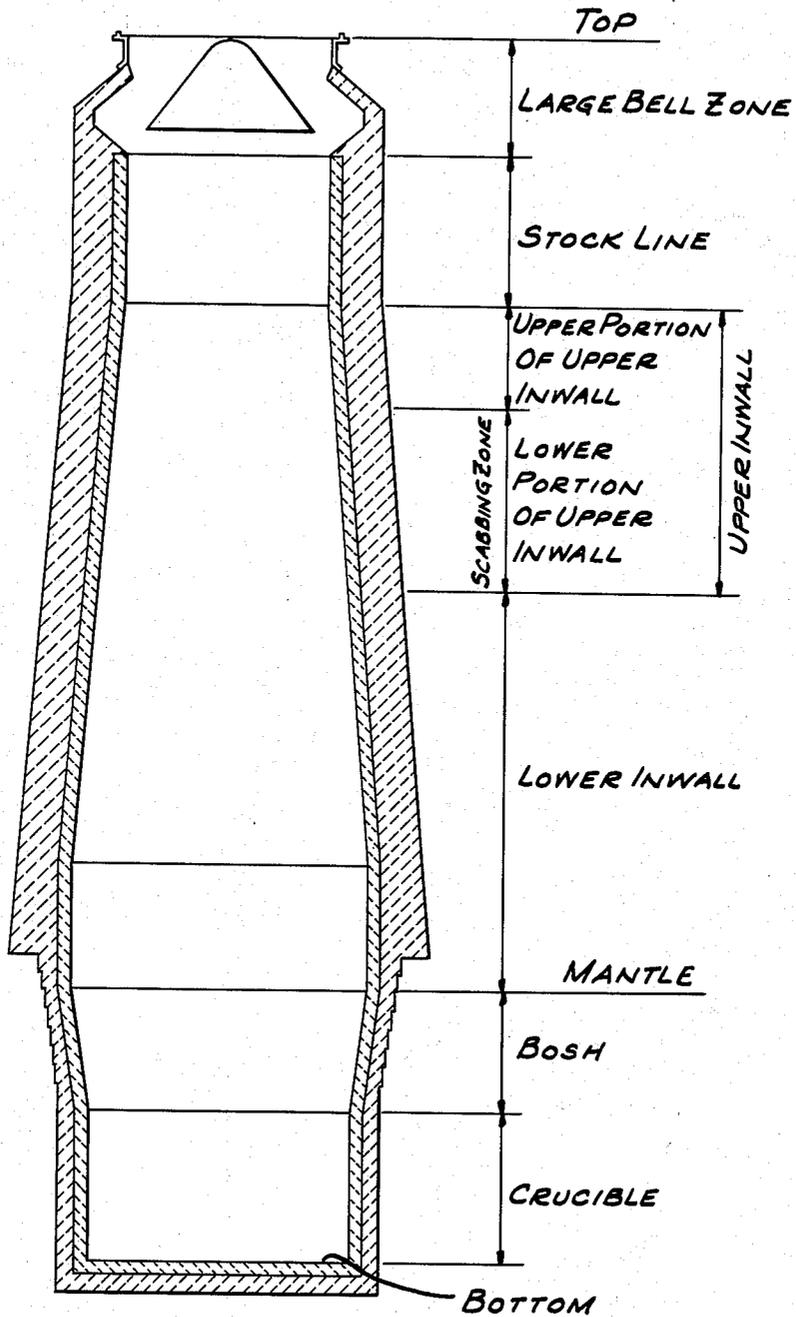


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BLAST FURNACE LININGS

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## BLAST FURNACE LININGS

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This invention relates generally to linings for furnaces and more particularly to linings for blast furnaces employed to produce pig iron.

A blast furnace for the production of pig iron is constructed on a foundation or floor and is built up in different sections that vary in shape from the bottom to the top of the furnace and which are known as the crucible, the bosh, the mantle, the lower and upper inwall, the stock line and the bell. The bottom of the furnace comprises a crucible which contains the molten iron and it must have refractory walls and floor suitable to contain the molten iron. Immediately above the crucible is what is known as the bosh. The bosh increases in diameter from the top of the crucible to what is known as the mantle and is the zone in which the tuyeres are placed for the purpose of introducing gases into the blast furnace. The largest diameter of the blast furnace is at the upper end of the bosh and the lower end of the mantle. The inwall extends from the top of the bosh or mantle upwardly to what is known as the stock line, which is that portion in the top of the furnace employed to receive the raw materials prior to their being melted and descending downward to the reducing zone. The inwall section may be divided off in two parts; the lower inwall section and the upper inwall section, both of which are substantially the same height. The whole of the inwall section is large in diameter at the mantle and may be cylindrical for a short distance, possibly ten feet, and then it becomes gradually smaller in diameter and the furnace rises for about approximately forty-five feet until the bottom of the stock line is reached. Above the stock line is what is known as the bell which is a conical cover over the center of the furnace on which the raw materials are dumped when loading the furnace.

The principal object of this invention is the provision of different characters of refractory linings for blast furnaces for the purpose of increasing the life of the blast furnace and also to increase the production of the same. Linings are ordinarily constructed from forty to sixty inches thick. These linings are made principally from fire-clay brick which will disintegrate at predetermined temperatures owing to the presence of carbon monoxide. When carbon monoxide comes into contact with ferric oxide in the brick and the oxygen transfers from the monoxide to the iron leaving free carbon, the free carbon grows within the refractory structures and causes them to break and destroy the lining of the furnace. This weakening of the furnace lining is due to disintegration. Also, other faults are created such as erosions or the production of scabs such as the growth of a conglomerate on the refractory wall. Faults of this character increase the coke's consumption and decrease the life of the lining, requiring the furnace to be shut down sooner than it should be and be relined before its production can be again increased to normal and reduce the coke consumption.

The present invention contemplates the use of a refractory that is low in ferric oxide or will not take on ferric

oxide which, when subjected to carbon monoxide, produces a free carbon that will accumulate and disintegrate the lining structure. An ordinary fire-clay brick will contain a certain amount of ferric oxide, which ferric oxide will be attacked by the carbon monoxide and leave a deposit of carbon, unless in the firing of the brick, the lining structure has been hard burned to above that temperature at which the ferric oxide will combine with the aluminum and silica and produce a ferric alumina silicate that is impervious to the carbon monoxide.

Another object is the provision of a blast furnace lining constructed of an alumina refractory that has a very low porosity in combination with a high fusion hard burned mullite lining and a high fusion silicon carbide lining. Each of these refractory materials may be formed into bricks or other suitable lining shapes after which they may be built into the lining to produce a finished blast furnace, which then can be charged and operated without additional treatment.

In accordance with the teachings of this invention an ordinary fire-clay lining requires a special burning prior to operating the same unless the brick is hard burned. A hard burned brick provides a low porosity lining and prevents the ingress of carbon monoxide.

A hard burned fire-clay brick which has been turned to a sufficient temperature to convert any ferric oxide into a ferro-alumina silicate or any one of the alumina mullite or silicon carbide lining materials are of low porosity and have low ferric oxide and will be more resistant to the ingress of the carbon monoxide. Thus, they will not be attacked by the growth of free carbon within their structures. A blast furnace lining of this character will not disintegrate due to the growth of free carbon. Again, these bricks are of a materially higher order of refractoriness than of an ordinary fire-clay and they produce a lining that will withstand much higher temperatures and are impervious to the attack of the reducing atmosphere of a blast furnace. Thus the thickness of a blast furnace lining may be reduced from sixty inches to approximately twenty-seven inches. This mechanically increases the capacity of the blast furnace, yet the lining itself will last a materially longer time than the sixty inch lining of fire-clay and, thus, provide an increased production of pig iron which is far greater than the increased cost of the lining over an ordinary fire-clay brick lining.

It has been found preferable to construct the blast furnace lining by placing on the bottom of the crucible a floor of alumina brick, whereas the lining in the vertical wall forming the crucible may be constructed from a mullite brick. This mullite brick may be extended up to the bosh or to the mantle and a high fusion alumina brick may be made to line the lower inwall above the bosh and the mantle. A high fusion silicon carbide brick is employed to line the upper inwall and the stock line. Reasons for employing a silicon carbide brick in the upper inwall are to provide a brick that is impervious to sudden changes in temperature as well as abrasion and at the same time will not be attacked by the carbon monoxide and to prevent scab formations.

A blast furnace lining may be constructed using a high alumina brick of low porosity in the bottom of the crucible with a high fusion hard burned mullite brick lining the walls of the crucible and the bosh above the same. Starting at the mantle and upwardly a high fusion alumina brick of low porosity may be employed for the lower inwall and a high fusion silicon carbide brick lining may be employed for the upper inwall section. A similar mullite brick can be used for lining the upper portion of the inwall section. Thus, the lower inwall section and the lower portion of the upper inwall section would form three different zones of different character of brick designed to withstand the temperature and the erosion con-

ditions at those levels and to withstand the carbon monoxide. The bell zone at the top of the furnace may be lined with a fire clay brick.

All of these linings are of a materially higher grade refractory than the ordinary fire-clay brick. However, a material improvement may be made in the fire-clay brick, if it is burned to a much higher degree than ordinarily employed for such a brick. The disintegration in any lining due to the carbon monoxide reacting with ferric oxide to deposit carbon is known to exist from around 420° C. to 500° C. and if a brick is burned at a temperature materially higher, that is, in the order of a 23 cone, the fusion point of such a brick will rise to a 33 cone. However in most instances the fusion point of a mullite brick is about a 39 cone and that of an alumina brick with a 14% porosity would be around a 42 cone, whereas a vitrified alumina with a 2% to 3% porosity may have a fusion point at a 42 cone. The silicon carbide brick which is burned around a 26 cone disassociates around 4000° F. or over. If the mullite type of brick contains about 64% to 72% alumina, it may be burned at a 35 cone and it will not melt above a 38 cone. Refractories of this nature will provide a much better lining than that of a fire-clay and will not be subjected to the disintegration as these refractories are less porous and will not admit the carbon monoxide gas in sufficient quantities to disintegrate it. There is nothing in these refractories which would function in the manner of a catalyst to convert the gas to a free carbon causing it to grow and disintegrate the refractory, whereas the more porous fire-clay structure, which frequently has ferric oxide, will admit carbon monoxide, giving rise to the conversion of the gas to carbon between 400° C. and 700° C. and allowing the entrapped gas to change chemically and release the carbon to provide the oxygen for the iron oxide to which it has greater affinity at these temperatures.

The accompanying drawing is a view in vertical section of a blast furnace.

Referring to the drawing it will be noted that the blast furnace shown has six distinct zones from the bottom to the top which are set out and labeled on the drawing as the crucible, the bosh, the lower inwall, the upper inwall, the stock line, and the large bell zone. It will be also noted that the upper inwall is divided into two sections, a lower portion of the upper inwall indicated as the zone in which scabbing is formed, and the upper portion of the upper inwall which is referred to as merely the upper portion of the upper inwall zone.

High fusion alumina brick of low porosity lines the bottom of the furnace which is also the bottom of the crucible. A high fusion charred burned mullite brick lines the walls of the crucible and the bosh above said bottom, and a high fusion alumina brick of low porosity lines the lower inwall above the bosh and the mantle.

The upper inwall and the stock line zones may have different linings in accordance with this invention. The

lower portion of the upper inwall which may be referred to as the scab zone is lined with silicon carbide brick. The upper portion of the upper inwall may be lined with either silicon carbide brick or a high fusion hard burned mullite brick.

The stock zone may likewise be lined with different character of brick. The stock line may be lined with either silicon carbide brick or a fire-clay brick which has been fired under conditions that the ferric oxide will combine with the aluminum and silica to produce a ferric alumina silicate that is impervious to carbon monoxide gas.

The large bell zone which is above the stock line is ordinarily lined with a fire-clay brick of similar character of that used in the stock line.

I claim:

1. A blast furnace lining comprising a high fusion alumina brick of low porosity covering the bottom of the furnace, a high fusion hard burned mullite brick lining the crucible and the bosh above said bottom, a high fusion alumina brick of low porosity lining the lower inwall above the bosh and mantle, and a high fusion silicon carbide brick lining the upper inwall and the stock line of the furnace.

2. The structure of claim 1 which also includes a fire-clay brick lining the bell zone at the top of the furnace.

3. A blast furnace lining comprising a high fusion alumina brick of low porosity lining the bottom of the furnace, a high fusion hard burned mullite brick lining the walls of the crucible and bosh above said bottom, a high fusion alumina brick of low porosity lining the lower inwall above the bosh and mantle, a silicon carbide brick lining the lower portion of the upper inwall, and a fire-clay brick lining the bell zone at the top of the furnace.

4. A lining for a portion of the blast furnace which comprises a silicon carbide brick lining the lower portion of the upper inwall, and a silicon carbide brick lining the stock line.

5. A blast furnace lining comprising a hard burned brick of low porosity lining the bottom of the furnace, the crucible and bosh above the bottom, the lower inwall above the bosh and mantle, the upper part of the upper inwall, the stock line and the bell zone, and a silicon carbide brick lining the lower portion of the upper inwall.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

1,328,380	Laird	Jan. 20, 1920
2,567,007	Brassert et al.	Sept. 4, 1951

##### OTHER REFERENCES

American Foundryman, May 1947, page 66.  
 Iron Age, June 10, 1948, page 94.  
 Steel, Sept. 11, 1950, page 105.  
 Iron Age, Sept. 21, 1950, pages 92 to 94.  
 Steel, Nov. 27, 1950, pages 74, 77 and 78.