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METALLURGICAL FURNACE

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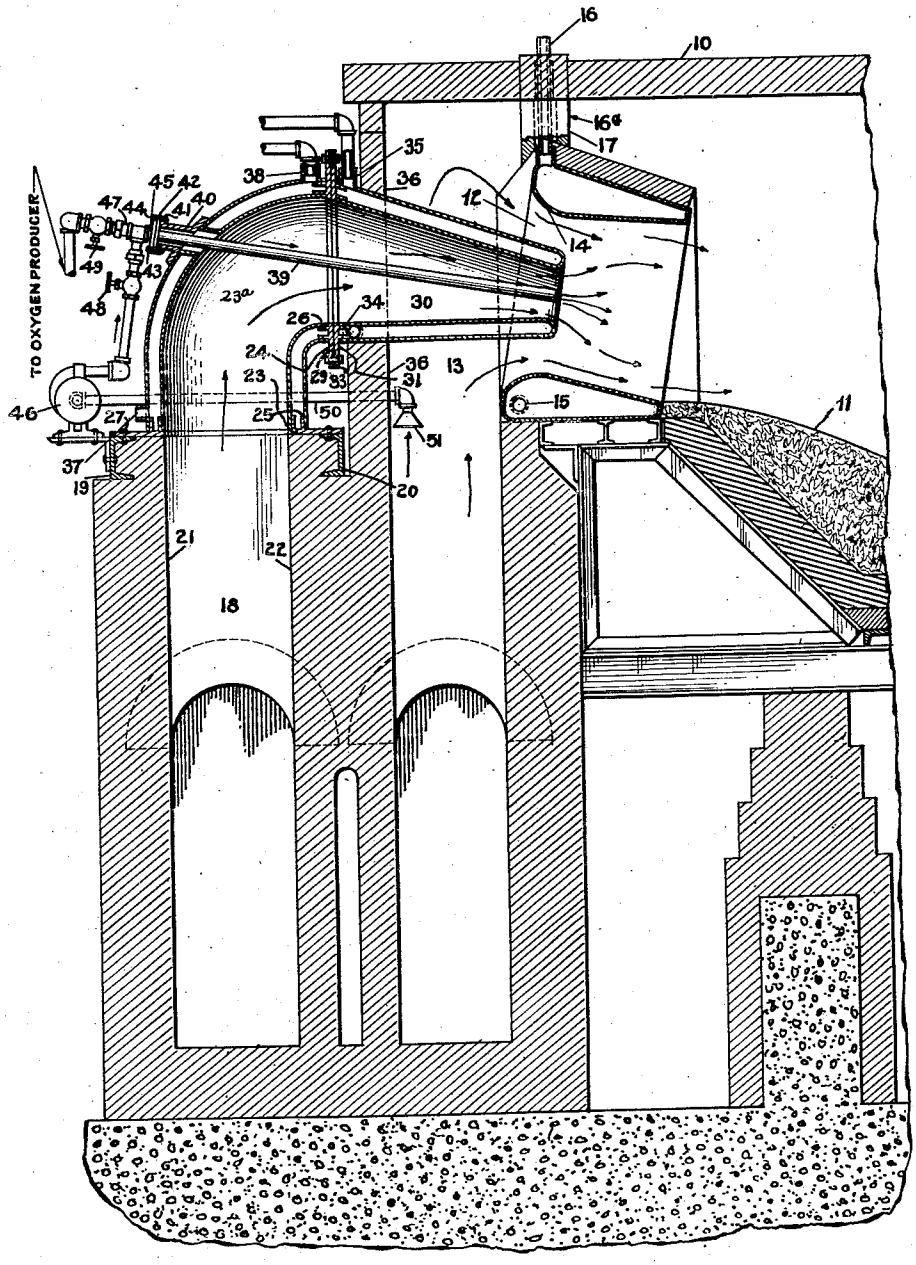


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# UNITED STATES PATENT OFFICE

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## METALLURGICAL FURNACE

Application filed April 25, 1921. Serial No. 464,227.

This invention relates more particularly to a regenerative or reverbatory furnace and in particular to a furnace employing the general characteristics of a Venturi port arrangement shown and described in my co-pending application filed March 22, 1921, Serial No. 454,496.

One of the characteristic features of the invention described in my co-pending application is the Venturi gas port arrangement in combination with the mixing chamber whereby relatively all of the air on the incoming end is automatically caused to pass through the mixing chamber without the necessity of using valves, throttles or the like, to wholly or partially close the auxiliary air channel on the incoming end as has heretofore been attempted.

With my present invention, as is true in the invention disclosed in my co-pending application, it is necessary to introduce the gas or air under pressure in order to obtain the best results. With the form of furnace now in general use the pressure is applied to the air at the reversing valves which are located below the charging floor. This is accomplished by the use of a large blower which requires considerable power to operate and is very expensive and too, by applying the pressure at the valves the regenerators are placed under extra strain, wear and tear, which materially shortens the campaign or life of the brick work. With my present invention I increase the velocity and pressure by passing a small volume of pre-heated air from the air up-take by means of a booster fan or blower through the gas nozzle and release it near the discharge end of the gas nozzle where it imparts an increased velocity to the stream of fuel gas. This arrangement also provides, which is a further object of my invention, a more thorough co-mingling of the gas and air by bringing each portion of the carbonaceous material or gas in contact with its required amount of oxygen in order to form more perfect combustion.

Another object of my present invention is the introduction of free oxygen into the mixing chamber through regulated valves whereby the reducing qualities or powers of the flame are controlled to such an extent that the process of decarbonization of the heat is entirely at the command of the operator, as carbon has a great affinity for oxygen at high temperatures.

It is a further object of my present invention to provide means which will more quickly and efficiently reduce the metal to the molten stage and which will more quickly carry out the process of decarbonization.

It is a further object of my present invention to provide a port construction for a furnace of this class which can be readily and quickly, at a small expense, cut over for burning coke oven gas or oil, in other words to provide a readily convertible furnace.

The above and other features of novelty, advantages and capabilities will become apparent from a detailed description of the accompanying drawings, in which I have illustrated one embodiment of my invention, but the construction there shown is to be understood as illustrative only and not as defining the limits of my invention.

The drawing shows a vertical sectional view of one of the ends of a regenerative furnace similar to the furnace shown and described in my said co-pending application, embodying one form of my invention.

In view of my co-pending application and the construction there illustrated I have not deemed it necessary in this case to show the entire furnace construction but only so much of the furnace as is necessary in order to illustrate the application of my present invention. However, so far as the furnace construction proper is concerned the one here is substantially identical with that of my co-pending application except in this case the roof 10 extending across and above the hearth 11 is flat instead of arched as heretofore shown. As the construction for each is identical in all respects it was thought unnecessary to show the application of both ends as this would be well understood by those skilled in this art.

Referring to the drawings in detail, the furnace is provided with the usual hearth 11 and checker chambers below the charging floor not shown. The roof 10 as before

stated, is flat instead of being arched and extends across the hearth from one end to the other. The furnace is provided at each end with a combined fuel and air port or mixing chamber 12. This chamber is formed preferably of sheet steel approximately 3/8ths of an inch thick and is of a hollow cylindrical formation opening into the air port 13 at one end and the hearth 11 at the opposite end.

The inner wall of the mixing chamber has its smallest diameter or area at approximately the point 14 and from that point towards the intake end is curved outwardly and backwardly and from the point 14 flared gradually to the discharging end. The combined fuel and air port or mixing chamber is preserved by means of a circulation of water or other cooling element which circulation is introduced preferably in the lower portion through the pipe 15 and out the pipe 16, which pipe is protected by means of a brick pier $16^a$, extending through the auxiliary channel 17, which channel opens into the furnace and upper end of the air flue 13.

The gas flue 18 leading from the checker chambers is provided near its upper end with channel beams 19 and 20, which are rigidly secured to and supported on a substantial steel structure (not shown) surrounding the gas uptake. Supported on these channel beams is a stream line fluid cooled elbow $23^a$ which forms a part of the gas flue. This elbow comprises two heads, 23 and 24, which are integrally provided with a pair of circular flanges 25 and 26 spaced apart. Tightly and rigidly secured to these flanges by any well known means, such as welding, are sheets, preferably of steel, three eighths of an inch thick. The head 23 is provided with openings for receiving bolts or screws 27 or the like for detachably securing the elbow in place at one end. The opposite head, of the elbow $23^a$, is provided with an extension 29 to which is tightly but detachably secured the gas nozzle 30. This nozzle is provided with a head 31 having a central opening with a pair of circular flanges adjacent thereto, to which flanges are rigidly and tightly fixed by welding or any other suitable means, a steel sheet forming the hollow body of the nozzle which is gradually restricted from its intake to its discharging end. The head 31 also has a flange 33 corresponding with the flange 29 which flanges are provided with registering openings for receiving bolts or the like for securing the parts tightly together. In order to more securely insure an air tight joint a gasket of any suitable material may be placed between the heads. The nozzle 30 as will be seen in the drawing, has its greatest diameter or area at the point where it joins the elbow $23^a$ and that it tapers gradually inwardly or rather is gradually restricted towards its discharging end, which end terminates in the mixing chamber at about the point where the diameter or area of the mixing chamber is the smallest. Both the nozzle and elbow are preserved by the circulation of water or other cooling element in any satisfactory manner. In the modification shown the gas nozzle 30 is provided with an inlet tap 34 near its lower portion and a similar outlet tap 35 at its upper portion, both outside the wall 36 to which taps may be secured in any well known manner, suitable inlet and outlet pipes. The elbow $23^a$ is similarly provided with an inlet tap 37 and an outlet tap 38 to which inlet and outlet tap pipes may be secured by being screw-threaded therein or by any other suitable means. It will be noted that by having the inlet and outlet pipes for both the nozzle and elbow entirely outside the walls of the furnace that these parts can be readily and quickly removed by simply unscrewing the bolts which hold them in place and swung out of the way by means of a crane and new ones substituted without in any wise disrupting or interfering with the walls or brick work.

Passing through the outer shell of the elbow and extending inwardly to the end of the gas nozzle is a relatively small water cooled or fluid cooled pipe 39. The pipe 39 is detachably mounted in and through the elbow $23^a$, by means of a casing 40 which casing is provided with a circular flange 41 against which the flange 42 on the pipe 39 is tightly pressed by means of a disc 43 and bolts 44. The disc 43 is a part of the pipe 45 which has a connection with the booster fan 46 and another connection 47 leading to an oxygen producer or other source of supply. The connection leading to the booster fan is provided with a valve 48 of any well known construction and the pipe leading to the oxygen producer is likewise provided with a valve 49. Running from the fan 46 to the air port is a pipe 50 provided with an intake 51.

In operation, in the particular modification shown, the pre-heated gas is forced through the gas port into and through the water cooled elbow and nozzle thence discharged into the combined fuel and air port or mixing chamber. The preheated gas upon entering the throat or restricted portion of the combined fuel and air port or mixing chamber produces a vacuum and causes relatively all of the air from the incoming air flue to be drawn into the mixing chamber where the air and gas are mixed. With this arrangement relatively all of the air is automatically caused to pass through the combined fuel and mixing chamber notwithstanding the fact that the auxiliary air channel 17 is constantly open. In other words, with my arrangement in this and my co-pending application relatively all of the air on the incoming end is automatically caused to pass into the mixing chamber without the necessity of using

valves, throttles or the like, to wholly or partially close the auxiliary air channel on the incoming end as has heretofore been attempted. One of the disadvantages or objections to the valve construction is that it calls for close attention and the manipulation of valves or throttles to wholly or partially close the auxiliary air channel on the incoming end and open it on the outgoing end every time the furnace is "turned over" or reversed, whereas with the invention shown in this and my co-pending application the furnace is provided with a combined fuel and air port or mixing chamber and a substantial auxiliary air channel in both ends of substantially equal area all of which are constantly open, but because of my venturi system of gas port and mixing chamber the auxiliary air channel which is constantly open is on the incoming end rendered practically idle, that is, there is relatively little air passing through the auxiliary channel on the incoming end. The amount depends somewhat on the force behind the fuel gas or air and the vacuum produced in the mixing chamber. However the air that does pass through the auxiliary channel is desirable as it forms a blanket or protection for the roof and upper portions of the side walls. While this operation is going on and in order to bring about a quicker and more positive co-mingling of the products of combustion I have provided a booster supply of pre-heated air at the center of the stream of fuel gas in the mixing chamber and as the products of combustion enter the mixing chamber there is an outer stratum of pre-heated air, a middle stratum of pre-heated fuel gas and on inner core of pre-heated air. This accelerates the co-mingling of the air and fuel gas as it brings about a better exposure of the particles of carbon to the required amount of oxygen to form complete combustion. This arrangement is brought about through the booster fan drawing a supply of pre-heated air from the air port or flue, and shooting it through the connections including the fluid cooled pipe 39 where it is discharged in the mixing chamber at or near the end of the gas nozzle.

When desired with my present invention, by manipulating the valve 49 the free oxygen may be introduced wholly under the control of the operator, for the purpose of controlling the reducing qualities or powers of the flame to such an extent that the process of decarbonization of the heat of steel is entirely at the command of the operator, for carbon has a great affinity for oxygen at high temperatures. Thus introducing free oxygen also causes a more complete combustion, promotes the rapid co-mingling of the components of the combustible mixture and produces a flame whose temperature is extremely high, therefore the metal can be reduced to a molten stage very quickly and after the metal reaches such a stage the process of decarbonization can be accomplished in a very short time.

Another important feature of my present invention is its flexibility or rather wide range of application. By this I mean a furnace can be readily and quickly cut over for using coke oven gas. When so using the furnace the pipe 39 and connections can be removed and a feed line for introducing coke oven gas in the mixing chamber can be used. In burning coke oven gas in the open hearth furnace it is not passed through the gas regenerators as the pre-heating has a tendency to break up certain parts of the gas which causes a material loss in efficiency, therefore it is burned without being pre-heated. Under the old method it requires considerable time to rebuild a furnace in order to adapt it for burning coke oven gas while with my present invention the furnace can be cut over to coke oven gas in less than thirty minutes. The same applies to the burning of liquid fuel such as oil. This is accomplished somewhat in the same fashion by simply withdrawing the pipe arrangement 39, and introducing the usual oil burner instead. The flexibility of this arrangement is extremely important because of these and other inherent advantages. With the construction now in use a furnace can not be cut over for these different purposes without practically rebuilding at a loss of considerable time and expense.

The increased velocity and pressure on the fuel gas and burner of this type can be effected by introducing a stream of gas or air in the region of the nose of the fuel gas nozzle, that is, the booster fan may be connected for discharging either pre-heated air or gas near the nose of the gas nozzle by simply having the intake 51 open either into the air or gas flue. While I have illustrated it opening into the air flue it may connect only with the gas flue and produce satisfactory results, so far as increasing the velocity and pressure in the region of the nose of the nozzle.

Having thus described my invention, I claim:

1. In a furnace of the class described the combination of a combustion chamber and means for introducing into said combustion chamber a core of pre-heated air, under superior pressure to that of the air regenerator, an envelope of pre-heated gas and an outer envelope of pre-heated air.

2. In the method of operating a regenerative furnace which consists in comtemporaneously delivering to a mixing chamber a core of pre-heated air, under superior pressure to that of the air regenerator, an envelope of pre-heated gas and an outer envelope of pre-heated air.

3. In a furnace of the class described, a

combustion chamber, air and gas ports communicating with said chamber, a separate relatively small channel opening into said chamber at one end and the air flue at the opposite end and means connecting with said air and gas ports for drawing air or gas thereto and discharging it into the combustion chamber for the purpose set forth.

4. In a furnace of the class described, the combination of an air and gas port or mixing chamber, an air flue, communicating with said chamber, a gas flue having a restricted discharge entering said mixing chamber and separate means for delivering a relatively small volume of air or gas through the gas flue into the mixing chamber.

5. In a furnace of the class described a mixing chamber, an air flue communicating therewith, a gas flue having a restricted discharge into the mixing chamber and readily controllable means for introducing preheated air into the mixing chamber for the purpose set forth.

6. In a heating furnace, the combination of entering gas and air ports, auxiliary gas discharge ports, means for supplying a jet of gaseous medium at a velocity to direct the combustible gases into the furnace through the entering ports and prevent said gases from entering the furnace through the discharge ports.

7. In a regenerative open hearth furnace, the combination of a melting chamber, regenerators for said furnace, a relatively restricted mixing chamber at each end of said furnace leading to and from said melting chamber, and means for passing into said mixing chamber under major pressure before the melting chamber is reached, a mixture comprising a core of preheated air, a ring of gas and an envelope of preheated air.

In witness whereof, I hereunto subscribe my name to this specification.

FRED H. LOFTUS.