March 6, 1962 A. G. BOYLES 3,023,478

GAS-FIRED KILN

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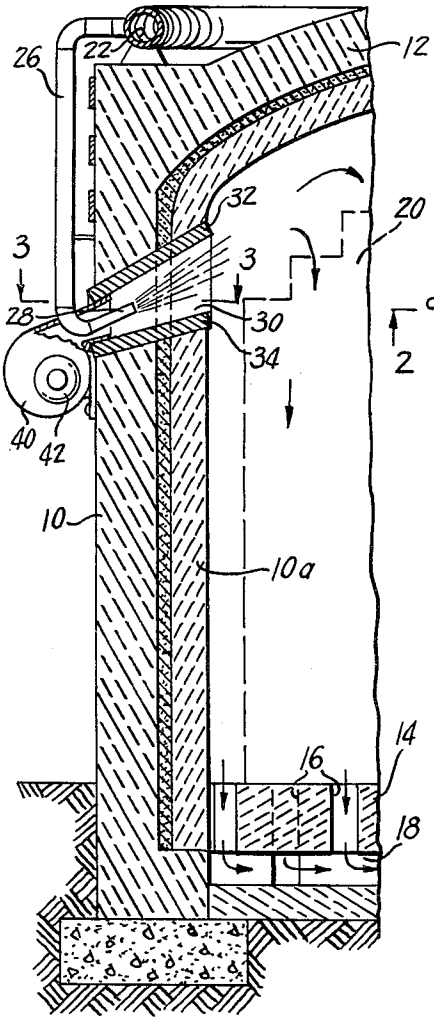


FIG. 2

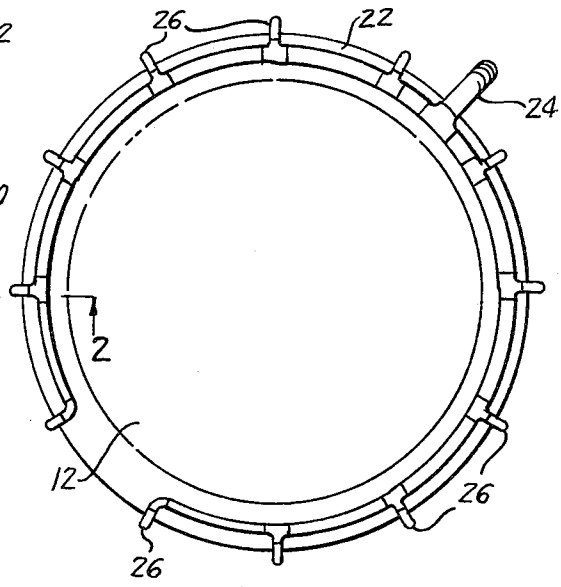


FIG. 1

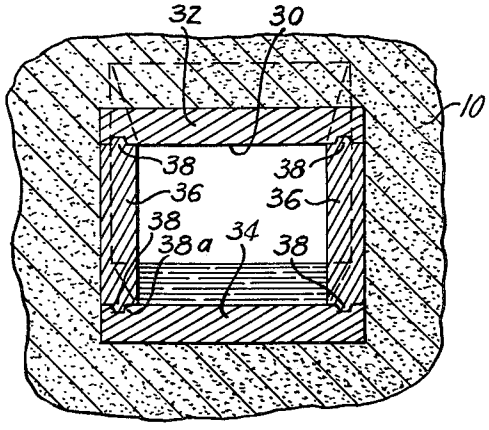


FIG. 4

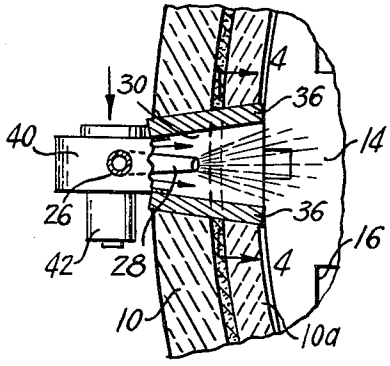


FIG. 3

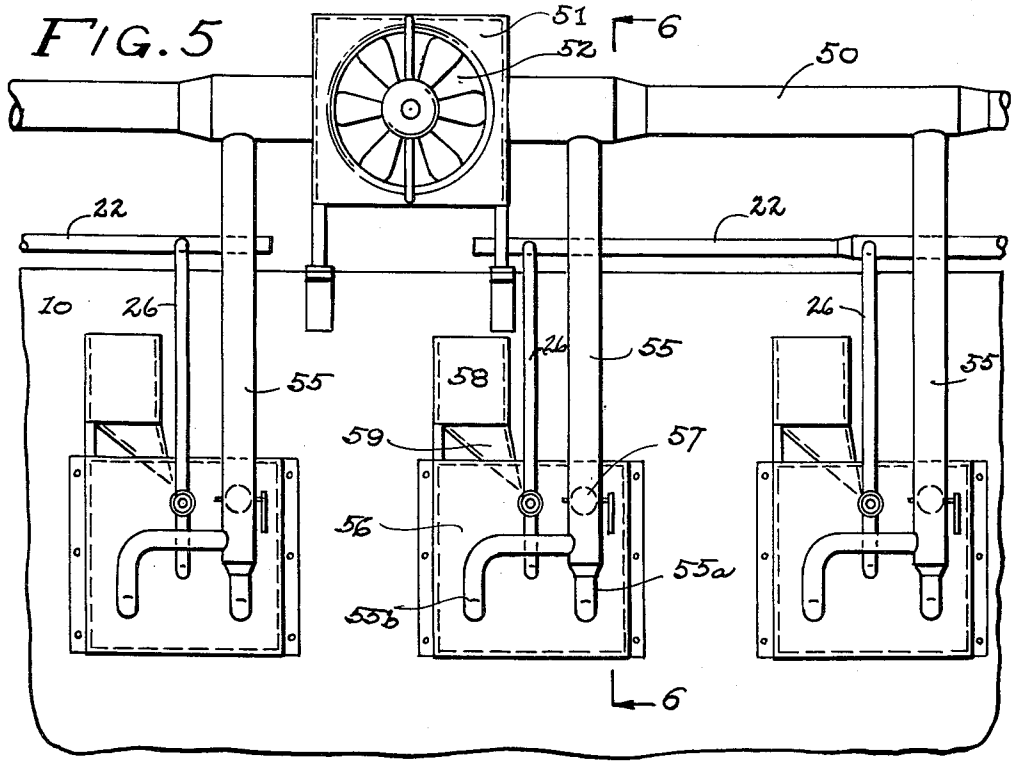
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FIG. 5



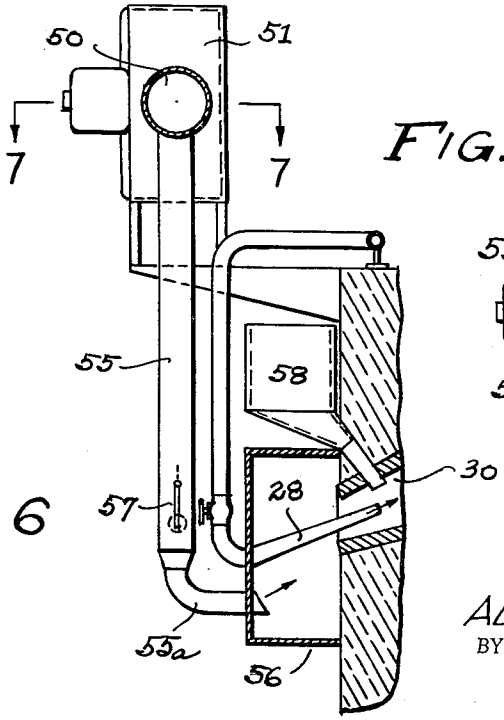
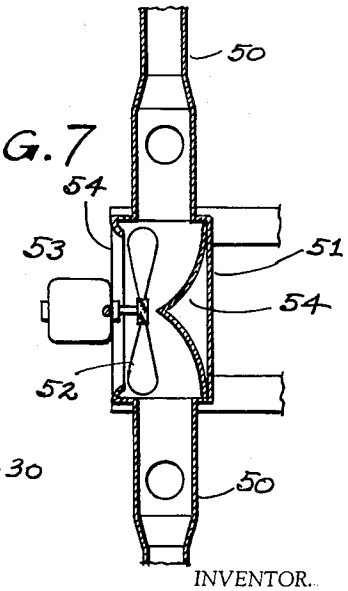


FIG. 6

FIG. 7



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GAS-FIRED KILN

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3 Claims. (Cl. 25—145)

This invention relates to kiln and oven constructions, and more particularly to gas-fired kilns of the down-draft type for calcining bricks, clay pipe or other clay products.

While the firing of kilns and ovens by various types of fuel, such as wood, coal, oil and gas, is common practice in the treatment of clay products, the results have not been altogether successful because of the difficulty in obtaining the proper circulation of the combustion gases in order to insure the complete and uniform heating of the products. In some instances the kilns are constructed so as to provide a series of upright, circumferentially-spaced, fuel boxes built into the side wall of the kiln chamber with the tops of the fuel boxes opening below and adjacent the roof of the chamber, causing the combustion gases to be directed vertically-upward against the roof near its outer edge. Such kilns, as exemplified by the patent of Walter B. Wright, Ser. No. 405,935, are subject to the objection that the concentrated streams of hot gases impinging against the roof produce hot spots that tend to rapidly burn out the lining, both along the side wall of the kiln as well as at localized areas of the roof. Furthermore, much of the heat of the gases is dissipated by reason of being absorbed by the kiln structure rather than usefully employed in heating the clay products.

In other types of kilns, as typified by the patent of John T. Underwood et al., No. 1,224,978, the hot combustion gases are directed centrally downwardly through the roof directly upon the clay products, so that the clay products stacked immediately below the inlet for the combustion gases are exposed to the full blast of the gases, which are reflected back against the roof, causing either overheating or underheating of the clay products, depending upon their position in line or out of line with the gas stream. In either case, the location of the combustion zone is such that the flow of the hot gases throughout the kiln is not conducive to the best performance of the kiln, even though means are provided, as suggested by the patents referred to above, intended to overcome the objections.

It is an important object of the present invention to provide a gas-fired kiln or oven of the down-draft type in which the hot combustion gases delivered by the gas-supply nozzles flood the top of the kiln chamber producing a zone of maximum temperature in the area below the roof of the kiln and above the stack of clay products to be calcined and without direct impingement upon either a portion of the kiln structure or upon the clay products being treated. Consequently, there is induced a substantially even and unobstructed flow of the gases downwardly over and through the stack which completely bathes the clay products in an atmosphere of hot gases and causes an even and thorough penetration of heat into such products.

Another object of the invention is to provide a gas-fired kiln or oven of the above character in which there is provided a plurality of laterally spaced burner units arranged in the wall of the kiln adjacent its roof for discharging hot combustion products inwardly of the kiln and towards its roof in a manner such as to promote the downward passage of the hot combustion products through the stack of clay products being fired.

Yet another feature of the invention is to provide a gas-fired kiln of the above character in which the wall of each of the burner units includes a plurality of removable, interfitting slabs, whereby the burner units may be easily relined as this becomes necessary from time to time.

Still another object of the invention is to provide a gas-fired kiln or oven of the above character which is of comparatively simple and inexpensive construction, which is efficient and cheap in operation, and which may be expeditiously built and installed, either as original equipment or by converting currently used types of kilns into kilns embodying the novel features of the invention.

The foregoing and other objects, advantages, and features of the construction will become apparent from a consideration of the following detailed description of a preferred embodiment of the invention considered in connection with the accompanying drawings, in which:

FIGURE 1 is a plan view of a kiln embodying the novel structure of the present invention;

FIGURE 2 is a vertical sectional view on an enlarged scale, of the kiln taken substantially upon a plane passing along section line 2—2 of FIGURE 1, illustrating the structural arrangement of one of the burner units in relation to the kiln;

FIGURE 3 is a transverse, plan sectional view taken substantially upon a plane passing along section line 3—3 of FIGURE 2, illustrating further structural details of a burner unit and its relationship to the kiln;

FIGURE 4 is a detailed sectional view taken substantially upon a plane passing along section line 4—4 of FIGURE 3, and illustrating, on an enlarged scale, the structural arrangement of the removable slabs of a burner unit,

FIGURE 5 is a side view of a portion of a kiln similar to that of FIGURE 6 but including certain modifications;

FIGURE 6 is a detailed view of the kiln taken on the line 6—6 of FIGURE 5; and

FIGURE 7 is a detailed top sectional view of the fan housing taken on the lines 7—7 of FIGURE 6.

For purposes of illustration, the present invention has been illustrated in connection with a cylindrical type of kiln having a dome-shaped roof. The kiln comprises a circumferential wall **10** closed at its top by a crown **12**, both the wall and crown being made of brick in the conventional manner and lined by some refractory material **10***a* to withstand and prevent loss of heat from the closed chamber. The bottom of the chamber is provided with a floor or hearth **14** formed of brick arranged in checker formation so as to define outlet openings **16** extending through the hearth. These outlets communicate with subflues or passageways **18** below the hearth which, in turn, lead to a chimney (not shown) outside the kiln. As shown in FIGURE 2, the clay products **20** (as indicated in broken lines) to be calcined are stacked or otherwise arranged in spaced and staggered relation on the hearth to permit the downward passage of hot combustion gases over, through, around and between the clay products for their complete exposure to the hot gases.

Mounted on the top of the crown **12** exteriorly of the chamber is an annular gas supply pipe or manifold **22** connected to a source of combustible gas by suitable pipe line **24**. At circumferentially spaced points around the supply pipe **22** there are connected down-pipes **26**. The annular pipe **22** does not extend completely around the top **12** of the kiln but has its ends spaced apart a distance equal to the circumferential spacing between adjacent down-pipes **26**.

As illustrated in FIGURES 2 and 3, each of the down-pipes **26** terminates in an inwardly directed and upwardly inclined burner nozzle **28** which is disposed within a burner orifice **30**. The burner orifice extends through the wall **10** of the kiln and communicates with the heating chamber adjacent to but below the inner surface of the crown **12**. As best illustrated in FIGURE 2, the longi-

tudinal axis of the orifice **30** is inclined upwardly and inwardly towards the crown **12** so that the hot combustion gases discharged from the orifice will initially be directed radially inward and at an upward inclination to produce a zone of maximum heat within the area below the crown and above the stack of clay products.

The burner apertures **30** pass completely through the wall **10** of the kiln and each aperture is lined with slabs defining a top wall **32**, a bottom wall **34** and side walls **36** all of which diverge from the outer end of the orifice located on the outer circumference of the kiln toward the inner end of the orifice located on the inner circumference of the kiln. The slabs constituting the two side walls **36** have longitudinal tongues or projections **38** thereon for reception in corresponding grooves **38***a* on the facing surfaces of the slabs forming the bottom wall **34** and the top wall **32**. Thus, by removing the trapezoidal-shaped slabs **32**, **34** and **36**, the lining for an entire burner orifice may be removed by simply knocking the slabs inwardly into the interior of the chamber. The tongue-and-groove interfit of the slabs facilitates the wedging assembly of the slabs in the burner orifices and subsequently maintains them against buckling during the operation of the kiln.

Surrounding each nozzle **28** is a space which forms an air flow passage. Such air flow may be induced by the combustion taking place in the chamber or when the kiln is to be operated under forced draft a centrifugal fan **40**, powered by an electric motor **42**, may be provided. The fan **40** may be of any suitable type, such as a squirrel cage fan or the like, and there may be a single fan for each burner unit; or, alternatively, there may be an air manifold with a single fan connected thereto for pressurizing the air. The air passing between the burner nozzle and the slabs lining the burner orifice tends to reduce the temperature upon the slabs and also serves to propel the hot combustion gases or flame into a zone located centrally of the chamber and below the top of the kiln. Thus, the hot combustion gases will pass downwardly over, through, around and between stacks of clay products supported on the hearth.

From the foregoing description, it will be apparent that the gases delivered by the burner nozzles **28** located in circumferentially spaced relation around the wall of the kiln will expand in their passage through the orifices **30** and be directed by such orifices upwardly and inwardly of the kiln chamber, filling the upper end of the chamber with flame and hot combustion gases and while avoiding direct impingement of the gases issuing from the orifices either upon any part of the kiln structure or upon the stacked supply of clay products. The hot combustion gases in their passage through the chamber to the outlets **16** in the hearth of the chamber will circulate over and through the stack, subjecting the exposed surfaces of the clay products to a thorough and uniform heating. Because only a minimum amount of heat is absorbed by the kiln structure, the major portion of the heat of the gases is usefully employed in heating the clay products with a resultant economy of fuel consumption and a reduction of the time required for kiln operation.

Moreover, the slabs **32**, **34** and **36** lining the burner orifices **30** may be quickly renewed when necessary by simply knocking out the burnt-out slabs and replacing them with new ones. The tongue-and-groove interfit between the slabs insures the proper initial erection of the slabs within the orifices as well as maintains the slabs against buckling under the high temperature of the kiln. If desired, the cracks between the slabs and the sides of the orifices may be sealed with a refractory cement.

The gas-fired burner assembly may be employed with various different types of kilns which may be either round, rectangular or the like, with the size of the gas burner nozzle being variable depending upon the capacity of the kiln. The details of the kiln per se have not been described since various kiln constructions are well known in the art and form no essential part of the present invention. This invention also is readily adaptable for converting present known types of kilns to the gas-fired type employing the burner assemblies in the manner described above.

As was stated above, there may be a single fan for each burner unit (or for certain of the several burner units) or there may be an air manifold requiring but a single fan for pressurizing the air. This latter modification is illustrated in FIGS. 5, 6 and 7 of the drawing in which the kiln corresponds in all other major respects to the kiln of FIGS. 1 through 4.

The air supply manifold according to this modification comprises a duct **50** skirting the circumferential edge of the crown **12** in generally concentric relation to the gas supply manifold **22**. The duct **50** does not define a closed circle but instead its circle is interrupted to provide space for a housing or plenum chamber **51** with which the duct communicates through openings in the two opposite side walls of the housing. A fan **52** is located within the housing **51** and is driven by an electric motor **53** to draw air into the housing through an inlet **54**, and to forcibly discharge it against a V-shaped deflector plate **54** which directs the air into the two ends of the communicating duct **50**. The duct **50** is thus supplied with air under pressure during operation of the kiln.

At radially spaced locations around the kiln, corresponding to the locations of the burner orifices **30**, drop pipes **55**, communicating at one end with the air manifold **50**, extend vertically downwardly upon the outside of the wall **10** of the kiln and terminate adjacent the burner orifices **30**. Each drop pipe **55** is divided at its lower end into two branches **55***a* and **55***b* which are directed inwardly of the kiln and pass through openings in an air box **56** closing the outer end of a burner orifice. Thus, air delivered by a drop pipe from the air manifold **50** is discharged into the air box and thence into the burner orifice in two streams of equal volume upon opposite sides of a burner nozzle **28**. For controlling the volume of air fed to each burner unit, there is provided a damper **57** which can be manually regulated to produce the desired heating conditions within the kiln.

In the manufacture of glazed earthenware it is customary to introduce a silica composition into the kiln atmosphere which will condense and form a film upon the surface of the products being treated. For this purpose a hopper **58** may be mounted exteriorly upon the kiln wall in the vicinity of, and preferably at an elevation above, each burner aperture for containing a supply of glaze composition. Each hopper **58** discharges at its bottom through a spout **59** that terminates within a burner aperture **30**. The fast moving air and gases passing through the burner aperture catch up and sweep the glaze composition into the kiln. A valve (not shown) may be provided for controlling the feed of glaze to the burner orifice. Such hoppers may also be used in the embodiment of the invention described in connection with FIGS. 1 through 4, since this feature is not dependent upon any special manner in which air is supplied to the kiln. Also it will be apparent that the air manifold may be arranged with respect to the kiln in other ways than that described above. For example, the air manifold may rest or be supported upon the crown **12** inwardly of the circumferential edge of the kiln adjacent to and concentric with the gas manifold **22**. Nor is it essential that all of the burner units be supplied with air under pressure but certain of the burner orifices, or all of them, may receive their supply of air by natural draft through unobstructed burner orifices. By providing a single fan for servicing all the burner units, instead of an individual fan for each burner unit, economy in the construction and operation of the kiln is achieved.

While this invention has been described in a specific form and as operating in a specific manner for the purpose of illustration, it is to be understood that the inven-

tion is not limited thereto, since various modifications will suggest themselves to those skilled in the art without departing from the spirit of this invention, the scope of which is set forth in the annexed claims.

I claim:

1. A gas-fired kiln for heat treating stacks of bricks and other clay products, comprising a substantially closed chamber having a continuous circumferential vertical side wall, a crowned roof having an arcuate interior surface shaped to produce a uniform downdraft of hot gases flowing into the interior of the chamber, a plurality of gas entrance ports located at equally spaced intervals laterally around the circumference of the chamber in the vertical side wall at an elevation just below the crowned roof, each of said ports extending entirely through the side wall in the form of a truncated pyramid so as to increase uniformly in cross-sectional area inwardly of the kiln and being inclined angularlly upwardly to direct the inflowing hot gases toward a zone just below the arcuate interior surface of the roof centrally thereof without impinging directly onto said surface, said ports having an easily removable and replaceable refractory lining composed of interengaging flat trapezoidal slabs mounted on each of the sides thereof, an injection nozzle for combustible gas positioned substantially centrally of each of said ports, and means for blowing air inwardly through the ports around the nozzles to support combustion of the gas therein.

2. The gas-fired kiln defined by claim 1, wherein the combustible gas is supplied to all of the nozzles simultaneously at a uniform flow rate through a manifold extending around the side wall of the kiln, and the means for blowing air inwardly through the ports is an individual fan mounted on the exterior of each port.

3. The gas-fired kiln defined by claim 1, wherein a first manifold extending around the side wall of the kiln supplies the combustible gas to all of the nozzles simultaneously at a uniform rate, and a second manifold extending around the kiln and having a fan therein constitutes the said means for blowing air inwardly through the ports around the nozzles.

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