May 26, 1925.

G. W. SAATHOFF

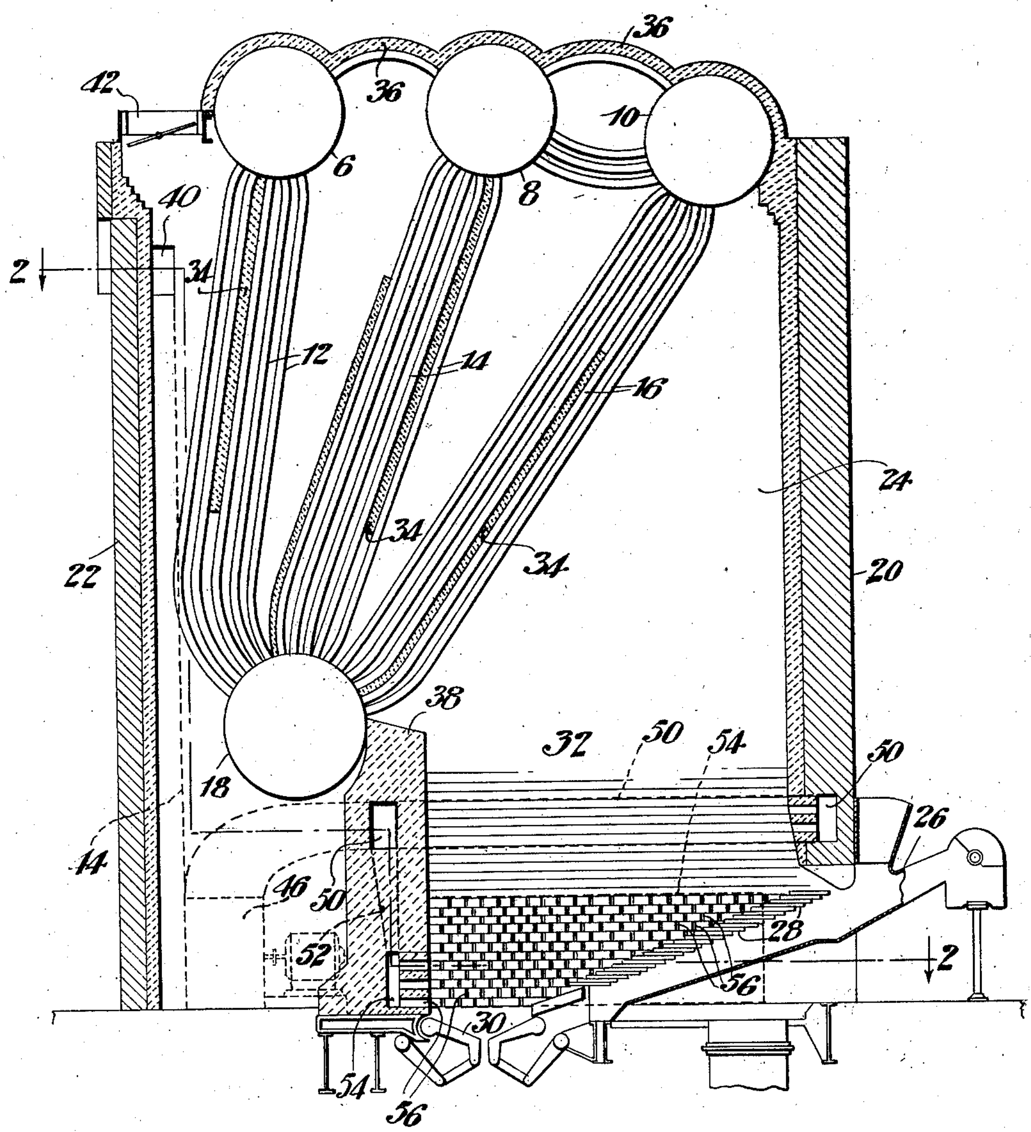
1,539,275

METHOD OF PROTECTING THE LININGS OF FURNACES

Filed Feb. 18, 1922

2 Sheets-Sheet 1

Fig. 1.



George W. Saathoff Inventor

By His Attorney

Edmund G. Borden

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Fig. 2.

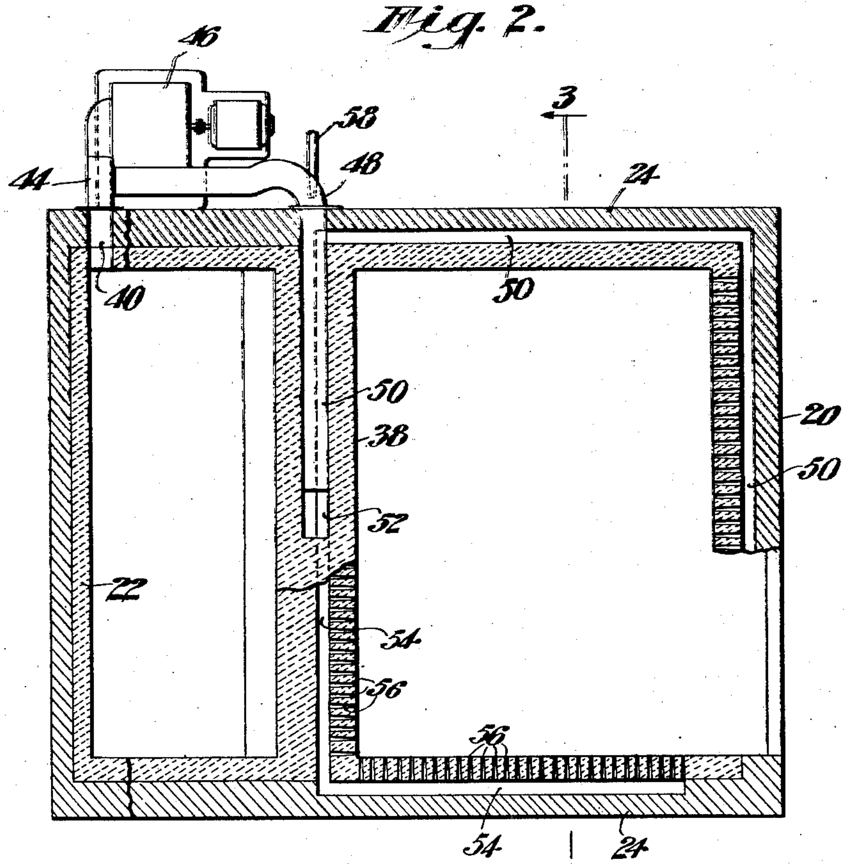
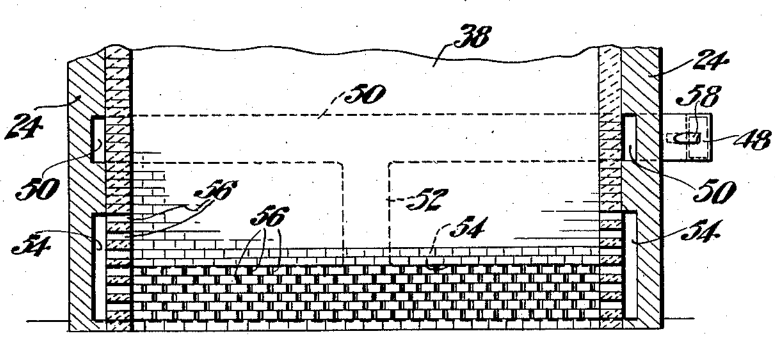


Fig. 3.



George W Saathoff Inventor

By His Attorney

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UNITED STATES PATENT OFFICE.

GEORGE W. SAATHOFF, OF SOUTH ORANGE, NEW JERSEY, ASSIGNOR TO DOHERTY RESEARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

METHOD OF PROTECTING THE LININGS OF FURNACES.

Application filed February 18, 1922. Serial No. 537,651.

To all whom it may concern:

Be it known that I, George W. Saathoff, a citizen of the United States of America, residing at South Orange, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Methods of Protecting the Linings of Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a method of protecting the linings of furnaces or combustion chambers during the operation thereof so as to prevent fusion or corrosion of the walls.

A considerable amount of difficulty and expense has heretofore been met with in the maintenance of linings of furnaces and the like, due to the fusing and clinkering of the linings, and due also to the wearing or corroding action of flames from the fuel bed coming into contact with the surface of the linings.

In the operation of a furnace under a boiler, for instance, it is necessary to maintain a certain rate of firing in order to attain the required boiler horse-power demanded of the apparatus, and also to attain efficiency in the operation of the unit. The maximum capacity of the ordinary furnace is limited to the rate at which a fuel can be made to burn by the passage of air therethrough. It is apparent that in order to attain an economical operation of the ordinary furnace, it is necessary to burn fuel at a fairly constant rate which under normal conditions of operation is in the neighborhood of from 35 to 40 pounds of coal per square foot of projected grate area per hour. Under such conditions of operation the temperature of the furnace is generally in the neighborhood of 2500° F., and may run as high as 3000° F. or as low as 2000° F., depending upon the fuel employed, the type of stoker used, and various other factors, such as forced draft, etc.

When a temperature of 2500° F. or over is reached, there is frequently a partial fusion of the furnace lining, which takes place particularly adjacent the top of the fuel bed, and there is generally an absorption into the lining of more or less foreign matter, such as silicates and other salts, which are probably derived from the ash formed on the surface of the coal adjacent to the lining. The absorption of this foreign matter lowers the melting point of the brick lining of the furnace and causes portions thereof to melt off. There is also generally a more or less adherence of clinkers to the partially fused surface of the lining which must be broken off from time to time, thereby causing a rapid corrosion of the lining, due to parts thereof being broken away when the clinkers are removed. As soon as there has been a partial fusion of the furnace lining, there is a rapid deterioration or corrosion of the walls of the combustion space.

Another cause of the wearing away or corrosion of the furnace linings is due to the fact that flames from the fuel bed impinge on the lining and gradually wear away its surface. It is frequently found that there is a hollow zone in the linings just above the top of the fuel bed, due to the wearing action of the flames. Whether this action is due to particles of unconsumed carbon in the flame or to the wearing action of the flame itself, is not known, but the fact that such corrosion takes place due to some such cause is very apparent from a study of furnace operation.

The primary object of the present invention is to provide a method whereby the fusion of the linings of furnaces or combustion chambers is prevented.

In accordance with this object one feature of the invention contemplates the use of a blanket of gas adjacent the furnace linings which reacts endothermically with the fuel in the furnace, whereby the temperature of the linings is maintained below its fusing temperature.

Another object of the invention is to provide a method of preventing the corrosion of furnace walls due to the wearing action of flames in a fuel zone of a furnace.

In accordance with this object another feature of the invention contemplates the passage of a gas outwardly from the furnace walls so as to deflect the flames in proximity thereto, and thereby prevent such wearing action.

A further object of the invention is to abstract heat from the hottest zone of the furnace and to subsequently give up this heat in a cooler zone of the furnace, so as to prevent fusion of the walls in the hottest zone, and thereby prevent the adherence of the clinkers to the lining surfaces.

The means by which this object of the invention is accomplished is by the use of a gas which dissociates at a high temperature with an absorption of heat, and recombines at lower temperatures with a liberation of heat. It is desirable to employ a gas which will act over a fairly wide temperature range and produce cooling in proportion to the temperature of the fuel bed. It is desirable also that a gas be employed which has a low flame propagation, as otherwise a too sudden recombination of gases will take place, with a consequent liberation of a large quantity of heat, which would be disastrous to the furnace walls at a point of recombination.

A further object of the invention is to provide a method of combustion whereby the life of the furnace linings will be increased and thereby increase the economy of furnace operation.

With the objects enumerated above in view, the invention consists in a method which will be described in connection with the apparatus illustrated in the accompanying drawings, in which;

Fig. 1 is a vertical sectional view of a furnace for a water tube boiler embodying the preferred form of the invention;

Fig. 2 is a horizontal sectional view of the furnace taken on the line 2—2 of Fig. 1, showing means of injecting gas through the furnace walls; and

Fig. 3 is a transverse sectional view of the furnace wall taken on the line 3—3 of Fig. 2.

The present invention is based upon the discovery that by passing a gas such as carbon dioxide gas along the face of the linings of the combustion space so as to form a blanket between the fuel and the linings, the fusion of the linings and the adherence of clinkers to the linings may be substantially prevented. When passing the gas in the particular way hereinafter disclosed it has been found also that the wearing action of the flames in the fuel zone is largely obviated. It is possible that the specific mode of introducing the gas which will be disclosed has a considerable influence on the success of the method for the protection of the linings from the fuel bed itself.

The specific embodiment of the invention is illustrated in the drawings as applied to a Sterling type boiler. The boiler consists of a series of water or steam drums 6, 8 and 10, which are connected by means of banks of tubes 12, 14 and 16, respectively, with a lower mud drum 18. The drums and tubes are mounted on a proper setting between a front wall 20, and rear wall 22, and side walls 24. The furnace is shown as being fed with fuel by means of an automatic stoker 26, the fuel passing over tuyer grates 28 to a dumping grate 30. The combustion gases formed by the combustion of the fuel in a chamber 32 above the grates flow through a circuitous passage formed around the banks of tubes by means of refractory baffles 34, positioned in the banks of the tubes, and the refractory arches 36 positioned above the steam drums 6, 8 and 10, to close the space above them.

The present invention is applied to the combustion chamber 32 which chamber is included between the front wall 20, a bridge wall 38, and the sections of the side walls 24 between the bridge wall and the front wall. The main combustion of the fuel takes place in the combustion chamber 32 and in order to obtain the high ratings of the boiler it is necessary to develop very high temperatures in the combustion chamber. For this reason the facings of the furnace walls and the bridge wall as well as the baffles on the tube banks are all made of refractory material, such as clay, silica, or carborundum fire brick. At the present time no refractory brick or linings are known which will not fuse or waste away under the high temperature conditions used on some boiler furnaces. By the use of the present invention, however, the life of the furnace refractories may be materially lengthened.

To form the protecting blanket of carbon dioxide or an endothermically reacting gas upon the face of the furnace walls or linings in the immediate zone of the higher temperature combustion, an exhaust flue gas which may be taken from the last pass of the boiler, is circulated through ducts in the furnace walls and passed through the walls at the higher temperature zone. To accomplish this, the exhaust flue gas is removed from the furnace through an opening 40, Fig. 1, located in the last pass of the furnace immediately below the stack breeching 42. The exhaust flue gases entering the opening 40 pass through a duct 44, Fig. 2, to a blower 46, from which they are forced through a pipe 48 to a distributing duct 50. The distributing duct 50 extends through the bridge wall 38, the side walls 24 and the front wall 20 entirely around the combustion chamber. In the bridge wall the duct 50 is connected by a duct 52, see Figs. 1 and 3, to a duct 54, which extends along the base of the bridge wall and along the side walls 24 immediately adjacent the combustion chamber. Leading from the duct 50 in the front wall 20 and the duct 54 in the bridge wall 38 and side walls 24 are a large number of openings 56, which are tapered from the ducts in passing into the combustion chamber. These openings 56 are comparatively narrow spaces and allow the carbon dioxide gases to pass through them very slowly in entering the combustion chamber. As illustrated in Figs. 1, 2 and 3, the openings 56 are distributed over substantially the entire area of the combustion chamber in which the highest temperatures are developed, and the fine streams of carbon dioxide gas which pass through the ducts under a low pressure, form a blanket which passes upwardly along the furnace walls to form a protection from the high temperature fuel bed and from the high temperature combustion gases. By passing the flue gas through the linings of the combustion chamber at the portion where the fuel comes in contact therewith in the manner outlined above, the temperature of both the linings and the portion of the fuel bed in contact therewith is maintained below the fusing temperature of the linings. Further, the flue gas serves to maintain such a blanket protection to the face of the linings which prevents the flames from the fuel from coming into direct contact with the linings, and thereby prevents the corrosion by the flame.

In forming the cooling blanket for the linings of the combustion chamber, use is made of an endothermically reacting gas. The waste flue gases which consist of a large portion of carbon dioxide and nitrogen may be used to a great advantage for this purpose, but it is preferred to mix steam with the carbon dioxide as it passes to the combustion chamber. To accomplish this steam is introduced into the pipe 48 through a nozzle 58, and, in fact, the nozzle may be used as an injector for drawing the flue gases from the last pass of the boiler. Furthermore, steam alone may be used for the endothermically reacting gas to form the protecting blanket for the furnace linings.

By the use of a mixture of steam and flue gas for cooling the furnace lining walls, any and all of the three heat reactions may take place:

(1) $C+CO_2=2CO-39000$ cal.
(2) $2H_2O+Heat=2H_2+O_2-138000$ cal.
(3) $H_2O+C=CO+H_2-40000$ cal.

It will be noted that all of these reactions abstract a large amount of heat from the zone in which the reactions take place, and this cooling action is sufficient to protect the furnace linings. Furthermore, the gases which pass through the furnace walls are much cooler than the fuel and combustion gases in the combustion chamber, and therefore these gases absorb a large amount of heat in being raised to a temperature at which they will be decomposed in undergoing the endothermic reactions. Also, steam and carbon dioxide are types of gases which are not decomposed until they are heated to a very high temperature, and therefore they are admirably suited for forming the cooling blanket. Although in the decomposition of the cooling gases other gaseous constituents are formed such as hydrogen, oxygen and carbon monoxide which enter into combustion, the combustion of these constituents will take place in the combustion chamber above the high temperature zone, and therefore the work of cooling gas will have been accomplished before these gaseous constituents are burned.

The present invention has been illustrated as applied to a water tube boiler, but it is obvious that it may be used in any type of furnace or combustion chamber in which high temperatures are developed. Furthermore, the invention is well adapted for protecting any combustion chamber linings—whether solid or gaseous fuel is being burned in the chamber.

The preferred form of the invention having been thus described, what is claimed as new is:

1. A method of protecting furnace refractories from corrosion which comprises passing adjacent to the side refractories a sufficient amount of an oxidizing gas which will not evolve heat when reacting with furnace gases to maintain the said refractories below the slagging temperature and to deflect the flame from said refractories.

2. A method of protecting furnace refractories from corrosion from high temperature furnace gases which comprises passing a sufficient amount of a gas which will decompose only at high temperatures with an endothermic reaction, into close proximity with the said refractories to maintain said refractories below the slagging temperature and to deflect the flame from said refractories.

3. A method of protecting furnace refractories from corrosion which comprises passing at a low pressure a sufficient amount of a gas having an endothermic reaction with carbon into close proximity with the said refractories to maintain the said refractories below the slagging temperature and to deflect the flame from said refractories.

4. A method of protecting furnace refractories from corrosion by high temperature furnace gases which comprises passing at a low pressure a sufficient amount of a gas, having an endothermic reaction with carbon, through small openings in the refractory surface adjacent to the fuel bed of the furnace to maintain the said refractories below the slagging temperature and to deflect the flame from said refractories.

5. A method of protecting furnace refractories from corrosion which comprises passing a sufficient amount of a gas comprising a mixture of steam and carbon dioxide in small streams into proximity with the refractory walls to be protected so as to form a gas blanket adjacent thereto.

6. A method of protecting furnace refractories from corrosion which comprises passing a sufficient amount of a relatively cool gas, capable of dissociation with absorption of heat, into proximity with the refractory wall to be protected, and thereby maintaining the side wall below the temperature at which corrosion takes place.

7. A method of protecting furnace refractories from corrosion which comprises passing a sufficient amount of a gas consisting largely of carbon dioxide into proximity with the refractory wall to be protected, and causing thereby an endothermic reaction with carbon present in the fuel employed to maintain the temperature of the said wall below the corrosion temperature.

8. A method of protecting the refractory walls of a furnace from corrosion which comprises continuously passing at a low pressure a sufficient amount of a gas containing steam into contact with the refractory wall adjacent to the fuel bed of the said furnace, to thereby prevent corrosion of the side wall.

9. A method of protecting the refractory walls of a furnace from corrosion during the operation of the said furnace which comprises passing a sufficient amount of a gas comprising steam and carbon dioxide at a temperature lower than that of the furnace walls into a heat transferring relation to the said walls to abstract enough heat from the furnace gases and the refractory walls by absorption of the heat through its dissociation at the temperature to which it is subjected to prevent corrosion of the side wall.

10. A method of protecting the walls of a furnace from corrosion during operation of said furnace which comprises passing at low pressure enough of a gas dissociating at a high temperature with absorption of heat, and reacting endothermically with carbon, into proximity with the said walls and fuel bed of the furnace to form a protecting and cooling blanket for the said walls.

In testimony whereof I affix my signature.

GEORGE W. SAATHOFF.