Aug. 12, 1941. A. F. HOLDEN 2,252,319

INDUSTRIAL FURNACE

Filed Feb. 6, 1940 4 Sheets-Sheet 1

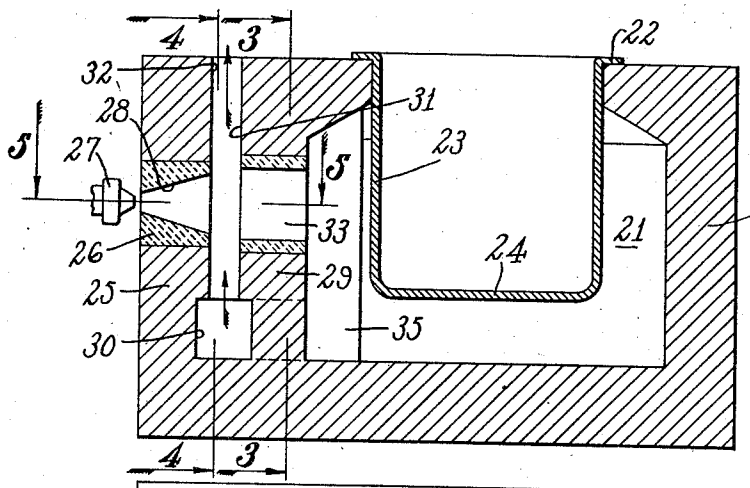


Fig.1.

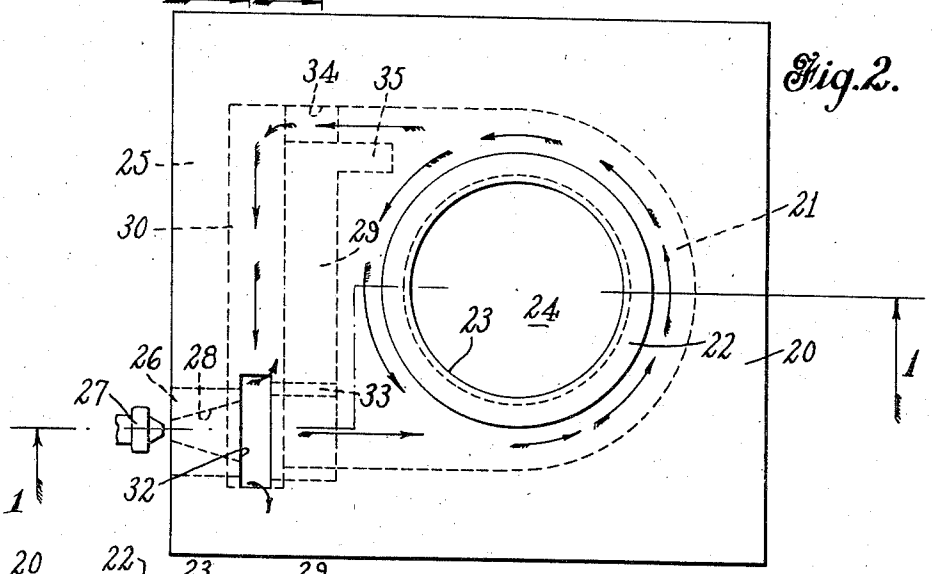


Fig.2.

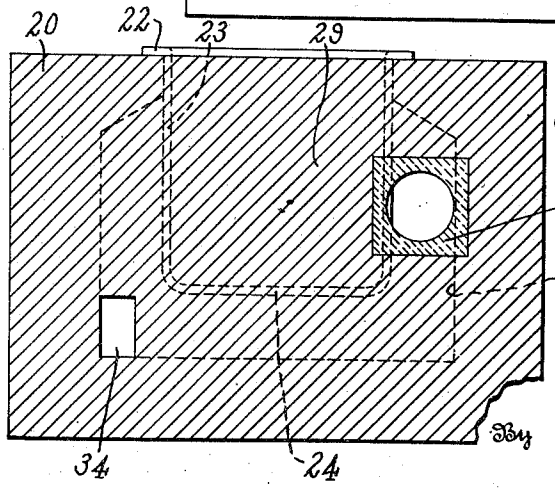


Fig.3.

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Aug. 12, 1941. A. F. HOLDEN 2,252,319

INDUSTRIAL FURNACE

Filed Feb. 6, 1940 4 Sheets-Sheet 2

Fig. 4.

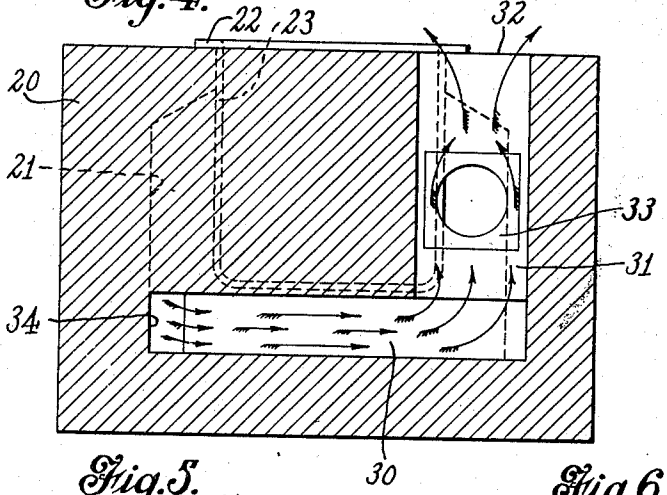


Fig. 5.

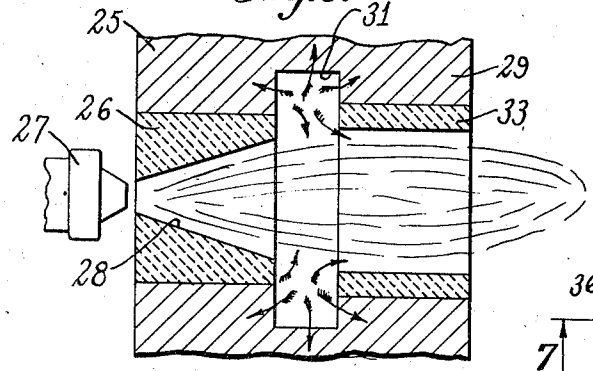


Fig. 6.

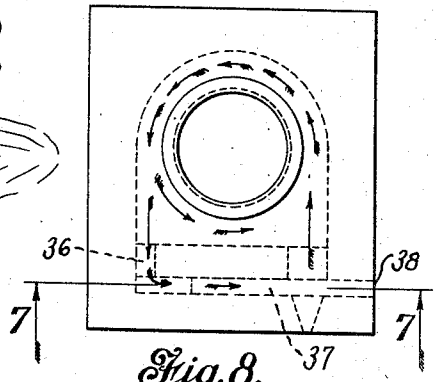


Fig. 7.

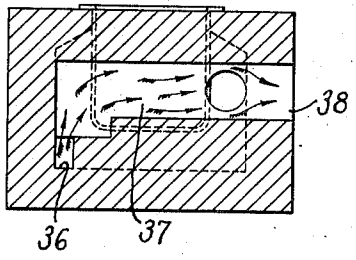


Fig. 8.

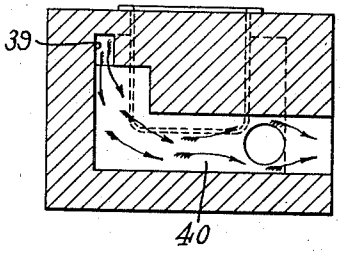
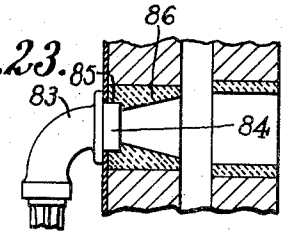


Fig. 23.



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Aug. 12, 1941. A. F. HOLDEN 2,252,319

INDUSTRIAL FURNACE

Filed Feb. 6, 1940 4 Sheets-Sheet 3

Fig. 9.

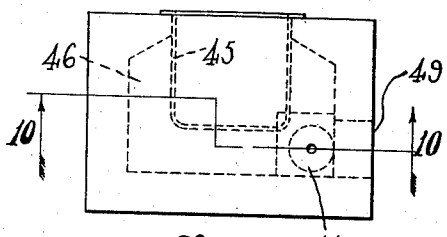


Fig. 10.

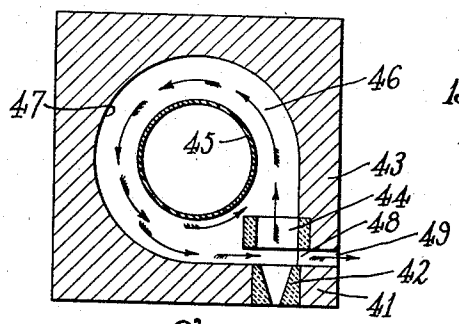


Fig. 11.

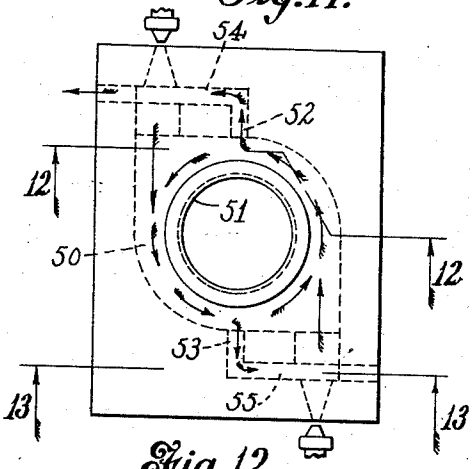


Fig. 12.

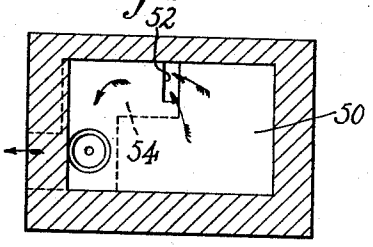


Fig. 13.

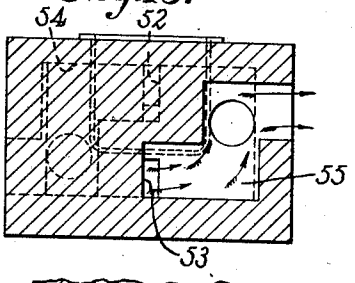


Fig. 14.

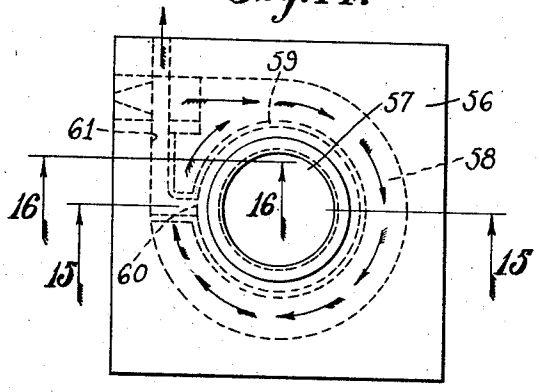


Fig. 15.

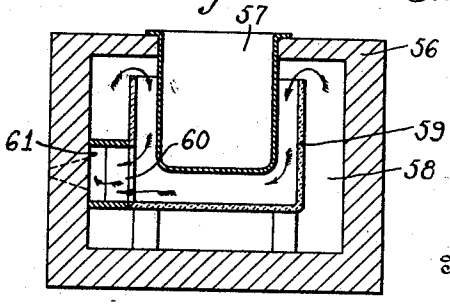
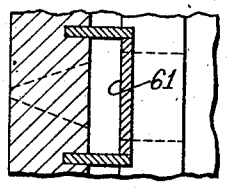


Fig. 16.



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Aug. 12, 1941. A. F. HOLDEN 2,252,319

INDUSTRIAL FURNACE

Filed Feb. 6, 1940 4 Sheets-Sheet 4

Fig. 17.

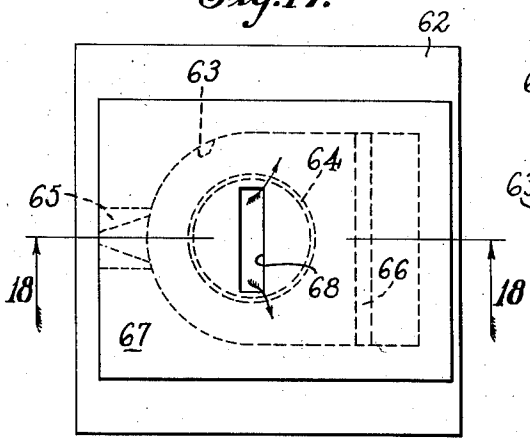


Fig. 18.

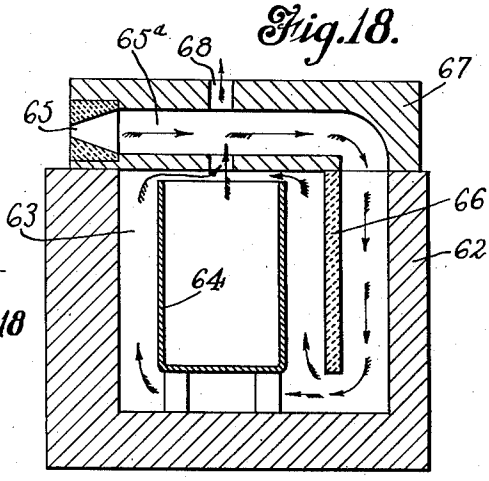


Fig. 19.

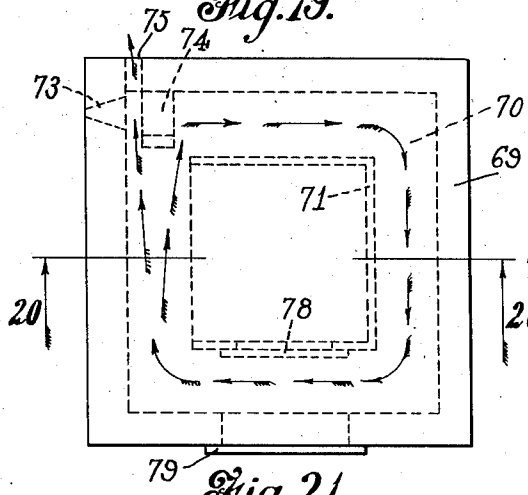


Fig. 20.

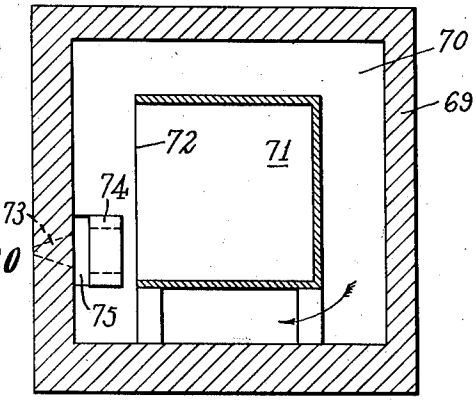


Fig. 21.

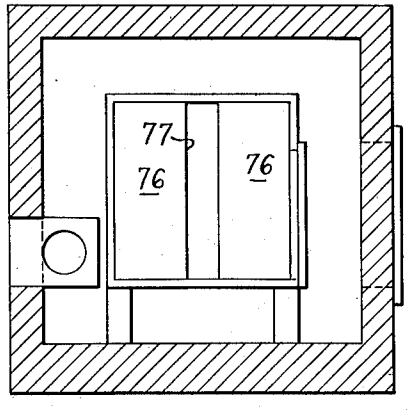
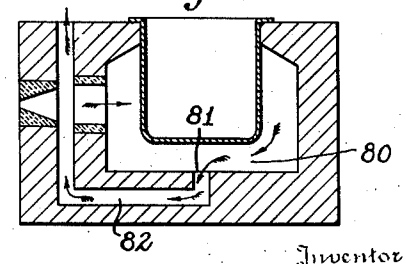


Fig. 22.



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Patented Aug. 12, 1941

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UNITED STATES PATENT OFFICE

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INDUSTRIAL FURNACE

Artemas F. Holden, Northford, Conn.

Application February 6, 1940, Serial No. 317,539

23 Claims. (Cl. 263—14)

This invention relates to a new furnace and to a new method of firing and applying heat in a furnace.

This invention is applicable to industrial furnaces of the pot type, the crucible type, the oven type, and to other furnaces. While particularly adapted for the burning of oil, in connection with which it has special advantages, the invention is useful in other connections, for example, in furnaces employing manufactured gas, natural gas, butane or propane or any solid fuel.

One of the principal objects which I have in view is increased efficiency of the furnace, the promotion of better control and combustion of the fuel, and more economical heating than has been possible heretofore.

It is also aimed to increase the rate of heat transfer to the work, speed up the output with reduced fuel consumption and less possibility of backfiring, and to increase the life of the furnace. It is also desired to provide for the retention of heat in the heating chamber after closing down, because of the preferred location of the vent, which prevents any circulation of induced secondary air through the chamber when the blower supplying primary air is not in operation.

To these and other ends the invention consists in the novel features, procedure, and furnace structure hereinafter described and pointed out in the claims.

In the accompanying drawings:

Fig. 1 is a vertical sectional view of a pot furnace such as I use in carrying out my new method; this view being taken on line 1—1 of Fig. 2;

Fig. 2 is a top plan view of the furnace shown in Fig. 1;

Figs. 3 and 4 are sections, respectively, on lines 3—3 and 4—4 of Fig. 1;

Fig. 5 is an enlarged detail section taken on line 5—5 of Fig. 1, illustrating the parts adjacent the burner flame;

Fig. 6 is a top plan view on a smaller scale showing a modified form of pot furnace;

Fig. 7 is a section on line 7—7 of Fig. 6;

Fig. 8 is a view similar to Fig. 6, showing a further modification;

Figs. 9 and 10, respectively, are a front view and a horizontal section on line 10—10 of Fig. 9 showing a further modified form of pot furnace;

Figs. 11, 12 and 13 are, respectively, a top plan view, and sections on lines 12—12 and 13—13 of Fig. 11, showing a form of double-fired pot furnace;

Figs. 14 and 15 are, respectively, a top plan view and a section on line 15—15 of Fig. 14, illustrating a further modification, this also being a pot furnace;

Fig. 16 is an enlarged detail section on line 16—16 of Fig. 14;

Figs. 17 and 18 are, respectively, a top plan view and a section on line 18—18 of Fig. 17, showing a crucible furnace;

Figs. 19 and 20 are, respectively, a top plan view and a section on line 20—20 of Fig. 19, showing an oven-type furnace;

Fig. 21 is a sectional view of an oven furnace having an oven similar to that shown in Figs. 19 and 20, but provided with a restricted side opening;

Fig. 22 is a somewhat diagrammatic sectional view of a pot furnace; and

Fig. 23 is a sectional detail showing the setting of a gas burner.

The furnace shown in Figs. 1 to 5 is an industrial furnace of the pot type, comprising a rectangular or generally square refractory body 20 built up of brick or the like, having an inner chamber 21 in which is suspended by means of a lip or ring 22 on its rim a steel or other metal pot 23, whose bottom 24 is spaced upwardly somewhat from the floor of chamber 21. In this particular case, the pot is round, and the heating chamber is rounded but provided with a squared off or straight wall at that side from which the chamber is fired. There is full access of hot gases to the bottom of the pot, and to the greater part of its side wall.

The burner wall is indicated at 25, and it will be noted that in this wall is a flame-directing means such as a burner tile or ignition tile 26 into which is discharged the flame from a burner nozzle 27. It may be assumed for purposes of description that the nozzle 27 is part of an oil burner injecting a mixture of oil and air (or steam) into the conical opening 28 of the burner tile. In this instance, as shown, the burner nozzle is located wholly outside of the furnace, with a space between it and the mouth of the conical opening 28 to permit the entrainment of secondary air. Parallel to the wall 25 and between the same and the heating chamber 21 is a wall 29 of refractory material presenting a flat or squared off surface partially defining the heating chamber. This wall is partially separated from wall 25 by a narrow chamber or flue 30 extending horizontally, and by a vertical vent flue 31 extending from flue 30 to an opening 32 at the upper surface of the furnace structure. It will be noted that the burner nozzle and burner tile are located

adjacent a corner of the heating chamber, being offset from the longitudinal median line of the furnace, as appears from Fig. 2. The vent flue 31 is symmetrically located with respect to the burner tile, so that the burner flame passes through the vent flue in the manner hereinafter more particularly described, the vent flue being somewhat wider than the opening at the inner end of the burner tile and lying laterally beyond said opening on both sides. Located in the wall 29 on the opposite side of the vent flue from the burner tile is a combustion tile 33 which is preferably of somewhat larger diameter than the inner end of the burner tile opening.

The combustion tile 33, as will be seen from Fig. 2, is located at the corner portion of the heating chamber 21 occupying a position where issuing gases will pass around the pot in what I term a "horseshoe" or U-shaped chamber without any localized impingement of hot gases on the side of the pot. The pot may be set as illustrated or slightly off center so as to constrict the gases toward the opposite side of the chamber from which the burner tile is located.

The vent flue 31 is preferably of an elongated rectangular shape in cross section, its longest cross-sectional dimension being somewhat in excess of the diameter of the burner tile and combustion tile so as to allow the exhaust gases a path of travel at either side of the flame which is firing into the combustion tile. In this particular case the smaller dimension of the vent flue cross section is somewhat less than the width of the flue 30. In this particular case also the bottom of the flue 30 is level with the bottom of the heating chamber, but variation may be made in this and other respects, as will hereinafter appear. The vent from chamber 21 will be of such size that there will be a drop in pressure from chamber 21 into the vent which goes across the bottom of the furnace and then upward and across between the burner tile and the combustion tile.

The hot gases issuing from the combustion tile 33, and passing along one side of the pot tangentially to the pot, thereafter have a course by which they pass around the pot at the rear in an arcuate path, as shown by the arrows in Fig. 2, whereby the original direction is reversed and the gases pass toward the wall 29 of the heating chamber at the opposite side of the chamber. When, as in this instance, the hot gases enter the heating chamber from the right side (Fig. 3), they are passed around the pot to the left side of the chamber. When the latter region is reached, the hot gases separate, part of them issuing through a restriction or port 34 into the left-hand end of flue 30, while part of the gases continue around the pot and enter the main stream again and are recirculated. Separation of the gases adjacent the port 34 is promoted by providing within chamber 21 at one side of the entrance to port 34 a deflecting pillar 35, which acts as a separator and has a tendency to catch the gases at any point in the height of the heating chamber and direct them toward the port 34, which is adjacent the floor of the chamber.

In the operation of a furnace of this type the burner tile 26 becomes highly heated by the flame issuing from the burner nozzle, which nozzle may be burning oil, for example. The flame passes through the burner tile and into and through the combustion tile 33, and the effect of the flame on the combustion tile is to heat the latter to incandescence. This aids in converting the oil and air into a gas. The gases passing around the pot have a tendency to back up when they encounter the wall 29 of the chamber, and are permitted to pass only through the restricted opening or port 34 in said wall. They are partially forced into this port and thence into the flue or chamber 30, which I term an induction chamber or draft tunnel and which preferably has a somewhat larger cross-section than port 34; and when the gases arrive in the chamber 30, their pressure is lowered and they expand somewhat. From the left-hand end of the chamber (Fig. 4) the gases travel to the right, and then enter the lower end of the vent flue 31, where, but for the presence of the flame directed across said vent flue, they would discharge straight up the flue to the atmosphere. As a result, however, of the flame established in the flue and extending completely across the same approximately at the center and in the direction of the smaller dimension of the flue, the gases necessarily are divided and separated to pass to opposite sides of the flame. At the opposite sides of the flame the bodies of gas are further separated, part of each body being entrained by the flame so as to pass horizontally and inwardly toward the heating chamber, and part escaping in an upward direction and moving to the discharge.

The effect of the burner flame passing directly across the vent flue, or, as it may be stated, of drawing or inducing the combustion gases directly to and around the flame, is, among other things, to preheat effectively the air being supplied to the burner and the fuel being burned. This is a most important result because, among other things, it provides a smaller and hotter flame. The flame is shorter than would otherwise be the case because of the fact that, due to the action of the highly heated exhaust gases in direct contact with the body of the flame, the fuel and air are effectively preheated in a region near the base of the flame. The fuel and air in this region being much more highly heated than heretofore, the flame is shorter, the combustion under better control, and instead of having a raw oxidizing flame in contact with the wall of the pot, there is a stream or flow of better combusted hot gases, which reduces scaling or other harmful effect on the pot wall. The heat transfer to the work is better and the output speeded up. There is also a distinct reduction of any tendency to backfire because the gases being burned are well preheated, and because of the exhausting of the gases in an open vent at and adjacent the point of firing. The recirculation of a certain amount of the hot gases, a portion of them passing around the pot more than once approximately in a circle, and another portion of them going back into the heating chamber adjacent the firing point, obviously brings about economy, as the hot gases remain longer in the heating chamber and have an increased heating effect. It is possible in a furnace of this type to increase the pressure in the heating chamber without creating a tendency to backfire, and to speed up the output without its being necessary to use a stack or any special air-circulating means for draft-forcing purposes.

The type of oil burner which I prefer to employ is that in which oil and air are fed by pressure to a suitable nozzle (having an adjustable discharge), the nozzle serving to inject the combustible mixture in atomized form into the burner tile, which opening is sufficiently large to permit the entrainment of atmospheric or secondary air,

which is drawn in by the suction produced by the primary air. The burning of the fuel is, of course, assisted by the high heat of the brickwork adjacent the flame. Substantially complete combustion takes place before the back wall or firing wall of the heating chamber is passed. One of the very important results which I bring about by carrying the combustion products directly to and against the flame at the side of the latter is the effective preheating of the fuel mixture, and more particularly at a point which is adjacent the base of the flame; but another feature of prime importance where a liquid such as oil is injected with air, is that the outgoing products of combustion from the heating chamber are employed (by surrounding or practically surrounding the flame in free and immediate contact therewith) to bring about a complete gasification of the fuel mixture, and the burning efficiency and controllability of the mixture is therefore comparable to that of a high-grade gas (manufactured or natural). Thus my method of firing has special advantages where the furnace has a liquid fuel burner, but I do not limit myself to the use of liquid fuel, as in some cases the furnace may be gas fired.

Attention should be called to the fact that in accordance with the improved method I not only cause all the hot gases to be carried directly to the flame, in an intersecting direction laterally of the flame and in a region where the flame is fully formed or developed, but that means are provided for preventing passage of the gases behind the flame, or, in fact, as far back as the point where the flame originates, because the firing wall of the furnace and (in the case of an oil burner) the cone of secondary air coming in around the flame through the burner tile, prevent travel of the exhausting gases toward the burner wall of the furnace. The exhausting gases, split into two bodies in the manner previously described, are partially moved into the heating chamber and partially discharged at the outlet of the vent.

While in the case above described the fuel is injected across the vent flue at right angles to the latter, the angle need not necessarily be a right angle.

It will be noted that, before the products of combustion which are to be returned to the heating chamber from the induction chamber or draft tunnel are so returned to the heating chamber, they are caused to give up part of their heat to the incoming air and fuel, and to be intimately mixed with them. The heat of these products of combustion and the heat of the adjacent brickwork causes a rapid vaporization of the liquid fuel, and with the preheated air present heated by these products of combustion and by the adjacent brickwork, combustion takes place very rapidly. This is further accelerated and completed as the combined gases continue to pass on through the incandescent combustion tile before entering the heating chamber proper.

The invention provides for maintaining a certain higher pressure within the heating chamber while maintaining combustion. It also provides for a higher pressure on the work, thus speeding up the rate of heat transfer in comparison with conventional flued furnaces which have direct flues from the heating chamber to atmosphere with a lower internal pressure necessary to maintain comparable combustion.

In addition to the advantages previously pointed out, there is obviously a complete and thorough recirculation of gases through the heating chamber and around the pot.

To assist the recirculation, the heating chamber is rounded at the corner toward which the gases from the flame are directed.

A further decided advantage of the invention arises from the practical elimination of carbon deposits on the combustion tile and adjacent brickwork.

Another desirable feature of the form of furnace above described is that the furnace chamber retains the heat after discontinuing the firing (as, for example, in closing down over night) because of the location of the vent which prevents any circulation of induced secondary air through the chamber when the blower used for forcing in primary air is not in use. The furnace stays hot for a considerably longer time, and the brickwork is prevented from cracking and spalling.

The importance of my improved method of firing for oil-heated furnaces, as distinguished from those which are gas fired, should not be overemphasized, because in the latter case the preheating of the air content of the combustible mixture is of great advantage for increasing efficiency. Moreover, the preheating of the gas content of the charge may be of decided advantage also, as in the case where water gas is being burned. Water gas supplied to the furnace will be subjected at once to a drying effect as a result of the above-described action of the hot gases in passing across the flame.

In the form of furnace shown in Figs. 6 and 7, the port **36**, which is similar to the port **34** previously described, serves to conduct gases upwardly to a horizontal vent flue **37**, which is arranged midway of the height of the furnace chamber. This vent flue has an outlet **38** at the side of the furnace. It will be evident that in this case the gases are directed to and cross the flame as before, but in this instance they are horizontally rather than vertically directed.

In the form shown in Fig. 8 the port **39**, which corresponds to the port **34**, is arranged at the upper part of the heating chamber, and the gases are conducted from it in a downward direction to a horizontal vent flue **40** arranged adjacent the floor of the heating chamber. In this case the burner has a lower location so that its flame will intersect the vent flue intermediate of the ends of the latter.

Figs. 9 and 10 show a simplified construction of pot furnace in which the firing wall **41** is provided with a burner tile **42**. Projecting from the side wall **43** of the furnace, which is adjacent the corner where the burner tile is located, is a suitably supported combustion tile or block **44**. The flame is directed tangentially to the pot **45**, as before, but in this case the heating chamber **46** has an inner surface **47** which for the most part is concentric with the pot. The gases travel around the pot, and are then separated by the combustion tile **44**, some of them passing around the pot again, while the remainder move through a vent flue or duct **48** that is arranged at right angles to the flame axis. The flue **48** has an outlet **49** at the side of the furnace.

Figs. 11, 12 and 13 illustrate a duplex type of furnace which is fired from opposite sides. There is a rounded heating chamber **50** containing a pot **51**. Adjacent diagonally opposite corners, burner tiles are arranged, each having adjacent thereto a combustion tile. The burner tile and the combustion tile are separated by a vent, which in this case has a horizontal por-

tion leading from a heating chamber port, a vertical portion in which a part of the burner flame is located, and a further horizontal part leading to an opening in the side of the furnace. As will be seen from the drawings, the burners in this particular case are arranged at different elevations. One of the ports leading from the heating chamber is shown at 52, and the other at 53. The vent flue communicating with port 52 is shown at 54, and the vent flue communicating with port 53 is shown at 55. The burner flames operate in the vent flues in the manner previously described.

In the form of furnace shown in Figs. 14, 15 and 16, the furnace structure or block 56 is provided with a pot 57, which is disposed in a round heating chamber 58, generally similar to that disclosed in Figs. 9 and 10. However, in this instance a cup-shaped receptacle 59 (preferably of refractory material) is supported around the pot, with its bottom spaced upwardly from the floor of the chamber. The flame and products of combustion are directed around the receptacle 59, and in order to discharge have to pass over the rim of receptacle 59 and downwardly into that receptacle around the pot. The products of combustion issue from the lower part of the side wall of the receptacle 59 at the point 60, and pass to a vent flue 61, which in this case is horizontal and vents at one side of the furnace. The burner flame is directed across the vent flue, as before.

Figs. 17 and 18 illustrate a furnace of the crucible type, where the furnace block 62 has an interior heating chamber 63 in which a crucible 64 is supported in such a manner that its bottom is spaced upwardly from the floor of the heating chamber. At the front upper portion of the heating chamber is arranged a burner opening 65, and at the rear of the heating chamber is an upright partition 66. On top of the furnace block is a cap piece 67, and the burner opening 65 is at the front end of this cap piece communicating with a horizontal passage 65a formed in the cap piece. Leading from the passage 65a in a location above the crucible 64 is an elongated vertical vent opening 68. The flame is thrown into passage 65a, and the products of combustion pass downwardly along the rear side of the partition 66, underneath the crucible, and upwardly at the front part of the crucible. Other products of combustion pass upwardly around the crucible adjacent its rear portion in front of partition 66. All of these gases in escaping have to pass across passage 65a to and through the vent 68, and before so doing they pass to and around the incoming flame substantially in the manner previously described, although there is obviously some variation in detail.

In the form of my invention shown in Figs. 19 and 20 the furnace is of the oven type, having a block 69 with an interior approximately cubical heating chamber 70 in which is disposed an oven 71 spaced upwardly from the floor of the chamber and open along one side, as shown at 72. A burner opening 73 and combustion tile 74 are provided so that a flame can be produced parallel to the oven adjacent one of the closed sides. The products of combustion pass around and under the oven, as indicated by the arrows. Between the burner tile and the combustion tile a lateral vent 75 is located. The hot gases immediately before reaching this vent passage (which intersects the flame axis as before) move across the open side 72 of the oven. If desired, the open side of the oven may be partially closed by the members 76, as shown in Fig. 21, which members provide between them a restricted opening 77 to the oven. Articles may be placed in the oven through a door 78 in one side thereof, which door is accessible by way of a door 79 which controls an opening through one side of the heating chamber.

A furnace of this type is useful, for example, in the heat treatment of steel products and the like. The arrangement is such that a neutral or reducing atmosphere can readily be maintained in the oven. It is possible to use a sufficiently rich mixture of fuel at the burner so that, upon opening door 79 momentarily for introducing the parts to be heat treated and then closing the door, the entering oxygen will be burned up immediately, and there will be no decarburizing or scaling of the steel being treated.

In the form of furnace shown in Fig. 22, which is another furnace of the pot type, a round chamber is fired from a burner or burners of oil or other type, in an approximately tangential direction, and the gases issue from the bottom of the heating chamber 80 at the point 81 in a downward direction, passing into a flue having a radial portion 82 communicating with a vertical vent flue across which the heating flame is thrown.

In Fig. 23 I have shown by way of example a type of gas burner nozzle which may be employed when the furnace is gas fired. In this case the nozzle 83 has a portion 84 set into an opening 85 in the firing wall in front of a burner tile 86. In this case the burner nozzle is sealed in place in the wall socket, there being no air drawn into the furnace around the burner.

While I have described several furnace structures suitable for carrying my invention into effect, it will be understood that various changes can be made in the procedure as herein described, and in the furnace structure (both with regard to the organization of the principal parts and details), without departing from the principles of my invention or the scope of the claims.

Where I have referred to the hot gases being directed "laterally" toward the flame, and to the gases making contact with the "side" of the flame, I use these terms in a broad sense, intending them to apply generically to the different conditions indicated, for example, in Figs. 4 and 7.

What I claim is:

1. The method of firing a furnace, which comprises creating a heating flame, venting the gases after their heat has been utilized, and directing the venting gases in a body against and across the flame.

2. The method of firing a furnace, which comprises creating a flame of which the products of combustion are used for heating purposes within the furnace structure, and venting and discharging the exhaust gases so that just before issuing into the atmosphere they cross the flame and are thereby split into two bodies disposed respectively at opposite sides of the flame.

3. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed at least partially within a heating chamber with a circulation space about the receptacle, which comprises creating a heating flame of which the products of combustion are conducted about the receptacle at different sides thereof so that the gases follow a path generally in the form

of a loop, and causing the discharging gases shortly before they leave the furnace to impinge laterally upon the flame body.

4. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed at least partially within a heating chamber with a circulation space about the receptacle, which comprises creating a heating flame of which the products of combustion are conducted about the receptacle at different sides thereof so that the gases follow a path generally in the form of a loop, and causing the discharging gases shortly before they leave the furnace to impinge laterally upon the flame body while preventing the gases meeting the flame from reaching a point behind the flame.

5. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed at least partially within a heating chamber with a circulation space about the receptacle, which comprises creating a heating flame of which the products of combustion are conducted about the receptacle at different sides thereof so that the gases follow a path generally in the form of a loop, and conducting the gases in a transverse direction to and around the flame intermediate of the ends of the latter, and then venting them.

6. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed in a heating chamber with surrounding space for gas circulation, which comprises creating a heating flame, conducting the products of combustion about the receptacle, and carrying them out of the furnace by a course in which just before leaving the furnace they cross the flame in contact therewith.

7. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed in a heating chamber with surrounding space for gas circulation, which comprises creating a heating flame, conducting the products of combustion about the receptacle, and carrying them out of the furnace by a course in which just before leaving the furnace they cross the flame in contact therewith, the gases being led to the flame straight from the side thereof at a substantial angle to the flame axis.

8. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed in a heating chamber with surrounding space for gas circulation, which comprises creating a heating flame, conducting the products of combustion about the receptacle, and carrying them out of the furnace by a course in which just before leaving the furnace they cross the flame in contact therewith, the gases being led to the flame straight from the side thereof at a substantial angle to the flame axis, the gases passing the flame in a confined stream slightly wider than the flame.

9. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed in a heating chamber with surrounding space for gas circulation, which comprises creating a heating flame, conducting the products of combustion about the receptacle, and carrying them out of the furnace by a course in which just before leaving the furnace they cross the flame in contact therewith, the gases being led to the flame straight from the side thereof at a substantial angle to the flame axis, the gases passing the flame in a confined stream slightly wider than the flame, the stream and the flame being symmetrically disposed so that the body of gas is temporarily divided by the flame into substantially equal parts.

10. The method of firing an industrial furnace of the type in which a heating chamber provides space surrounding a work-holding receptacle, which comprises creating a flame through and across a stream of exhausting gases that have passed around the receptacle.

11. The method of firing an industrial furnace of the type in which a heating chamber provides space surrounding a work-holding receptacle, which comprises creating a flame laterally through a stream of exhausting gases that have passed around the receptacle such that the fuel being burned is preheated at the flame, there being a preheating zone completely surrounding the flame intermediate of its ends, and the gases passing in part directly from said zone to the atmosphere.

12. The method of firing an industrial furnace of the type in which a heating chamber provides space surrounding a work-holding receptacle, which comprises creating a flame laterally through a stream of exhausting gases that have passed around the receptacle, said flame being formed by burning a gasifiable liquid fuel, and said gases just before being vented to the atmosphere traveling around the flame in gasifying relation thereto.

13. The method of firing an industrial furnace of the type in which a work-holding receptacle is disposed within a heating chamber with surrounding circulation space, which comprises creating a flame by burning a mixture of oil and air supplied under pressure, directing the products of combustion from said flame about the receptacle on different sides so that their direction is substantially reversed, and then leading the gases in a generally lateral direction so that they follow a loop-like path and are vented, and passing the venting gases to the flame laterally of the flame so that they are in preheating and gasifying relation to the fuel being burned.

14. In an industrial furnace, a furnace block provided with an interior heating chamber, a work-holding receptacle disposed in said chamber for circulation of gases about the receptacle, a burner tile arranged to direct a heating flame toward the heating chamber so that the products of combustion will pass about the receptacle on different sides, and means for conducting the products of combustion laterally to and across the flame and venting them.

15. In an industrial furnace, a furnace block provided with an interior heating chamber, a work-holding receptacle disposed in said chamber for circulation of gases about the receptacle, a burner tile arranged to direct a heating flame toward the heating chamber so that the products of combustion will pass about the receptacle on different sides, and means for conducting the products of combustion laterally to and across the flame and venting them, said last-named means comprising an induction flue substantially transverse to the burner axis.

16. In an industrial furnace, a furnace block provided with an interior heating chamber, a work-holding receptacle disposed in said chamber for circulation of gases about the receptacle, a burner tile arranged to direct a heating flame toward the heating chamber so that the products of combustion will pass about the receptacle on different sides, and means for conducting the products of combustion laterally to and across the flame and venting them, said last-named means

comprising an induction flue substantially transverse to the burner axis, and said heating chamber having an exit port by way of which gases are led into said induction flue.

17. In an industrial furnace, a furnace block provided with an interior heating chamber, a work-holding receptacle disposed in said chamber for circulation of gases about the receptacle, a burner tile arranged to direct a heating flame toward the heating chamber so that the products of combustion will pass about the receptacle on different sides, and means for conducting the products of combustion laterally to and across the flame and venting them, said last-named means comprising an induction flue substantially transverse to the burner axis, said heating chamber having an exit port by way of which gases are led into said induction flue, and said induction flue being created in part by a wall shutting it off from the heating chamber and provided with a combustion tile in line with the burner tile.

18. In an industrial furnace, the combination of a furnace block having a heating chamber therein, a work-holding receptacle disposed at least partially within said heating chamber, there being a space extending completely about the receptacle for the circulation of gases, a burner tile in one wall of the furnace block for the establishment of a flame so directed that the products of combustion will pass about the receptacle and establish a path in the form of a loop before leaving the furnace, said furnace having a combustion tile in line with but spaced from the burner tile and also having a vent flue communicating with the space between the tiles.

19. An industrial furnace comprising a refractory furnace block having an interior heating chamber, a pot depending from the upper portion of the block so as to have its side wall and bottom disposed within the heating chamber, one wall of the furnace block being provided with a burner flame inlet, an open-topped receptacle within the heating chamber around the pot, the furnace being constructed so that the combustion gases travel around the recepatcle and over its top wall and thence around the pot, and means for carrying the gases from the receptacle laterally across the burner flame, and then venting them.

20. An industrial furnace comprising a refractory block having an interior heating chamber, an oven in said chamber spaced from the walls thereof so that there is circulation space around the oven, one of the furnace walls having a burner-flame-directing means located so that the products of combustion pass around the oven, and a vent for the gases which carries them into contact with and across the burner flame.

21. A furnace such as described in claim 20, in which the oven is open at that side from which the gases pass directly to the vent.

22. In an industrial furnace, the combination of a furnace block having a chamber therein, a work-holding receptacle disposed at least partially within said heating chamber, there being a space extending completely about said receptacle for the circulation of gases, a burner tile in one wall of the furnace block having a flame cavity, a burner nozzle in association with said tile, said nozzle and tile establishing a flame so directed that the products of combustion will pass in loop form about the receptacle, and a combustion tile in line with and spaced inwardly from the burner tile, said furnace having a waste gas flue leading from the heating chamber to the atmosphere, which flue in proximity to its discharge leads across and through the space between said tiles.

23. The method of operating an industrial furnace, which comprises creating a flame whose gases are used for heating, and leading the gases from the heating region into the space where the flame is established so that they have intersecting contacting relation to the flame and leading them thence in the same general direction and in a short course to the atmosphere.

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