June 20, 1961 J. W. CORRISTON 2,989,296

METALLURGICAL FURNACE ROOF DESIGN

Filed Feb. 14, 1958 2 Sheets-Sheet 1

FIG. 1.

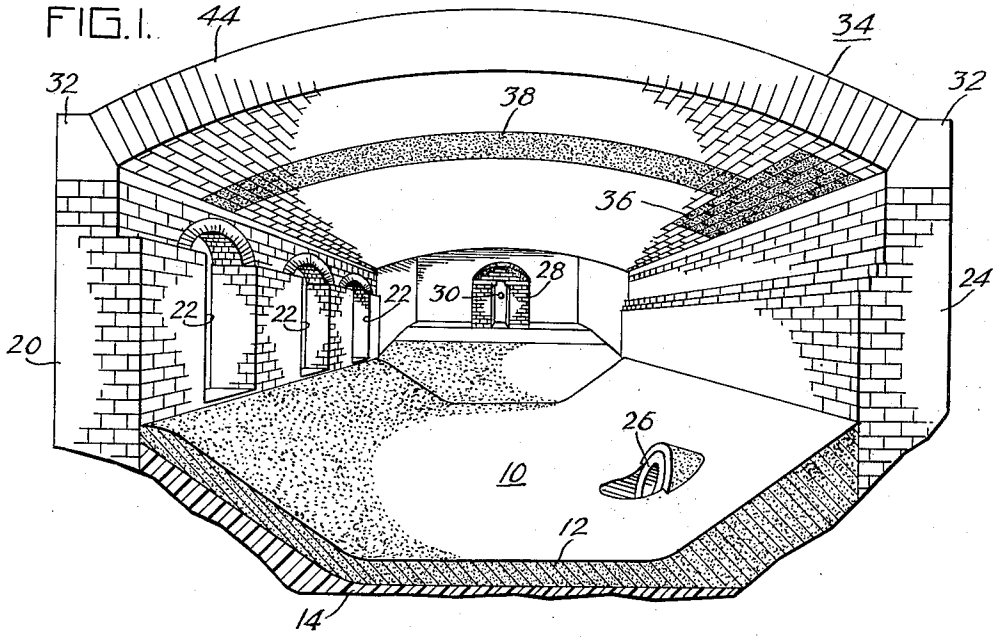
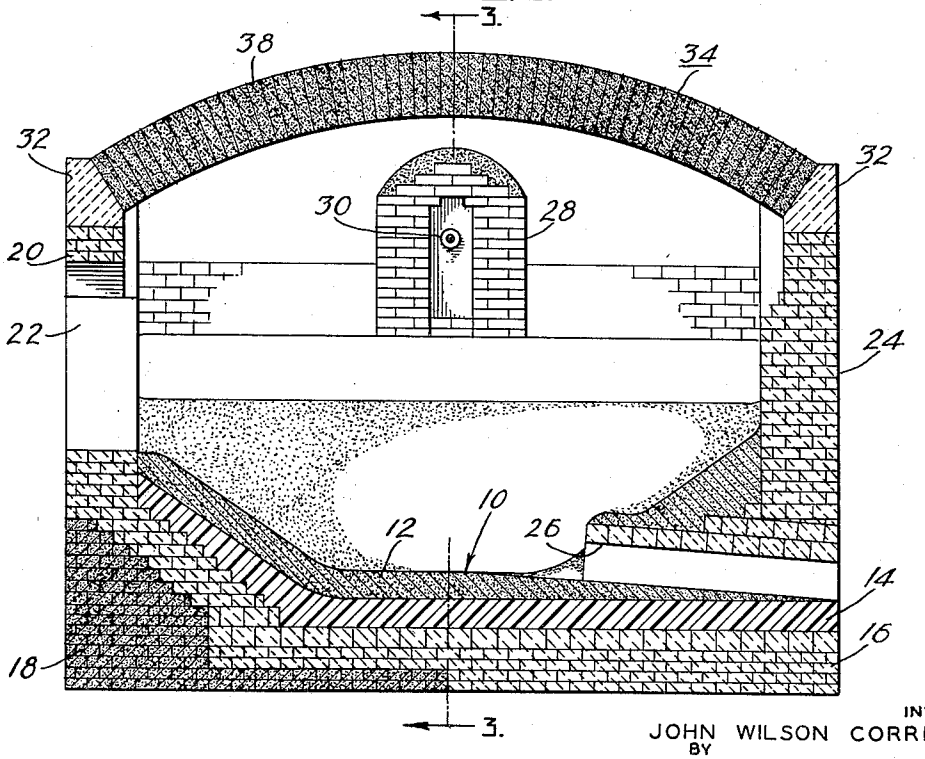


FIG. 2.



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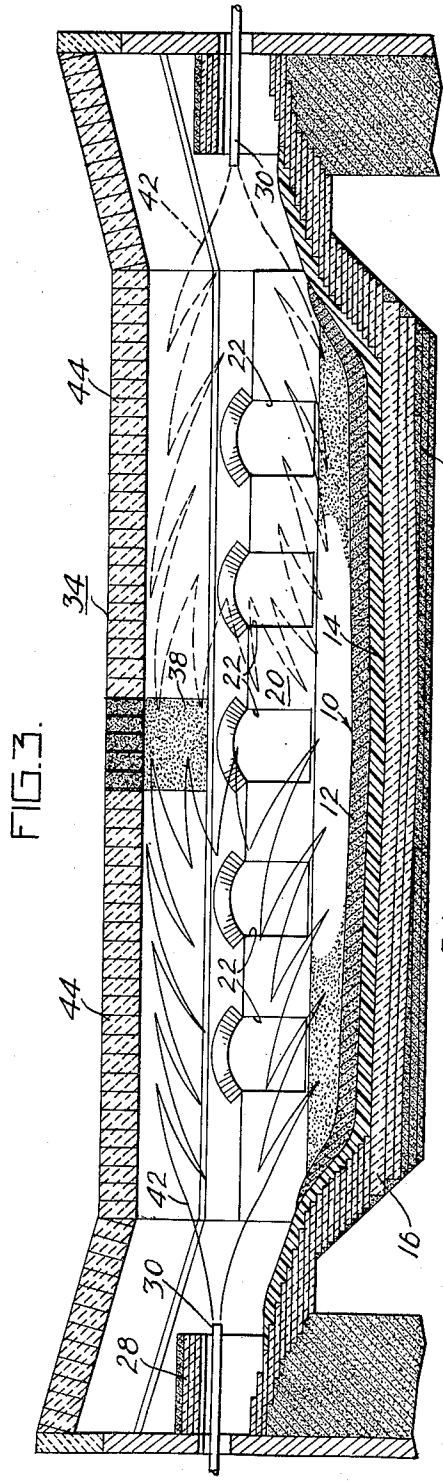


FIG. 3.

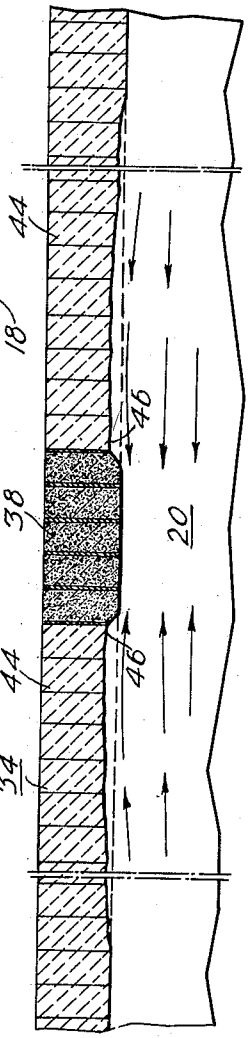


FIG. 4.

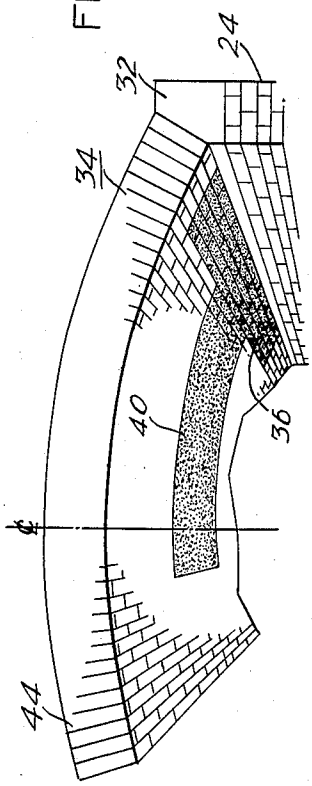


FIG. 5.

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METALLURGICAL FURNACE ROOF DESIGN

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9 Claims. (Cl. 266—33)

The present invention relates broadly to metallurgical furnaces, and particularly to a new type of roof construction which overcomes presently encountered difficulties and failures.

Heretofore, many efforts have been made to improve the roof construction of metallurgical furnaces, and particularly in furnaces of an open hearth design, since such roofs are susceptible of short life and must be repeatedly and often patched to keep furnaces in operation. Such patching or replacing of roofs incurs considerable expenses, including the loss of production time during the time the furnace is being so repaired.

As is well-known, roof constructions in metallurgical furnaces have primarily been of silica brick which are relatively strong, have a high melting temperature and are somewhat resistant to erosion by gases. Normal silica roof constructions are also economical in having a low initial cost. It has been found, however, that silica roofs have a tendency to burn out rapidly. Attempts have been made to overcome this failure in the silica roof constructions by incorporating basic brick in varying arrangements with the silica brick, or on the other hand to construct entire basic brick roof constructions. Basic brick, as compared with silica brick, are much heavier but are physically weaker at high temperatures, although much more resistant to erosion and have a higher melting temperature. When utilizing an all basic brick construction in roofs, however, and particularly in a large open hearth roof construction, the basic bricks are so heavy that they must be supported by suspending means, or otherwise sprung, and this involves materials that cost several times that of normal silica roof constructions.

It is an object of the present invention to develop an economic roof utilizing benefits derived from basic brick in order to increase the life of this limiting part of the furnace so as to obtain longer furnace life, greater production, and at the same time to effect an economical structure.

In general all-basic roofs have, so far, been found impractical unless supported by an intricate and costly mechanical system. While improvements in basic refractories are being made and perhaps may be developed shortly to a point where satisfactory strong basic roofs may become fairly economical, it does not always appear presently feasible or warranted to install entire basic roofs, whether supported or sprung, in open hearth constructions which otherwise have been found to fail at certain well-known locations. The roof section in most cases has been found to burn through earliest in a strip of varying width, outward from the back wall roof skew over an appreciable percentage of the length of the roof, centered over the tap hole.

Attempts have been made to correct this burning out zone of silica roofs by the use of "super-silica" brick of unusually low alumina content, but these efforts have proved largely unsuccessful. Attempts have also been made to establish skew brick of basic material, plus a solid basic brick shoulder, extending outwardly therefrom, in the hopes of providing a longer lasting basic refractory in the area of premature failure. It has been found, however, that while such basic shoulders have improved the life of the roof at the original critical point, the over-all desired results have not been attained since the burn out zone merely moves to new location outwardly from the basic section, toward the center of the furnace.

In operation, burners located in each end of a furnace fire toward the opposite end according to a fixed schedule of reversal. The burner flame, normally oil or gas, is forced through the furnace at high speeds, and the combustion gases completely fill the cross-sectional area of the furnace. The gases normally reach their maximum expansion, and washing or erosion effect on the refractories, in the vicinity of the center of the furnace. The least obstruction in the design or cross-sectional shape of the furnace tends to divert the burning gases to a new area where they may pass through with greater ease. As pointed out above, with an all-silica roof, flame erosion first occurs at an area along the back wall skew and extending outwardly toward the center of the furnace. This causes an increase of the furnace cross-section area, and the hot gases are then further drawn to the resulting thinned area, as this is the path of least resistance through the furnace, with the flame being further pulled toward the back wall and the erosion action intensified.

To obtain the advantages of the use of basic brick, a basic shoulder has been utilized at the critical location mentioned above, which tends to resist melting and erosion effects of the flame to a greater extent than the original silica brick, and tends to maintain its original thickness for a greater length of time resulting in a tendency to hang down slightly below the adjacent silica brick, restricting the area of the furnace along the back wall as the remainder of the silica roof burns thinner. When this condition develops, slight as it may be, it is sufficient to form a slight baffle effect to restrict the flow of the hot gases, which then take the path of least resistance and tend to concentrate adjacent to the basic section toward the center of the furnace and attack the weaker silica brick adjacent to the basic shoulder. When this occurs, the silica brick tends to become thinner adjacent to the basic section than it would have been at the same location before the basic brick was used and, in effect, the thin area tends to move outward as the basic section is extended further and further toward the furnace center. The silica brick only tended to fail prematurely in a new location of the roof because of the restricted effect of the basic section to the free flow of gases as set forth above.

Rather than make the entire roof basic, the present invention, in the interest of economy, only carries a relatively narrow strip of basic brick across the furnace, but which, in severe cases of operation, may be several feet wide.

The present invention results in obtaining over-all improved roof life by utilizing a combination of a basic shoulder and a solid basic brick strip of moderate width, extending across the roof from front to back wall, and centered over the tap hole. This results in a basic T design roof which delays widening of the eroded area transversely across the furnace by providing more resistance as the erosion tries to move outward. This construction, as will appear hereinafter, overcomes deficiencies and drawbacks of all silica roof constructions, all basic roof constructions, and heretofore known and used types of composite silica and basic brick roof constructions. Obviously also, the construction cost of such a T arrangement is but a small fraction of the cost of a complete basic refractory roof.

Other and additional features and advantages of the present invention will become more readily apparent from the following detailed description thereof, when taken together with the accompanying drawings, in which:

FIG. 1 is a fragmentary perspective view of an open hearth furnace utilizing the present invention;

FIG. 2 is a sectional view of the furnace of FIG. 1 taken transversely through the center of the tap hole;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2;

FIG. 4 is a fragmentary enlarged view of the central section, transversely of the roof, depicting results obtained by the invention; and

FIG. 5 is a fragmentary perspective view of a modification of the present invention.

In the figures of the drawings, in order to explain construction and operation of the present invention, an open hearth furnace construction has been shown. Manifestly, the invention is applicable to other types of metallurgical furnaces wherein the same problems exist.

The invention is shown as applied to a known type of open hearth furnace having a hearth **10** including a packed grain magnesite layer **12** overlying a layer of plastic K–N 14, under which there is a solid bank of chrome brick **16**, and an area **18** consisting of clay brick. The front wall **20**, likewise of a chrome or chrome magnesia brick or the like, has a plurality of usual doors **22** adapted for suitable closures in a known manner. Back wall **24**, of similar construction, is oppositely disposed from the front wall **20** and has a tap hole **26** extending therethrough in a known manner, and which is disposed centrally of the longitudinal length of the furnace. Dog houses **28** are disposed at opposite ends of the furnace in a known manner and burners **30** extend thereinto. Skews **32** are superimposed on front wall **20** and back wall **24**, also in a known manner. A roof generally designated **34** is supported by and extends between the skews **32**, **32**, and in the instance shown in the drawings is of a sprung type.

The foregoing described construction is substantially standard and in current use. As pointed out previously, however, where such roof structures are formed entirely of silica brick, or where zones of basic brick have been installed along a back wall skew outward from the back wall, excessive erosion or failure of the silica brick continued to take place adjacent the basic brick zone. These difficulties are overcome in the present invention by incorporating not only a shoulder **36** of basic brick along the juncture of the back wall **24** and roof **34**, consisting of a plurality of rows of basic brick which is centered over tap hole **26**, but additionally a solid basic brick strip **38** of moderate width which can extend entirely across the roof from the shoulder **36**, from front to back wall, and centered over the tap hole. Under some circumstances, it may be desirable to stop the basic strip somewhat short of the front wall, as shown at **40** in FIG. 5 of the drawings. The described construction results in a T design basic brick arrangement.

Due to this construction, the flames and burning gases which are diagrammatically shown at **42**, will be uniformally restricted over the entire cross-sectional area of the furnace, at its geometric center, resulting in the combustion gases being uniformly distributed in their effect upon the roof, in substantially the same manner as where an all-silica roof is used. The basic brick will still tend to erode and somewhat more near the back wall **24** although at a slower rate than the remainder of the roof constructed of silica brick, since the basic bricks, being more refractory, are not subjected to sudden melting by excessive temperatures such as often found in the area of the rear roof skew. In any event, the more refractory and resistant nature of the basic brick utilized in the present construction will give longer over-all roof life. Thus, the full span section **38** of basic brick enables a roof incorporating the basic shoulder zone **36** to be successful since it, in effect, extends the resistance zone as the erosion tries to move outward, whereas formerly when the basic zone was utilized by itself it was a failure.

A further favorable action obtained through utilization of the T construction, including the shoulder and strip across the center of the furnace, is that it acts as a slight curtain or baffle wall a short time after the roof has been in service since, as shown in FIG. 4, the silica brick **44** utilized for the major portion of the roof, and

on either side of the basic brick strip **38**, will recede more rapidly as shown at **46** than will the basic brick strip. The basic roof strip **38** then acts as a knuckle, but in a different location than commonly used in open hearth furnaces in the past. Instead of a knuckle being placed near each end of the furnace, the present invention results in the automatic development of a knuckle as the roof continues in service, and is only used across the center of of the furnace. The net result and benefit thus derived is that, as the burner fires alternately from each end of the furnace, the basic brick, which soon hang lower in the roof, due to erosion of the silica brick on either side thereof, act to deflect the flames slightly downwardly and restricting the furnace cross-section area as indicated at **48**. Thus the flame action becomes less severe on that section of the silica roof opposed to the direction of firing, being on the opposite side of the basic brick strip, and not as severely affected due to this downward deflecting of the flames.

It will accordingly be seen that by means of the T basic brick construction as defined above, the over-all roof life of a metallurgical furnace is greatly increased, and this is accomplished with a minimum of cost for expensive refractories or supporting structures. While the foregoing description has been confined to a sprung roof, the invention is applicable for any or all parts of a roof which may be either sprung or mechanically supported from the exterior. While it is not necessary that the basic strip extend completely across the furnace, it preferably should extend at least to the longitudinal center line of the furnace. Furthermore, the length of the shoulder section, which forms the head of the T, does not of necessity have to be of appreciably greater length than the width of the center section across the roof. While a single embodiment of the invention has been hereinbefore described, manifestly minor variations will be apparent to those skilled in the art to which the invention pertains without departing from the spirit and scope thereof, as defined in and limited solely by the appended claims.

I claim:

1. A refractory roof including a main body section composed of silica bricks, a shoulder section of basic bricks extending along a longitudinal edge of said roof, and a solid strip of basic bricks extending inwardly in said roof from said shoulder section for substantially the width of the roof.

2. A refractory roof comprising a T-shaped section of basic bricks having the head thereof extending along the back wall edge of the roof and the remainder of said roof being silica bricks.

3. In a furnace arch roof, a main portion exposed to the furnace interior and consisting of silica bricks and a T-shaped section exposed to the furnace interior consisting of basic bricks, the head portion of said T-shaped section constituting an edge portion of said roof and the leg portion thereof extending inwardly from said head portion across a substantial portion of the arch.

4. In a furnace arch roof as claimed in claim 3, said leg portion extending entirely across the arch of said roof from said head portion.

5. In a furnace arch roof as claimed in claim 3, said T-shaped section including a plurality of contiguous rows of basic bricks forming uninterrupted strips of substantial width.

6. In an open hearth steel furnace having skewbacks, and a tap hole centrally positioned with respect to the back wall of the furnace, a roof including a shoulder of basic brick contiguous to and extending partially along a said skewback and centered over said tap hole, a strip of basic brick extending inwardly in said roof from said shoulder along said back wall and centered with respect to said tap hole, the remainder of said roof being silica brick.

7. In an open hearth steel furnace as claimed in claim

6, said strip extending completely across said roof to the skewback along the front wall of said furnace.

8. In a refractory roof for a metallurgical furnace, silica bricks forming a major body portion of said roof and a T-shaped solid section of basic bricks integrated in said major portion of silica bricks.

9. A refractory roof including a main body section composed of silica bricks, a shoulder section of basic bricks extending along a central portion of a longitudinal edge of said roof, and a solid strip of basic bricks connecting with said shoulder section and extending inwardly in said roof beyond the longitudinal axis of the roof, said shoulder section and said solid strip of basic bricks

forming a T-shaped solid section of basic bricks integrated in the main body section composed of silica bricks.

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