

March 22, 1955

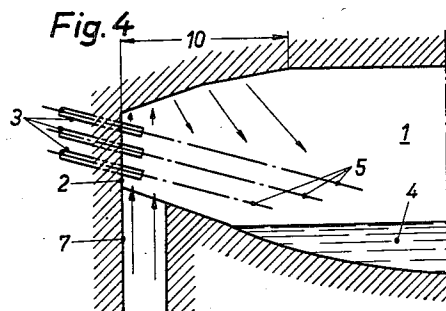
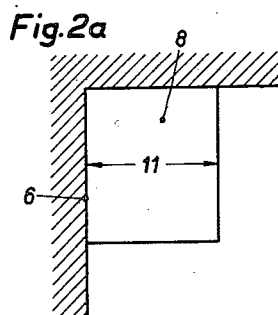
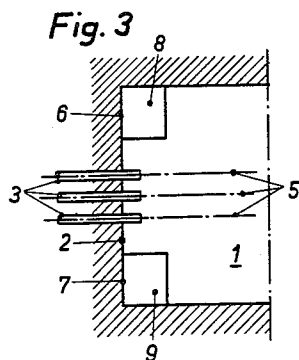
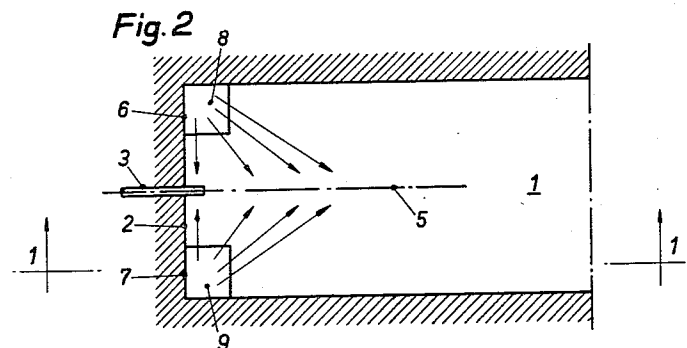
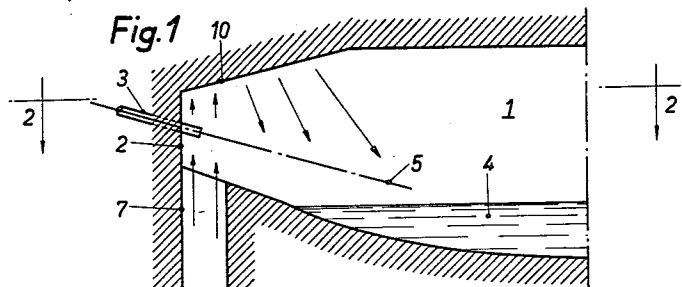
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LIQUID FUEL FIRED OPEN HEARTH FURNACES

Filed Feb. 7, 1951

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 5.

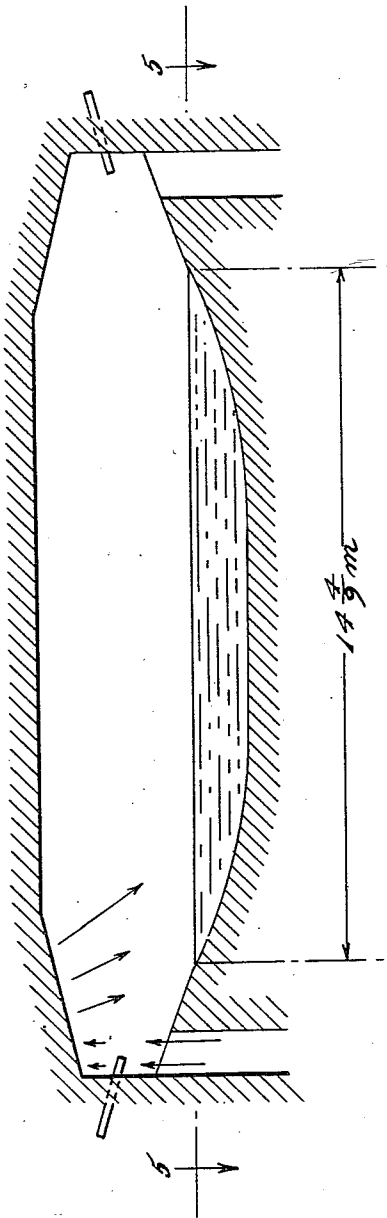
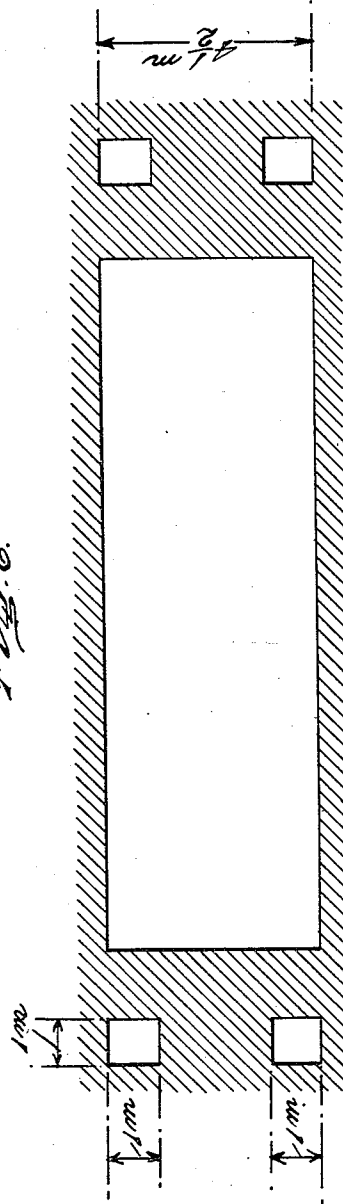


Fig. 6.



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LIQUID FUEL FIRED OPEN HEARTH FURNACES

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7 Claims. (Cl. 263—15)

The present invention relates to a fluid fuel fired open hearth furnace.

A purpose of the invention is to introduce the air into the fluid fuel, for example fuel oil, tar, pitch, natural gas, coke oven gas or any unpreheated fuel gas, more gradually, obtaining a longer flame and a more luminous flame which will increase the radiation heating effect.

A further purpose is to bring the air up in streams at either side of the fuel burner and deflect the air in the two streams inwardly, forwardly and downwardly, spreading out the streams and causing them to flow along with the fuel jet and mingle with it.

A further purpose is to gradually upwardly incline the roof from the end wall toward the hearth above the air flues so that the roof will assist in inwardly, forwardly and downwardly deflecting the air and spreading the air streams.

A further purpose is to make the angle between the roof above the air flues and the vertical axis of the air flues in the range between 95° and 135° and to extend the roof at this angle for a distance toward the hearth not less than one and one-half times the dimension of the uptake flue (width) in the direction of the hearth.

A further purpose is to direct the fuel burner forwardly and downwardly toward the hearth from the end wall and to provide air uptakes on either side of the burner immediately in front of the end wall, surmounting the uptakes with a gradually upwardly extending roof portion which, with the side walls, tends to deflect the air inwardly, forwardly and downwardly at either side of the jet.

A further purpose is to provide for deflection of the air from the roof before the air mixes with the jet, thus maintaining a cooler roof.

A further purpose is to make the ratio of the total horizontal area of the uptakes to the horizontal area of the hearth at the fore plate level range between 0.010 and 0.045 and preferably between 0.020 and 0.035, so as to assure air flow in relatively narrow inlet streams.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate one only of the numerous embodiments in which my invention may appear, with minor variations, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a fragmentary diagrammatic vertical section of an open hearth furnace to which the invention has been applied, being taken on the line 1—1 of Figure 2.

Figure 2 is a fragmentary diagrammatic sectional plan of Figure 1, the section being taken on the line 2—2.

Figure 2a is an enlarged fragment of Figure 2.

Figure 3 is a fragmentary view corresponding to Figure 2 but showing a variation.

Figure 4 is a fragmentary view corresponding to Figure 1 but showing another variation.

Figures 5 and 6 are diagrammatic views of the furnace according to Figures 1 and 2, but not limited to the one end, with approximate horizontal dimensions complying also with the specific example given in the next to the last paragraph of the specification. Figure 5 is in vertical longitudinal section through the fuel jet; Figure 6 is in horizontal longitudinal section along line 5—5 of Figure 5, which is taken at the fore-plate level.

Describing in illustration but not in limitation and referring to the drawings:

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Open hearth or Siemens-Martin furnaces fired by burners operating on fluid fuel such as, for example, fuel oil, tar, pitch, natural gas, coke oven gas or any unpreheated fuel gas, have previously been known in two forms. In one form the burner for the fluid fuel is pointing toward the charge from the end wall of the air shaft, and has its forward end in the air shaft. This form is similar to the well known gas fired furnace using a remote gas supply or cold gas, the appropriate type of burner being used. A second well known design has developed from that ordinarily used in open hearth steel furnaces fired by producer gas in that the rear part of the gas flue, where it is superfluous as in an oil firing plant, is omitted, and the oil or other appropriate burner is built in the remaining part of the gas flue.

In general both of these prior art forms operate in the same manner. Because of the use of comparatively wide air shafts having large air supply cross section, the air streams flowing into the furnace have only small amounts of kinetic energy. Where liquid fuel is used, the liquid fuel is atomized in the burner by means of compressed air, steam or natural pressure as well known, and the fuel enters the furnace space as a jet of fuel having a large amount of energy, and by reason of its high kinetic energy, sucks the combustion air immediately into contact with the jet. On the other hand, a large amount of energy from the fuel jet is required to produce a long flame, all the more so because in the prior art furnaces the energy is supplied exclusively by the fuel. This means that in the prior art the mixing of the air for combustion takes place very quickly and over a short distance from the end wall. With the prior art open hearth furnaces fired by oil, the suction of air is determined entirely by the laws of a free jet of oil vapor. Thus there are great disadvantages particularly due to the low luminosity of the flame.

The luminosity of the flame from the burning fuel is essentially based upon thermal cracking of hydrocarbons in the fuel in the absence of oxygen. With the open hearth furnace design hitherto known and described above and the previously used method of operation, only a small part of the fluid fuel can be cracked, because the air flows in the same direction as the jet of fuel and around it as it leaves the burner and is immediately sucked into mixing relationship by the jet of fuel.

According to the present invention the desired cracking of the hydrocarbons is promoted since the entire volume of air from combustion is not sucked in by the jet of fuel over a short distance from the beginning of the jet, but the air for combustion is fed separately from the jet of fuel into the furnace space and is mixed with the jet with natural energy over a longer course as the jet travels, thus mixing gradually or in a retarded way.

The air for combustion is suitably fed from the bottom of the furnace as from the usual checkers into the furnace space in such a way that it is deflected with natural energy from the furnace roof and is thus spread in the direction of flow of the jet of fuel. The open hearth furnace using the procedure of the invention has at least one burner, arranged in the end wall of the furnace for feeding fluid fuel in the form of a jet of fuel, with two vertical air shafts terminating in front of the end wall on their course from the bottom to the furnace space for feeding the air for combustion in the form of two streams of air rising by natural energy, located laterally of the burner, extending upwardly to the furnace roof and combining at the furnace roof in one air stream spreading in the longitudinal direction of the jet of fuel and gradually mixing with the jet.

According to the invention the jet of fluid fuel enters the furnace body with a large amount of energy. However, at the same time the combustion air arriving from the bottom of the two air shafts has a comparatively large amount of energy because of the relatively small air shaft cross sections as compared with the prior art.

A small air shaft cross section is assured by employing a ratio of the total horizontal area of the air shafts to the horizontal area of the hearth of between 0.010 and 0.045 and preferably between 0.020 and 0.035. In the prior art, the practice has been to employ much higher ratios.

Thus the air for combustion enters the furnace body with a large amount of natural motion and natural energy, and as a result of its natural energy, on the one hand, and because it does not encounter the jet until the jet has travelled for some distance, an immediate suction of air by the jet of fuel is avoided. Only after two air streams have turned forwardly and downwardly at the furnace roof will the air pass into the jet of liquid fuel at a slant from the top, and this action does not take place all at one point but gradually over a longer distance of the jet, thus producing a long flame. In this way, a complete cracking of hydrocarbons is accomplished.

To insure proper deflection at the roof, the roof above the uptake has an angle of the portion toward the hearth of 95° to 135° to the vertical axis of the uptakes. This roof portion above the uptake has a length of at least one and one-half times the horizontal dimension of the uptake toward the hearth (width).

The drawing shows by way of example an open hearth steel furnace to which the invention has been applied.

The open hearth furnace 1 has an end wall 2 which extends vertically at the combustion end of the furnace. A burner 3 for introducing fluid fuel such as fuel oil, tar, pitch, natural gas, coke oven gas, or any unpreheated fuel gas, is positioned in the end wall 2, preferably at the middle, inclined in a forward downwardly slanting direction toward the charge of molten metal 4 in the hearth, so as to produce the forwardly inclined jet of fuel 5. Immediately inside the end wall 2 there are vertical air shafts or uptakes 6 and 7, which are positioned on either side of the burner, and desirably immediately inside the side walls as shown. The air for combustion heated in the checkers is fed through the air shafts in the form of two air streams 8 and 9 rising vertically. The air shafts or uptakes have a ratio of the total horizontal area of the uptakes to the total horizontal area of the hearth of from 0.010 to 0.045 and preferably between 0.020 and 0.035. The horizontal area of the uptakes is the minimum area in case the uptakes vary in cross section. The area includes both uptakes. The horizontal area of the hearth is measured as a rectangle at the fore plate level of the furnace, as well known.

These air streams first rise on both sides of the burner 3 owing to their natural energy and encounter the roof portion 10 of the furnace which is gradually forwardly and upwardly inclined from the end wall toward the center of the furnace (the right in Figure 1). The angle of the roof portion 10 in Figure 1 to the vertical axis of the uptakes varies between 95° and 135° . The uptakes are normally vertical, so that usually this angle will be measured to the vertical as in the furnace shown, but where the uptakes extend upward at an angle to the vertical, the roof angle is measured with respect to the axis of the uptakes. The length of the roof portion 10 (Figure 1) is at least one and one-half times (but may be as much as ten times or more) the horizontal dimension 11 toward the hearth (Figure 2^a) of the uptake 6. At the roof of the streams flow forwardly and toward one another in the directions of the arrows of Figure 2. When the streams from the opposite sides meet at the middle of the roof they are deflected forwardly and downwardly as shown by the arrows toward the right of the uptakes or shafts in Figure 1, due to the inclined portion 10 of the roof. Thus the air flow streams form an air flow which spreads in the direction of the jet of fuel so that the air for combustion mingles with the jet over a comparatively long course, producing a long flame and a luminous flame.

Instead of having one burner 3 in the end wall, two or more burners 3 may be provided displaced horizontally as shown in Fig. 3, suitably in an arrangement symmetrical to the vertical longitudinal middle plate of the furnace or as shown in Figure 4 in an arrangement in the vertical longitudinal middle plane of the furnace. Figure 4 shows a modification of the inclined portion 10. In this case, said portion consists of two parts arranged at an angle to one another and to the axis of the uptakes in such a way, that the inclination of the first part adjacent to the end wall is greater than that of the second part adjacent to the horizontal roof portion.

By the suitable sloping of the portion 10 of the roof for the purpose of giving the proper reverse flow to air streams 8 and 9, it is possible to obtain any desired spreading of the air streams passing to the jet of fuel

and thus insure the desired gradual character of the mixing between the air streams and the jet.

In operation, the fuel enters through the burner 3, and is projected into the furnace as the jet 5. Air rises rapidly through the relatively constricted shafts and strikes the forwardly and upwardly sloping roof portion 10. The air flows toward the middle and forwardly, then down and forwardly, to meet the jet and mingle with it gradually, forming a long luminous flame.

To illustrate the present invention I refer to an open hearth furnace having the capacity of 180 metric tons. This furnace is designed in such a manner that the horizontal area of the hearth measured as a rectangle at the fore plate level of the furnace amounts to 65 m^2 and that the horizontal area of each uptake forming a square amounts to 1 m^2 so that the sum of both horizontal areas of the uptakes is 2 m^2 . The ratio of the total horizontal area of the uptakes to the horizontal area of the hearth is 0.0307. The length of the inclined portion of the roof amounts to 2.2 m.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the invention shown, without copying the process and apparatus, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. An open hearth steel furnace having a hearth, an end wall, and a roof, in combination with at least one fluid fuel burner in the end wall extending inwardly in a slanting downwardly direction, and projecting an inward jet, and two inlet airshafts extending vertically from below on either side of the jet in front of the end wall having a ratio of the total horizontal area of the airshafts to the horizontal area of the hearth at the fore plate level of between 0.010 and 0.045, the roof above the air shafts slanting upwardly toward the hearth of the furnace at an angle of at least 5° above the horizontal.

2. An open hearth steel furnace having a hearth, an end wall, and a roof, in combination with at least one fluid fuel burner in the end wall extending inwardly in a slantingly downwardly direction, and projecting an inward jet, and two inlet air shafts extending vertically from below on either side of the jet in front of the end wall having a ratio of the total horizontal area of the air shafts to the horizontal area of the hearth at the fore plate level of between 0.020 and 0.035, the roof above the air shafts slanting upwardly toward the hearth of the furnace at an angle of at least 5° above the horizontal.

3. An open hearth steel furnace having a hearth, an end wall, and a roof which extends from the end wall with an inclination which is upward in the direction toward the hearth and forms an angle between 95° and 135° with a line down the vertical axis of the air shafts mentioned below, in combination with at least one fluid fuel burner in the end wall downwardly inclined toward the hearth, extending inwardly, and projecting an inward jet, and two inlet air shafts extending vertically from below on either side of the jet in front of the end wall, having a ratio of the total horizontal area of the air shafts to the horizontal area of the hearth at the fore plate level of between 0.010 and 0.045, and the roof at the angle described having a length toward the hearth of at least one and one-half times the horizontal dimension in the direction toward the hearth of the air shafts, the roof guiding the air rising by natural energy from the shafts inwardly, downwardly and forwardly along with the jet to mix gradually with the jet.

4. An open hearth steel furnace having a hearth, an end wall, and a roof which extends from the end wall with an inclination which is upward in the direction toward the hearth and forms an angle between 95° and 135° with a line down the vertical axis of the air shafts mentioned below, in combination with at least one fluid fuel burner in the end wall downwardly inclined toward the hearth, extending inwardly, and projecting an inward jet, and two inlet air shafts extending vertically from below on either side of the jet in front of the end wall, having a ratio of the total horizontal area of the air shafts to the horizontal area of the hearth at the fore plate level of between 0.020 and 0.035, and the roof at the angle described having a length toward the hearth

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of at least one and one-half times the horizontal dimension in the direction toward the hearth of the air shafts, the roof guiding the air rising by natural energy from the shafts inwardly, downwardly and forwardly along with the jet to mix gradually with the jet.

5. An open hearth steel furnace having a hearth, an end wall, and an angled roof, having a first part adjacent the end wall and a second part adjacent the first part, both of which parts are inclined upwardly, considered in the direction of the hearth, at angles between 95° and 135° to a line passing downward along the axis of the air shafts mentioned below, the inclination of the first part adjacent to the end wall being greater than that of the second part of said roof, in combination with at least one fluid fuel burner in the end wall downwardly inclined toward the hearth, extending inwardly, and projecting an inward jet, and two inlet air shafts extending vertically from below on either side of the jet in front of the end wall, having a ratio of the total horizontal area of the air shafts to the horizontal area of the hearth at the fore plate level of between 0.010 and 0.045, and the roof at the angle described having a length toward the hearth of at least one and one-half times the horizontal dimension in the direction toward the hearth of the air shafts, the roof guiding the air rising by natural energy from the shafts inwardly, downwardly and forwardly along with the jet to mix gradually with the jet.

6. An open hearth furnace having a hearth, two vertical end walls and two side walls, two air uptakes on each furnace end extending vertically from below at each corner between the end walls and side walls, a roof, the portions of the roof extending above the air uptakes in each case slanting upwardly from the near end wall in

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the direction of the far end of the furnace, the upwardly slanting portions of the roof being in each case at an angle, taken in the direction of the upward slant, of between 5° and 45° above the horizontal, the portions of the roof slanting upwardly having a length measured in the longitudinal direction of the furnace of at least one and one-half times of the length of an air uptake, measured in the longitudinal direction of the furnace, at least one burner for liquid fuel in each end wall between the uptakes at that particular end and slanting downwardly toward the hearth, the ratio of the total horizontal area of the two air uptakes at a furnace end to the horizontal area of the hearth at the fore plate level being between 0.010 and 0.045.

7. An open hearth furnace as claimed in claim 6, the ratio of the total horizontal area of the two air uptakes at a furnace end to the horizontal area of the hearth at the fore plate level being between 0.020 and 0.035.

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