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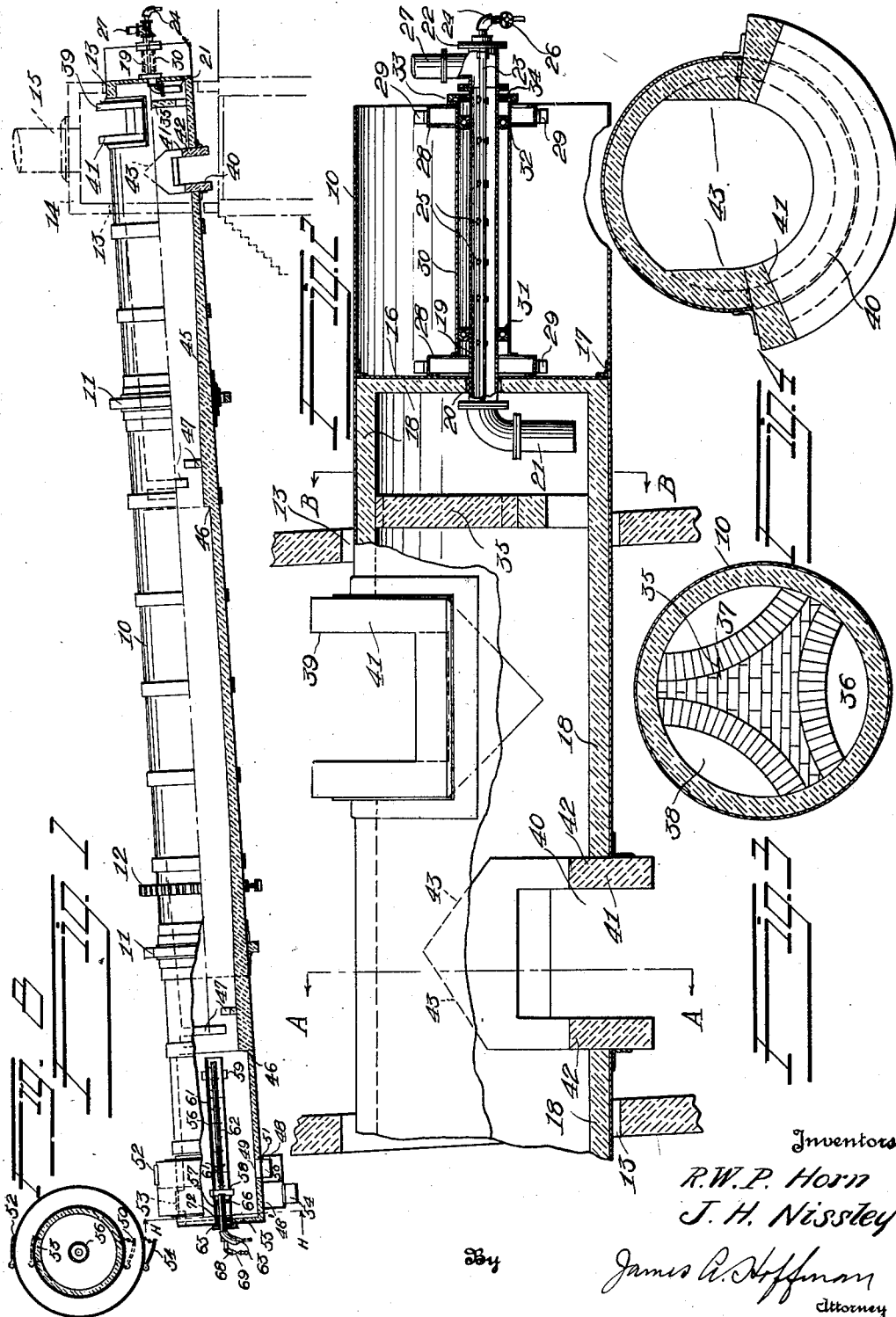
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ROTARY KILN

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ROTARY KILN

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This invention relates to kilns of the rotary type intended for any purpose for which such kilns have heretofore been used. The embodiment of the invention disclosed in this application was designed for the burning of cement, in particular. This application is a continuation in part of our copending application, Serial Number 221,332, filed September 22nd, 1927.

The primary object of the invention is to provide a kiln in which high efficiency in the consumption of fuel, may be attained by virtue of the manner by which the flow of fuel and air to support substantially complete combustion is controlled.

A further object of the invention is to provide a kiln provided with mechanism to supply air to both ends thereof in regulable quantities so that the combustion within the kiln is within the control of the operator.

A further object of the invention is to provide a kiln including means to slow up or retard the flow of material from its normal rate at the portion of the kiln at which the burning is most intense.

A still further object of the invention is to provide a kiln in which the velocity of the gases resulting from the combustion is reduced in order that the maximum heat contained therein may be utilized, and in order that particles of dust carried by the gas stream may be permitted to settle out of said stream before it passes out of the stack.

A further object of the invention lies in the production of a kiln in which the flow of air, fuel and raw material to the kiln is accomplished in an extremely practical and simple manner.

A still further object of the invention is to provide a kiln having means to supply air at the stack end thereof with the raw material customary fed thereinto at said end in order that any unconsumed fuel entered into the stack may be burned causing initial heating of the raw material as it enters the kiln.

Further objects of the invention will appear as a description thereof proceeds with reference to the accompanying drawings in which,

Fig. 1 is a part side elevation, part sectional

view of the improved kiln of this invention.

Fig. 2 is an enlarged part sectional and part side elevational view of the feeding end of the kiln.

Fig. 3 is a transverse section taken on the plane indicated by the line B—B of Fig. 2 looking in the direction of the arrows.

Fig. 4 is a section of the kiln taken on the plane indicated by the line A—A in Fig. 2.

Fig. 5 is a longitudinal sectional view of the burning end of the kiln showing a slightly modified construction.

Fig. 6 is a sectional view taken on the plane indicated by the line C—C of Fig. 5 looking in the direction of the arrows.

Fig. 7 is an enlarged part-sectional view of the discharge end of the kiln shown in Fig. 1.

Fig. 8 is a sectional view on the plane indicated by the line H—H on Fig. 1.

Like reference characters indicate like parts throughout the several figures.

Referring to the construction illustrated in Figs. 1 to 4, inclusive, the improved kiln of this application comprises an elongated shell 10 provided with tires 11 serving as supports for the kiln during its rotation in well known manner. Said kiln is provided with the usual driving gear 12 that meshes with a suitable driving pinion operated by any suitable motor arranged to rotate the kiln relatively slowly during the operation thereof. The kiln extends into openings 13 of a chamber 14 that is in communication with a stack 15. As clearly illustrated in Fig. 1 the end of the kiln extends beyond the rear wall of the chamber 14 and said end is provided with the mechanism for supplying the raw material by air to the kiln, as hereinafter described. The illustrated kiln is intended particularly for the burning of cement, but it obviously, may be used for other purposes, such as the treatment of ores and the burning of coke for example.

The feed end of the kiln is shown on an enlarged scale in Fig. 2. As shown in said figure, the shell 10 is provided adjacent its end with a transverse partition 16 secured to the shell by angle irons 17 or in any other suitable manner. The walls of the kiln and

said partition may be lined with fire brick or other similar lining material 18. A raw material supply pipe 19 extends through an opening 20 provided in the partition 16 and its lining, said supply pipe having an angularly bent end 21 discharging its contents adjacent the lining 18 of the kiln. Supply pipe 19 is closed at its opposite end by a plate 22 provided with an opening to receive an air supply pipe 23 connected at 24 to any suitable supply of air under pressure. As clearly shown in Fig. 2 the air supply pipe 23 extends axially of the raw material supply pipe 19 and is provided with a multiplicity of discharge nozzles 25 inclined in the direction in which the material is to be fed through pipe 19. The air supply pipe 24 may be provided with a control valve 26 of any suitable design.

The raw material enters the pipe 19 from a branch pipe 27 extending laterally therefrom and communicating with a suitable hopper or other feeding arrangement. Feed pipes 19, 21, 27 and air supply pipes 23 and 24 remain stationary, and the kiln is arranged to rotate with respect to said pipes. In order to support the relatively large raw material supply pipes in the kiln suitable rectangular hollow boxes 28 are supported from the walls of the kiln by transverse members 29 rigidly united at their ends to said walls. A supporting shell 30 is secured at one end to the side of one of said boxes 28 viewing Fig. 2, and extends through the other of said boxes 28 and is secured thereto in any approved manner. Said shell is spaced from the supply pipe section 19 and roller bearings 31 and 32 are arranged in said space providing bearings permitting relatively free rotation between the shell 30 carried by the kiln and the pipe section 19. It will be understood that the pipe 19 passes through the box 28 relatively freely in order to permit the free rotation between said pipe and said box. In order to prevent the unrestricted flow of air into the kiln proper around the box 28 and through the opening 20 in the partition 16 of the kiln, suitable packing rings 33 and 34 attached to the shell 30 and the pipe section 19 respectively, are provided. Said rings permit relatively free rotation between said shell and pipe section.

Disposed across the kiln relatively close to the partition 16 is a brick or similar wall 35 as clearly shown in Fig. 3. Said wall is provided with openings 36, 37 and 38 of any suitable form, but arranged adjacent the longitudinal walls of the kiln and constituting ports to supply the raw material to the kiln proper.

Within the chamber 14 the kiln is provided with gas outlets 39 and 40. The outlet 39 is spaced endwise of the kiln from outlet 40 and it is diametrically opposite the last mentioned opening for a purpose presently to be described. The openings of the kiln extend ap-

proximately through an arc of 150° and said openings are provided with linings 41 that extend a substantial distance into the interior of the kiln to provide shoulders 42 entirely around said openings. The wall of the kiln is so formed that no abrupt shoulders are provided in a direction circumferentially of the kiln. This is accomplished by gradually merging the lining for the openings into the side walls of the kiln as indicated at 43 (Figs. 2 and 4). Suitable angle irons 44 may be secured to the lining 10 of the kiln to attach the linings 41 to the kiln walls.

The wall of the kiln is preferably provided adjacent the chamber 14 with a lining 45 of gradually increasing thickness as clearly shown in Fig. 1. At intervals as shown at 46 said lining is sharply reduced in thickness providing shoulders at these points. Said lining may also be provided with projections 47, each extending through an arc of approximately 120° around the inner periphery of the kiln. Said projections however, are spaced laterally endwise of the kiln in order to permit the material to flow around the ends thereof and into contact with the adjacent spaced projection to be retarded thereby and subsequently discharged around the end or over the top thereof, as the material flows through the kiln as hereinafter more fully described.

It will be observed that the kiln is provided with gas outlet openings between its ends and means is provided to supply air to the feed end of the kiln. It will be understood, however, that the amount of air supplied at that end of the kiln is under the control of the operator of the kiln. The discharge end of the kiln is constructed in order that the supply of air to this end may, likewise, be under the control of the operator. Accordingly, the construction is such as to prevent substantial quantities of air from entering the kiln at any point throughout its discharge end, and particularly through the discharge openings. In order that the material may be discharged without permitting the entry of substantial quantities of air at this point the kiln is provided with two annular closed chambers 48 and 48' surrounding the kiln adjacent the discharge end thereof. The chamber 48 communicates through an opening 49 with the interior of the kiln. The flow of material through said opening is controlled by a hinged door 50, whose opening movement is limited by a chain 51 or in any other similar way. The material is discharged into the chamber 48 through the opening 49 when the door 50, opening under the action of gravity, during the rotation of the kiln, assumes the position shown in Fig. 8. A discharge opening controlled by a door 52 similarly connected to the outer wall of chamber 48 controls the discharge of material from said chamber. It will be observed from Fig. 1 that the door

52 is diametrically opposite the door 50, so that when the door 50 is opened to discharge the material into the chamber 48 the door 52 opening into the atmosphere is closed, and that when the kiln assumes a position of 180° from that illustrated in this figure, the door 50 is closed while the discharge door 52 is opened. In this way the contents of the material may be discharged from the kiln without permitting substantial quantities of air to enter therein. The chamber 48' is provided with similarly mounted doors 53 and 54 functioning in precisely the same manner, but it will be observed that the doors 50 and 53 are on diametrically opposite sides of the kiln and that the doors 52 and 54 are also so located. As a result, the chambers 48 and 48' discharge their material alternately at each half revolution of the kiln.

The discharge end of the kiln is provided with a lined end wall 55 and said portion of the kiln carries a two-part shell including a portion 56 and a portion 57. The portion 56 is secured at one end to the end wall 55 of the kiln and at its other end to a box-like member 58 rigidly supported in the walls of the kiln. The section 56 is secured at one end to the box-like member 58 and adjacent its other end is supported in a similar box-like supporting member 59, likewise rigidly secured in suitable manner to the side walls of the kiln. An air conduit 60, arranged axially of the shell section 56, is supported in said section by suitable supporting elements, such as rings 61, arranged in the annular space between said shell section and said conduit. Said conduit is provided with suitable air discharge nozzles 62 inclined in the direction of flow of the fuel into the kiln.

The fuel in the form of powdered coal, oil or any other suitable from is supplied to the kiln through a conduit 63 having a horizontal portion 64 extending through the end wall 55 of the kiln. Suitable packing rings are provided at 65 and carried by the end wall 55 and the fuel supply conduit 63, respectively, restricting the flow of air through said end wall along said conduit. A portion of the conduit extending within the kiln is supported on roller bearings 66 disposed in the space between the section 57 and said conduit, so that free rotation of the kiln with respect to said conduit can take place. An air supply pipe 68 controlled by a suitable valve 69 is provided with a horizontally extending portion 70 extending axially through the section 64 of the fuel supply pipe. The portion 70 extends within the end of pipe 60 before referred to, as shown at 71. Portion 70 is provided with inclined air nozzles 72, positioned to direct the air admitted through the pipe 68 into the fuel supply pipe section 64, the inclination of said nozzles being in the direction of the flow of fuel therethrough. In the form of the invention shown in Figs.

5 and 6, the kiln 10 is provided with discharge chambers 48 and 48' adjacent the discharge end thereof, that are similar in all respects to the discharge chambers illustrated on Fig. 1, and above described and the flow of the material from the kiln into said chambers and out of said chambers is controlled by hinged covers or doors 50, 52, 53 and 54 as above described. Attached to the end wall 55 of the kiln shown in these figures is a rectangular hollow box 73. The sides of said box are each provided with a plurality of openings 74, each of which is controlled by a slide cover 75 having a finger-hold 76 to facilitate the adjustment of said covers over the openings 74 in the box sides. Said box is supported by legs 77 extending from each corner thereof and attached in any suitable manner to the wall of the kiln (Fig. 6). The end wall 55 of the kiln is provided with a series of air ports 78 opening into the interior of box 74. The other end wall 79 of said box is provided with a circular opening 80 through which extends a fuel supply pipe 81. Suitable interlocking rings 82 and 83 are carried by the box 73 and pipe 80 respectively, said rings serving to prevent the free flow of air along the fuel supply pipe into the kiln.

A flanged fluid supply pipe supporting shell 84 is secured at one end to the wall 79 of box 73, as shown at 85 (Fig. 5) and at its other end it is secured to a box-like supporting member 86 that is itself suitably secured to the walls of the kiln as shown at 87. As illustrated in Fig. 5, the shell 84 is of a larger diameter than the diameter of the fuel supply pipe 81 and ball bearings 88 and 89 are arranged in the space between said pipe and said shell whereby the shell carried by the kiln is free to rotate with respect to the stationary fuel supply pipe.

The kiln is provided with a supporting frame 90 spaced substantially from the supporting frame 86 just referred to. The frame 90 is anchored in the walls of the kiln in any approved fashion and supported in said frame 90 is a supporting ring member 91 through which extends a shell 92. One end of said shell is flanged as shown at 93 and said flanged end is secured to the box-like supporting frame 86. Shell 92 serves as a support for an air supply pipe 94 arranged axially thereof and supported from the shell 92 by rings 95 and 96. Each of said rings is provided with a plurality of ports 97 permitting the flow of fuel along the inner wall of the shell 92. Said flow is caused by air under pressure projected from nozzles 98 carried by the closed pipe 94, said nozzles being inclined in the direction of flow of the fuel into the burning zone of the kiln.

Air is supplied to the air supply pipe 94 by an air conduit 99 that extends axially of the fuel supply pipe 81 and is provided with a multiplicity of nozzles 100; each of which

is inclined in the direction in which the fuel flows to the burning zone of the kiln. The air supply pipe 99 is secured to a plate 101 that closes one branch of a union 102 carried by pipe 81, another branch of which, 103, is connected to any suitable source of fuel, such as powdered coal, oil, gas, etc. The air supply pipe 99 is provided with a suitable control valve 104 controlling the flow of air from a pipe 105 connected to any suitable source of air under pressure. As clearly shown in Fig. 5, the air supply pipe 99 extends into the end of air supply pipe 94 of larger diameter. Said first named pipe is provided with an adjustable baffle 106 of frusto-conical form. Said baffle may be adjusted on the pipe 99 to bring it into proper position to cause the air discharged from the adjacent nozzles in said pipe to flow around the baffle and through the annular space between the pipe 94 and the shell 92. The air supply pipe 94 and the shell 92 terminate adjacent a portion of the kiln that is of restricted diameter by virtue of the fact that it is provided near said point with a relatively thick lining 107. Immediately adjacent the discharge ends of pipe 94 and shell 92, said lining is gradually reduced in thickness, as shown, by forming the steps 108 terminating in a lining 109 that is substantially thinner than the lining portion 107.

Operation

In operation the kiln 10 is set in slow rotation in well known manner. It will be observed that the longitudinal axis of the kiln is inclined from the feed end thereof toward the discharge end so that the raw material has a tendency to flow under the action of gravity, from the feed end to the discharge end thereof. Kilns operating on this principle are well known. As shown in Fig. 1 the kiln extends in the chamber 14 leading to the stack 15 and the products of combustion flow from the kiln through the openings 39 and 40 into said chamber 14 and from said chamber into the stack. When the opening 40 is in the position shown in Fig. 1 the discharge of the products of combustion takes place principally through the opening 39, while when the opening 39 opens downwardly the products of combustion are discharged through the openings 40.

The raw material is fed into the kiln adjacent the stack through the pipe 27. Said material enters the substantially horizontal portion 19 of the raw material supply pipe, and is caused to be carried therealong by air under pressure admitted through the nozzles 25. Air is thus positively mixed with the raw material supply and said material and air enters the downwardly extending portion 21 and enters the kiln adjacent the partition

35. As the raw material and air enters said portion of the kiln the combustion that is taking place in the burning zone of the kiln causes a flow of gases and partially burnt fuel toward the discharge openings 39 and 40. As the kiln is rotated the mixture of raw material and air admitted through the pipe 21 passes through the opening 36, 37 or 38 in the partition 35 successively in relatively small quantities. As the raw material and air is thus charged into the portion of the kiln to the left of the partition 35, viewing Fig. 1, the air supplied causes the completion of the combustion of any unburned fuel about to be discharged into the chamber 14. Such combustion preheats the raw material. The flow of air in a direction reverse to the flow of the products of combustion tends to retard their discharge to the stack and to thus cause dust to gravitationally settle on the raw material rather than be carried out through the stack. As said material moves along the kiln, as its rotation is continued, it is caused to pass around the openings 39 and 41, due to the fact that the inwardly projecting shoulders 42, surrounding said openings, prevent the discharge of said material from the kiln through said openings. It will be readily understood that the height of the shoulders around said openings may be adjusted so that the material admitted successively through the openings 36, 37 and 38 will not be caused to flow over the top thereof. As the rotation of the kiln continues the raw material continues to move toward the discharge end of the kiln and it is subjected to the highly heated gases coming from the burning zone of the kiln, raising the temperature of the raw material as it moves along the kiln. As the movement of the material continues it encounters the shoulders 47 which serve to momentarily retard the movement of the material endwise of the kiln thus maintaining the material for an appreciable interval of time at this point in the kiln. At the same time, said shoulders present an obstruction to the flow of the products of combustion from the burning zone of the kiln. The flow of said products are further restricted by the one or more annular shoulders 46 provided approximately midway of the length of the kiln. As a result, substantial portions of dust carried by said gases are caused to be dropped upon the raw material through the kiln, thus preventing the escape of such portions through the stack.

When the raw material reaches the first shoulder 46 (Fig. 1) its movement is accelerated momentarily and it enters the burning zone proper of the kiln. Said burning zone extends from said shoulder to the second shoulder 46 adjacent the discharge end of the fuel supply pipe 56 and the air supply pipe 60. Fuel and air under pressure are supplied in correct proportions to maintain

substantially complete combustion in this zone of the kiln and said fuel and air enter this portion of the kiln subjecting the matter contained therein to an intense heat. The spaced projections 47 tend to slow up or retard the flow of fuel and air sufficiently to permit substantially complete combustion in the burning zone. As the raw material flows therethrough it is subjected to intense heat and when it encounters projections 47 its movement is retarded at the hottest point in the kiln. As the raw material continues its flow along the kiln it passes over the shoulder 46 and into the cooling end of the kiln that surrounds the shell portions 56 and 57. As it further flows along the cooling end of the kiln it radiates heat that raises the temperature of shell portions 56 and 57 to relatively high temperatures causing a preheating of the fuel and of the air that passes axially through the air supply pipes 70 and 60, thereby increasing the efficiency of the apparatus by reclaiming the heat thus radiated. As the raw material continues its movement it reaches the discharge openings leading into the chambers 48 and 48' and it is discharged first into said chambers and after the doors controlling the discharge of the material into said chambers are closed by the rotation of the kiln the material is discharged from the chambers without admitting uncontrolled and uncontrollable quantities of air into the kiln while the material is being discharged therefrom.

In the form of the invention shown in Figs. 5 and 6 the operation is substantially the same as that above described. However, the additional air may be supplied to this end of the kiln by adjusting the covers 75 for the openings 74 in the box 73. Air admitted through these openings flows into the kiln through the ports 78. It will be observed that the air and the fuel admitted to this portion of the kiln is preheated separately by the material moving toward the discharge openings of the kiln, shell portions 56 and 57 preventing combustion from taking place before the air and fuel is discharged from the shell 92 and the air pipe 94 respectively. As a result, when the fuel enters the burning zone that begins adjacent the end of said shell and pipe, the temperature of the air and fuel is such as to cause relatively complete combustion to occur as soon as said air and fuel enter this portion of the kiln. It is possible by this arrangement to obtain an extremely high efficiency.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all

changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What we claim as our invention is:

1. A rotary kiln consisting of an elongated body substantially closed to the atmosphere at all points thereof, a chamber, a stack opening into said chamber, said kiln extending through said chamber and provided with openings arranged to be successively brought opposite the stack opening, and means to supply air and raw material to said body adjacent said stack, said air being supplied to cause combustion of unburned fuel or gases at this portion of the kiln, to heat the fuel entering said body.

2. A rotary kiln substantially closed to the atmosphere at all points thereof, one end of said kiln extending through a chamber, a stack opening into said chamber, the portion of said kiln extending through said chamber being provided with a plurality of discharge openings spaced endwise of the kiln and on diametrically opposite sides thereof, and means within said kiln around said openings to cause the material fed to said kiln to flow around said openings.

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