Sept. 18, 1945. J. M. CROWE 2,385,261

OPEN HEARTH FURNACE AND METHOD OF OPERATION

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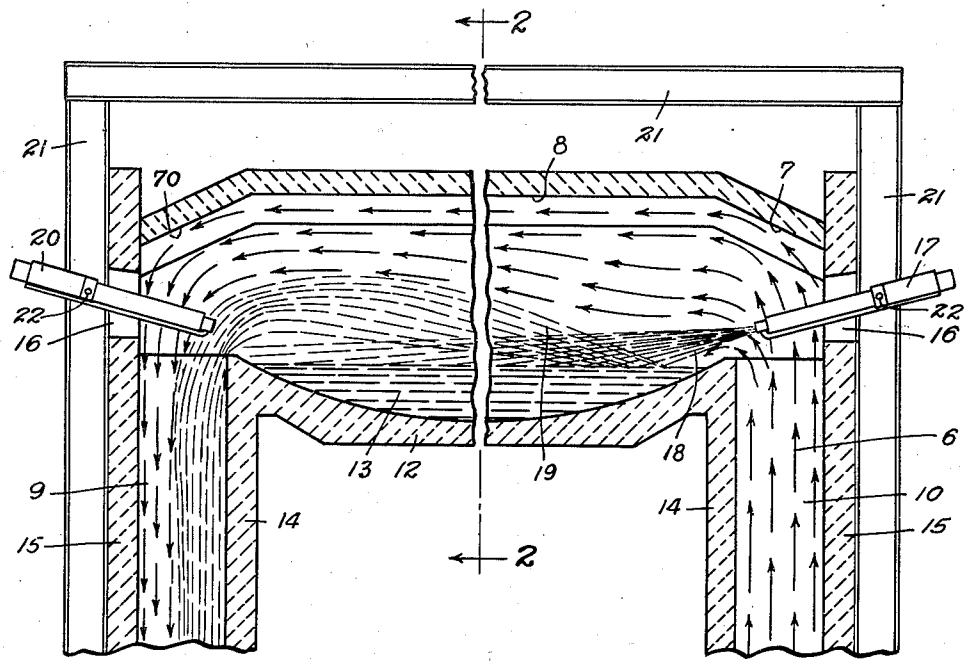


Fig. 1.

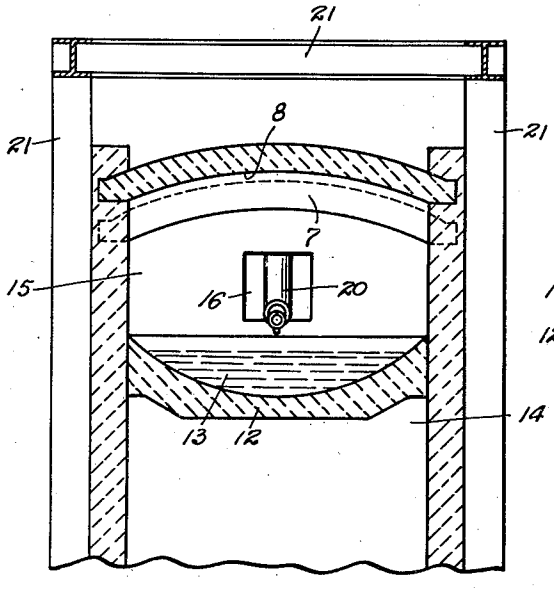


Fig. 2.

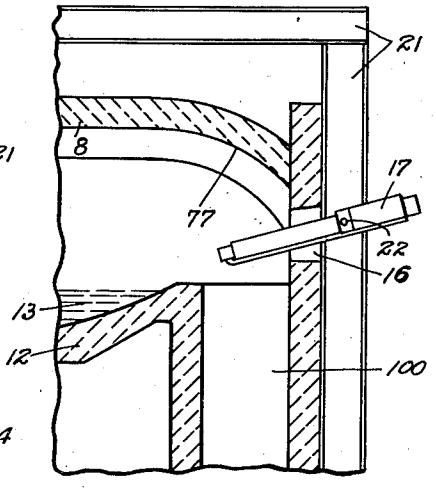


Fig. 3.

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OPEN HEARTH FURNACE AND METHOD OF OPERATION

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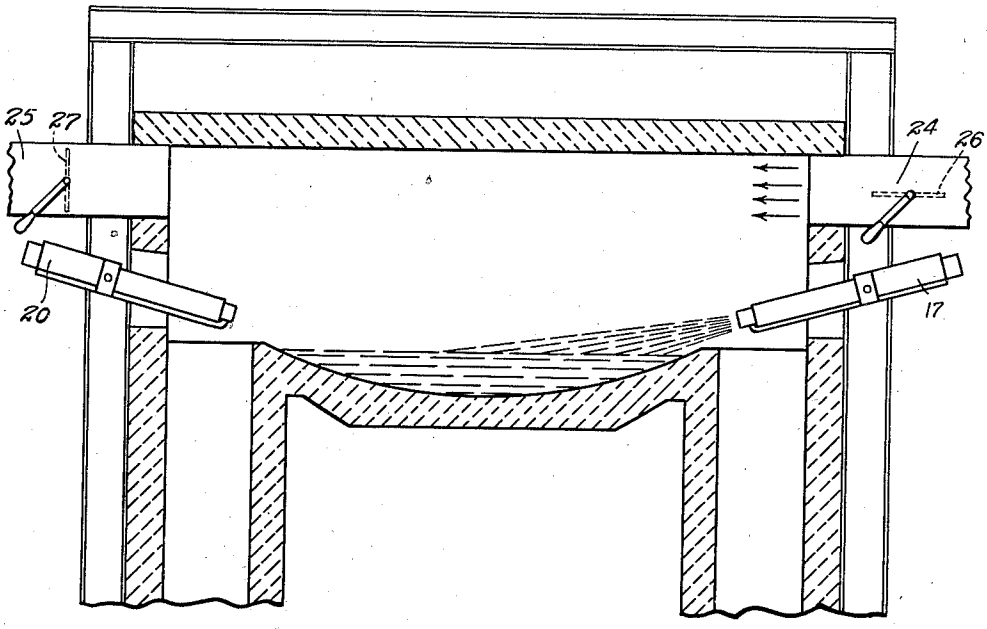


Fig. 4.

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OPEN-HEARTH FURNACE AND METHOD OF OPERATION

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Application September 2, 1942, Serial No. 457,058

4 Claims. (Cl. 263—15)

This invention relates to improvements in the construction and operation of open hearth furnaces.

An object of the invention is to provide a highly efficient method of operating open hearth furnaces, for effecting substantial savings in time, labor, and expenses.

Another object of the invention is to structurally improve open hearth furnaces for attainment of the foregoing object.

More specifically, the major objects of the invention are: to provide means in an open hearth furnace for substantially reducing erosion of the roof and the ends of the furnace, and thereby save the expense of frequent rebuilding and the loss of time and fuel incident thereto; to provide means for the purpose stated, which may readily be incorporated in existing furnaces as well as in new furnaces; and to improve generally upon the operation of such furnaces to enhance the utility and increase the productive capacity thereof.

The foregoing and other objects are attained by the means described herein and disclosed in the accompanying drawings in which:

Fig. 1 is a longitudinal cross-sectional view taken through an open hearth furnace, and wherein is incorporated the means of the invention.

Fig. 2 is a fragmental cross-sectional view taken on line 2—2 of Fig. 1.

Fig. 3 is a fragmental cross-sectional view similar to the right half of Fig. 1, and in which is illustrated a modification.

Fig. 4 is a view showing a second modification.

Prior to the present invention, it was customary to fire an open hearth furnace with the use of producer gas and preheated air forced upwardly through the uptakes at one end of the furnace, the products of combustion leaving the furnace at the opposite end thereof by way of the uptakes provided at said opposite end. In such furnaces, it was customary to arrange the brickwork above the uptakes so as to provide a pocket with a sloping roof portion inclined downwardly toward the hearth, so as to force the flame downwardly at an angle onto the melt and to thereby secure the greatest possible efficiency and speed in melting the material resting upon the hearth. By so directing the flame at an angle onto the top of the melt, deflected flame and reflected heat from the surface of the melt necessarily took an upward course and impinged strongly against the roof of the furnace, resulting in the rapid deterioration and burning away of the roof. The destructive effect of this character of combustion, moreover, was carried to the end walls of the furnace above the uptakes and resulted in destructive erosion in the area of the end walls. As a result of these conditions, it was necessary to frequently rebuild the roof and the lining of the end walls of the furnace, with an attendant substantial loss of production and service. As is well-known, the shutting down of a furnace for repairs involves a very substantial waste of time and fuel, in addition to the cost of the labor and materials required for restoring the furnace to an operating condition.

By means of the present invention, an open hearth furnace will remain in productive condition for a much greater period of time than heretofore, and as a direct consequence the capacity of the furnace is materially increased, while the cost of operating the furnace is very substantially reduced.

Broadly stated. the present invention consists chiefly in so constructing the furnace that the hot air from the checkers and uptakes will, to a great extent, be carried to the roof of the furnace and form a protective insulating stratum along substantially the full length of the furnace roof. In the accompanying drawings, the series of arrows indicated at 6 represent a current of heated air from the checkers, which current ascends through the uptakes at the right of Fig. 1, impinges upon the slope 7 above the uptakes, and travels across the under surface of the roof 8 until it finally strikes the opposite slope 70 which deflects the current or stratum of heated air downwardly through the uptakes 9 at the opposite end of the furnace. It should be understood that the uptakes 9 and 10, in actual operation of the furnace, will be used alternately when running a heat, to supply the heated air, or exhaust it, in accordance with common practice.

With further reference to the drawings, the character 12 indicates the hearth, and 13 indicates the molten metal supported thereon. The hearth ordinarily is supported by suitable refractory walls 14—14, and may in most instances be reinforced with steel girders. The uptakes 9 and 10 are formed between the inner walls 14 of the furnace and the outer walls 15 thereof, it being customary to provide a plurality of uptakes at each end of the furnace.

At the locations 16—16, the outer walls are apertured in order to accommodate any suitable form of burner 17—20 of a type which may be aimed for directing an intense flame at a

downward inclination onto the top of the melt, as indicated by the series of lines 18 of Fig. 1. Extensions of said lines are indicated at 19, and are intended to show how the flame will impinge upon the melt and be deflected from the surface thereof in the general direction of the exhaust portion or uptake 9. It will be noted that the deflected flame 19 from the burner 17 is prevented from reaching the roof 8 of the furnace, by reason of the protective current or stratum of air directed along the roof by the sloping surface 7 above the uptake 10. If this current of air were not maintained along the underface of the roof, reflected flame and heat directed upwardly by the surface of the melt would impinge strongly against the roof and induce rapid deterioration and destruction thereof. Such action of the reflected heat and flame is common to furnaces that are constructed with pockets or reverse slopes above the uptakes. However, under the teaching of the present invention, the reflected flame and heat from the melt is precluded from injuriously affecting the roof surface by reason of the presence of the current or stratum of air indicated by the arrows, which is maintained as an insulating blanket against the underface of the roof. The passages 9 and 10 sometimes are referred to as uptakes or downcomers, depending upon the direction of movement of the gases therethrough.

Whereas in the prior furnaces the slopes 7 and 70 generally were inclined from the outer wall of the furnace at a downward angle toward the melt, the slopes in the improved construction herein are inclined from the outer walls upwardly and away from the melt. The angle of the slope at each end of the furnace may vary, depending upon the size of the uptakes and the rate at which which air is forced through them. As a general rule, however, the angularity of the slope with respect to the outer wall 15 will be less than ninety degrees (90°) but greater than thirty degrees (30°). In a construction such as illustrated by Fig. 3, the slope is formed by an arch, as indicated at 77, constructed on a proper radius for directing the ascending air horizontally across the roof after said air leaves the uptake 100. In all views, the steel frame members 21 of the furnace are conventional, and may be installed in accordance with common practice.

By referring to the left hand of Fig. 1, it will be noted that the current of air directed downwardly by the slope 70 forms a protective blanket for the adjacent end wall of the furnace, so that the intense heat of the flame and such particles of impurities or slag as may be dislodged from the melt, may not come into direct contact with the end wall, and work destruction upon said wall. The insulating blanket also affords protection for that portion of the burner 20 which is adjacent to the aperture 16.

The burners 17 and 20 may be of any approved design, and so far as the invention is concerned the type of fuel with which the burners are operated is a matter immaterial to the invention. It may be stated, however, that burners used in accordance with the disclosure herein generally operate with gas, oil, pitch and steam, or any combination of such fuels as will produce a combustible mixture. The burner will preferably be pivoted as at 22 upon a suitable burner base, or upon some stationary portion of the furnace, to permit of adjusting the angle at which the flame is directed onto the melt. As will readily be understood, the use of burners of this type, wherein the flame is directive, does not require a draft of air to force the flame down onto the melt. It is by reason of this fact, that the protective blanket of hot air from the uptakes may be maintained as an insulating stratum along the underface of the roof, to prevent rapid deterioration and destruction of the roof and the furnace end walls.

As was previously stated herein, the furnace may be of the reverse type wherein the burner at the right end of the furnace operates as preheated air ascends by way of the adjacent uptakes for a predetermined period of time, and at the expiration of such time period the preheated air will be reversed so as to flow upwardly past the burner at the opposite end of the furnace while the first burner is shut off and the other burner 20 is placed in operation. The insulating effect of the preheated air is the same, regardless of which burner is in operation. The burner flame, of course, always projects in the same general direction as the current of air supplied by the uptakes.

From the foregoing it will readily be understood that a furnace constructed and operated in accordance with the present invention may be operated for long periods of time without the need for servicing or replacement of the roof and end walls, and may accordingly be kept in service without the need for frequent shut-downs which always result in a substantial waste of time and labor in restoring the operating condition of the furnace. The ability of the furnace to produce greater amounts of metal is thereby greatly enhanced, with a resultant saving of considerable expense in the processing of the metals.

As a modification of the invention, Fig. 4 shows an open hearth furnace with the burners or flame-throwers arranged as in Fig. 1, with an alternative form of means to establish the protective insulating blanket of preheated non-combustible gas or air along the under surface of the furnace roof. In this illustration the preheated gas, which preferably is hot air, is led into the furnace by way of the duct or feeder 24 arranged to discharge into the furnace at substantially the level of the roof, and in substantial parallelism therewith. The preheated gas or air delivered by the duct, may be obtained from any suitable source of supply; that is, it may be taken from the checkers of the same furnace, or from some other furnace or hot air generator independent of the furnace illustrated. When the burner 17 is operating, the heated air or gas is delivered by the duct 24, whereas upon reversal of the furnace operation, the supply of air or gas will be delivered by the duct 25 in conjunction with the operation of burner 20. The delivery and control of heated air or gas may be effected in any suitable manner. As one possible form of means for this purpose, the ducts are shown to include dampers or valves 26 and 27, each under the control of an operating handle or lever which is rendered accessible to the operator of the furnace.

In operating the furnace of Fig. 4, the burner 17 will heat the melt concurrently with delivery of heated air or gas from duct 24, as indicated. This will result in establishing an insulating blanket or stratum of air against the under surface of the roof substantially as indicated by Fig. 1, provided that the damper or valve 27 is closed. If the damper or valve 27 be opened under the conditions existing in the furnace of Fig. 4, the spent gases or exhaust will leave the combustion chamber of the furnace chiefly by way of

the duct 25, while slag or heavy particles dislodged from the melt by the flame of burner 17 will leave the combustion chamber by way of the downcomer 9. The exhaust gases, in either case, may be utilized for various purposes, including preheating of the air of other inert gas used in establishing the insulating blanket or stratum previously referred to.

As will readily be understood, reversal of the operation of the Fig. 4 furnace will require shutting off the burner 17, and placing the other burner 20 in operation, with the duct 25 open for the delivery of heated air or inert gas to the combustion chamber.

It is to be understood that various modifications and changes may be made in the structural details of the furnace, within the scope of the appended claims, without departing from the spirit of the invention. In this connection, it should be understood that the type of furnace illustrated and described herein is exemplary only, and may therefore be subjected to structural variations.

I claim:

1. An industrial furnace for the smelting of metal, which comprises in combination a hearth, a substantially vertical uptake and a downcomer at opposite ends of the hearth, a roof over the hearth, a flame-thrower pitched to project flame directly onto the contents of the hearth at an acute angle to the horizontal, causing a rebound of deflected flame and heat toward the furnace roof, and protective means for the roof, said means consisting of sloping surfaces above the uptake and the downcomer, one of said surfaces inclining upwardly and inwardly from approximately the top of the uptake toward the center of the roof, and the other inclining upwardly and inwardly from approximately the top of the downcomer toward the center of the roof, said sloping surfaces being disposed above the uptake and the downcomer to direct a voluminous upward current of air in excess, from the uptake across the under face of the roof and into the downcomer with a continuous sweep, for maintaining a depressed condition of the deflected flame and heat toward the hearth and away from the furnace roof.

2. An industrial furnace for the smelting of metal, which comprises in combination a hearth, a substantially vertical uptake and a downcomer at opposite ends of the hearth, a roof over the hearth, a flame-thrower pitched to project flame directly onto the contents of the hearth at an acute angle to the horizontal, causing a rebound of deflected heat and flame toward the furnace roof, and protective means for the roof and the walls of the furnace, comprising arches spanning the uptake and the downcomer, one of said arches inclining upwardly and inwardly across the top of the uptake and toward the center of the roof, and the other inclining upwardly and inwardly across the top of the downcomer toward the center of the roof, to provide a smooth uninterrupted path for a blast of excess air ascending the uptake, traversing the under surface of the roof, and exhausting through the downcomer, for maintaining a continuously depressed condition of the deflected flame and heat toward the hearth as the blast of air sweeps the under face of the furnace roof.

3. An industrial furnace for smelting of metal, which comprises in combination a hearth, a substantially vertical uptake and a downcomer at opposite ends of the hearth, a roof over the hearth, the uptake, and the downcomer, a flame-thrower pitched to project flame downwardly onto the contents of the hearth at an acute angle to the horizontal, causing a rebound of deflected flame and heat toward the furnace roof, and protective means for the roof comprising arches overlying the uptake and the downcomer, the arches being substantially tangential to the roof and to a wall of the uptake and the downcomer, to provide a smooth uninterrupted path for a blast of excess air ascending the uptake, traversing the roof, and entering the downcomer, for maintaining a continuously depressed condition of the deflected flame and heat toward the hearth and away from the furnace roof.

4. The method of operating an open hearth furnace for the manufacture of steel, which consists in projecting burning fuel downwardly at an inclination onto the contents of the hearth, and at the same time passing a continuously moving high-volume air current uninterruptedly across the full extent of the furnace roof, along a smooth substantially arcuate path to maintain the flow of air intact and effective for constantly depressing onto the hearth the hot gases deflected upwardly toward the roof due to the angular projection of the burning fuel.

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