units generally designated by the numeral 61. Each cooling unit 61 is provided with an arcuate shaped outer tubular end 62 having an internal partition 63 therein for accomplishing the same function as the partitions 56 of the cooling units 52. The cooling units 61 comprise opposite, spaced and substantially parallel tubular sides 64 which are connected together at their inner end portions by tapered tubular inner ends 65. The tapered ends of the cooling units 61 protrude into the spaces between adjacent lobes of the loop 47 and they are shaped to conform to the contour of the curvatures of the adjoining portions of the lobes. The lower extremities of the sides 64 and ends 62 and 65 of the cooling unit 61 are provided with inwardly extending flanges 66 upon which are supported grids 67 having intercepting substantially vertical walls having webs 68 on their lower extremities. The sides 64 of the cooling unit 61 are provided with outwardly extending flanges 69 which protrude into the spaces between adjacent units, and which substantially register with the external flanges 60 of the cooling units 52. There are two cooling units 61 each of which has a substantially greater radial dimension than arcuate length and these units are, as set forth above, disposed between adjacent cooling units 52 which are of substantially greater arcuate length than radial width.

The arcuate outer extremities of all of the cooling units are releasably clamped in direct metal to metal engagement with the inwardly extending flange 35 of the lower ring 30 of the roof ring 28'

by bolts 70 which are threaded in apertures formed in the inwardly extending flange of the uppermost ring 29 of the roof ring 28'. The bolts 70 are provided with lock nuts 71 by which they may be releasably held in adjusted position.

The upper left hand cooling unit 61, shown in Fig. 2, has a cooling medium inlet 72 on the left side of its partition 63 with which a cooling medium supply pipe 73 communicates. This cooling unit 61 has an outlet on the opposite side of the partition 63 which is connected by a pipe 74 with an inlet 75 of the clockwise adjacent cooling unit 52. The inlet 75 is also located on the left side of the partition 56 of the latter cooling unit. The upper right hand cooling unit 52 is provided with an outlet opening 76 which is connected by a pipe 77 with an inlet 78 which communicates with the interior of the upper side 41 of the yoke shaped cooling unit 40. The lower side 41 of the cooling unit 40 is provided with an outlet 79 which is connected by a pipe 80 with the inlet 75 of the lower right hand cooling unit 52, as viewed in Fig. 2, and the lower left hand cooling unit 61 is likewise connected by a pipe 81 in series relationship with the lower right hand cooling unit 52, the latter cooling unit being connected with the extreme left hand cooling unit 52 by a pipe 82. The extreme left hand cooling unit 52 is provided with an outlet 83 with which a drain or a return pipe 84 is connected. All of the cooling units are in this manner connected in a series relationship so as to cause the continuous flow of cooling medium through the passages of the successive cooling units and from one cooling unit to another from the inlet pipe 73 to the outlet pipe 84. These cooling units may be connected in parallel, each directly to the source of cooling medium if desired, in which case each unit would have an individual inlet and an individual return flow conduit.

All of the spaces between the various parts of the structure of the cooling units and other portions of the roof, with the exception of the electrode passages 48 are filled with refractory material 85 such as ganister, bricks or other suitable refractory composition and a layer of refractory material 86 is also preferably provided over the top of the cooling unit and over the space within the electrode passage providing loop 47 exclusive of the electrode passages.

The refractory material 85, which is contained within the spaces or compartments of the various grids, is supported in part by the webs 59 and 68 of the walls of the grids as well as by the inwardly extending flanges 57 and 56 of the cooling units 52 and 61 respectively. The refractory material in the spaces between the successive cooling units is supported in part by the outwardly extending flanges 60 and 69 of the adjacent sides of the cooling units 52 and 69 respectively. If, as illustrated in Fig. 4, a space is provided between the peripheries of the outer extremities of the cooling units and the roof ring 28', this space may also be filled with refractory material 87 which may comprise ganister or any suitable similar material.

A metal to metal contacting relation between the outer extremities of the cooling units and the inwardly extending flange 35 of the lower rings 30 carried by the roof ring 28' maintains the flange 35 at a comparatively low temperature, and since this flange seats upon the lining 24 of the furnace as, illustrated in Fig. 1, the upper extremity of the latter lining is also maintained at a comparatively low temperature and burning of flames through the junction of the side wall lining 24 and the roof, as well as the escapement of gases therebetween, is avoided. All of the various passages of the cooling unit are so distributed throughout the cross-sectional area of the entire roof as to maintain all portions thereof at a comparatively low temperature. This greatly increases the length of life of the roof and prevents breaking of the refractory material thereof and consequent falling of such refractory material into the metal under treatment in the furnace, and as a result the composition of the batch is not upset by the addition of foreign matter thereto. The tubular sides 41 of the yoke shaped cooling unit 40 protect the sides of the charging opening of the roof from excessive temperatures, thereby rendering charging operations less difficult, and enabling workmen to charge the furnace without great hazard. Accurate adjustments of the electrodes 88, which are in accordance with conventional practice slidably mounted in the passages 48 of the roof, are also facilitated. These electrodes are, as illustrated in Fig. 1, carried by fixtures 89 which extend over the furnace and which are slidably mounted on vertical upright supports 90. The electrodes may be adjusted by workmen standing upon the top of the furnace while the latter is in operation, and due to the comparatively low temperature at which the lining material 49 providing the walls of the electrode passages 48 is maintained, only a relatively small clearance need be provided between the outer surfaces of the electrodes and the walls of their respective passages. Sticking and binding of the electrodes in their respective passages, endangering breakage of the electrodes and consequent excessive carbon in the bath, is in this way avoided without employing excessively large clearance through which flames may burn and gases escape from the interior of the furnace.

All of the cooling units are conveniently removable and they may therefore be repaired or replaced, and if it becomes necessary to provide new refractory material in the roof, or replace any of the sections or connections, this may be accomplished by removing and replacing such portions of the roof structure as may be necessary in the particular instance.

Contrary to the common belief of practitioners, it has been found that substantial economy in both the operation and maintenance of electric furnaces is effected by cooling the roofs thereof in the foregoing manner. The furnace lining life has been substantially doubled for both continuous and intermittent furnace operations and the roof life has been practically doubled for continuous operation and substantially quadrupled for intermittent operation. The cooling of the walls of the electrode passages has decreased electrode breakage and increased electrode life. A material saving is also made in the time furnaces of this kind are shut down for repair. All these advantages are attained with only a slight increase in current consumption due to furnace heat loss in cooling the roof.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit and substance of the broad invention, the scope of which is commensurate with the appended claims.

I claim:

1. In a furnace, a roof including an outer peripheral wall, arcuately arranged spaced cooling medium conduits within said wall extending from the latter toward the center of said roof,

piping connecting the interiors of said conduits in a series relationship, and refractory material between said conduits and supported thereby.

2. In a furnace, a roof including an outer peripheral wall, arcuately arranged cooling medium conduits extending inwardly from said wall toward the center thereof and at an inclination to the plane of one extremity of said wall, and refractory material disposed between and supported by said conduits, corresponding sides of said conduits and refractory material providing an arched ceiling for said furnace.

3. In an electric furnace, a roof including an outer metal ring, an inner metal loop member having passages therethrough for accommodating electrodes, arcuately arranged spaced cooling medium conduits extending between said member and said ring supported by the latter and in turn supporting said loop member, and refractory material in the spaces within said ring between the latter and said electrode passages.

4. In an electric furnace, a roof including an outer metal ring having an inwardly extending radial flange, sectors having spaced cooling medium passages therein seated on said flange and extending inwardly toward the center of said ring, a metal loop member having electrode passages therethrough located at the center of said ring and contacting with the inner extremities of said sectors, and refractory material between said spaced cooling medium passages.

5. In an electric furnace, a roof including an outer metal ring having an inwardly extending radial flange, sectors having spaced cooling medium passages therein seated on said flange and extending inwardly toward the center of said ring, a metal loop member having electrode passages therethrough located at the center of said ring and contacting with the inner extremities of said sectors, refractory material between said spaced cooling medium passages, a lining within said member comprising refractory material and surrounding said electrode passages, and means for supplying a cooling medium to said cooling medium passages.

6. In an electric furnace, a roof including an outer metal ring having an inwardly extending radial flange, sectors having spaced cooling medium passages therein seated on said flange and extending inwardly toward the center of said ring, a metal loop member having electrode passages therethrough located at the center of said ring and contacting with the inner extremities of said sectors, means for releasably clamping said conduits to said metal ring, and refractory material between said spaced cooling medium passages.

7. In an electric furnace, a roof including an outer metal ring, an inner metal loop located centrally of said ring having an electrode passage therethrough, frame-like cooling units having tubular side and end extremities mounted on said ring and extending inwardly from the latter to said loop member, grids within said frame-like units supported thereby, and refractory material filling the openings of said grids.

8. In an electric furnace, a roof including an outer metal ring, an inner metal loop located centrally of said ring having an electrode passage therethrough, frame-like cooling units having tubular side and end extremities mounted on said ring and extending inwardly from the latter to said loop member, grids within said frame-like units supported thereby, refractory material filling the openings of said grids, and linings comprising refractory material between said ring and the adjacent extremities of said cooling units and surrounding said electrode passage respectively.

9. In an electric furnace, a roof including an outer metal ring, an inner metal loop located centrally of said ring having an electrode passage therethrough, frame-like cooling units having tubular side and end extremities mounted on said ring and extending inwardly from the latter to said loop member, grids within said frame-like units supported thereby, refractory material filling the openings of said grids, partitions in one tubular extremity of each of said cooling units, piping connecting the interiors of said units in series, and means for circulating a cooling medium through said units.

10. In a furnace including a hearth having an upper open end and adjacent side walls, a roof including an outer metal ring having an inwardly extending radial flange engageable with the upper extremities of said side walls, frame-like cooling units having tubular side and end extremities within said ring and extending inwardly thereof, the outer end extremities of said units conforming in curvature with said ring and being seated upon said flange, and means for supplying a cooling medium to said cooling units.

11. In an electric furnace including a hearth having an upper open end and adjacent side walls, a roof including an outer metal ring having an inwardly extending radial flange engageable with the upper extremities of said side walls, frame-like cooling units having tubular side and end extremities within said ring and extending inwardly thereof, the outer end extremities of said units conforming in curvature with said ring and being seated upon said flange, and the inner extremities of said units being inclined outwardly, a loop member having passages therein for accommodating electrodes and having an outer surface provided with an inclination corresponding with the inclination of the inner extremities of said units and fitted within the latter, and means for supplying a cooling medium to said cooling units.

12. In a furnace including a hearth having an upper open end and adjacent side walls, a roof including an outer metal ring having an inwardly extending radial flange engageable with the upper extremities of said side walls, frame-like cooling units having tubular side and end extremities within said ring and extending inwardly thereof, the outer end extremities of said units conforming in curvature with said ring and being seated upon said flange, means for clamping the outer extremities of said units to said flange in metal to metal contact therewith, and means for supplying a cooling medium to said units.

13. In a furnace including a hearth having an open end and adjacent side walls, a roof including an outer metal ring having an inwardly extending radial flange engageable with the upper extremities of said side walls, spaced frame-like cooling units having tubular side and end extremities within said ring, the outer end extremities of said units being seated upon said flange, means for clamping the outer extremities of said units to said flange, refractory material in the spaces between and within said frame-like cooling units, and means for supplying a cooling medium to the interior of the latter.

14. In a furnace, a roof including an outer metal ring having an inwardly extending radial flange, spaced frame-like cooling units having tubular side and end extremities within said ring,

the outer end extremities of said units being seated upon and secured to said flange, grids located between the tubular extremities of said units, a refractory material filling the openings of said grids and the spaces between said units, and means for supplying a cooling medium to the interior of said units.

15. In a furnace, a roof including an outer metal ring having an inwardly extending radial flange, spaced frame-like cooling units having tubular side and end extremities within said ring, the outer end extremities of said units being seated upon and secured to said flange, and the side extremities of said units being provided with inwardly extending flanges, grids located within said cooling units and supported by the flanges thereof, a refractory material filling the openings of said grids and the spaces between said units, and means for supplying a cooling medium to the interior of said units.

16. In a furnace, a roof including an outer metal ring having an inwardly extending radial flange, spaced frame-like cooling units having tubular side and end extremities within said ring, the outer end extremities of said units being seated upon and secured to said flange, and the side extremities of said units being provided with inwardly and outwardly extending flanges respectively, grids located within said cooling units and supported on the inwardly extending flanges thereof, refractory material in the openings of said grids, refractory material between said units supported at least in part by the outwardly extending flanges of said units, and means for supplying a cooling medium to the interior of said units.

17. In a furnace, a roof including an outer metal ring having an inwardly extending radial flange, spaced frame-like cooling units having tubular side and end extremities within said ring, the outer end extremities of said units being seated upon and secured to said flange, and the side extremities of said units being provided with inwardly and outwardly extending flanges respectively, grids located within said cooling units and supported on the inwardly extending flanges thereof, said grids including intersecting walls having webs on their lower extremities, refractory material in the openings of said grids supported at least in part by said webs, refractory material between said units supported at least in part by the outwardly extending flanges of said units, and means for supplying a cooling medium to the interior of said units.

18. In a furnace, a roof including an outer metal ring having a charging opening therein, a yoke-shaped cooling unit comprising tubular side walls extending through said opening into the central portion of said ring and having a tubular inner extremity, said tubular side walls and inner extremities having communicating cooling medium passages, spaced frame-like cooling units having communicating tubular side and end extremities within said ring, a loop member located centrally of said ring and extending between the inner extremities of said cooling units and contacting with the latter, refractory material between said cooling units and in the space between the extremities of said frame-like cooling members, and means for supplying a cooling medium to the interiors of said cooling units.

GABRIEL E. BLAGG.

CERTIFICATE OF CORRECTION.

Patent No. 1,992,465. February 26, 1935.

GABRIEL E. BLAGG.

It is hereby certified that the above numbered patent was erroneously issued to the inventor said "Blagg" whereas said patent should have been issued to Michigan Steel Casting Company, a corporation of Michigan, as assignee of the entire interest in said invention as shown by the records of assignments in this office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of April, A. D. 1935.

Leslie Frazer

(Seal) Acting Commissioner of Patents

## CERTIFICATE OF CORRECTION.

Patent No. 1,992,465. February 26, 1935.

GABRIEL E. BLAGG.

It is hereby certified that the above numbered patent was erroneously issued to the inventor said "Blagg" whereas said patent should have been issued to Michigan Steel Casting Company, a corporation of Michigan, as assignee of the entire interest in said invention as shown by the records of assignments in this office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of April, A. D. 1935.

Leslie Frazer

(Seal) Acting Commissioner of Patents