

Sept. 21, 1965

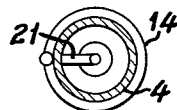
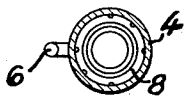
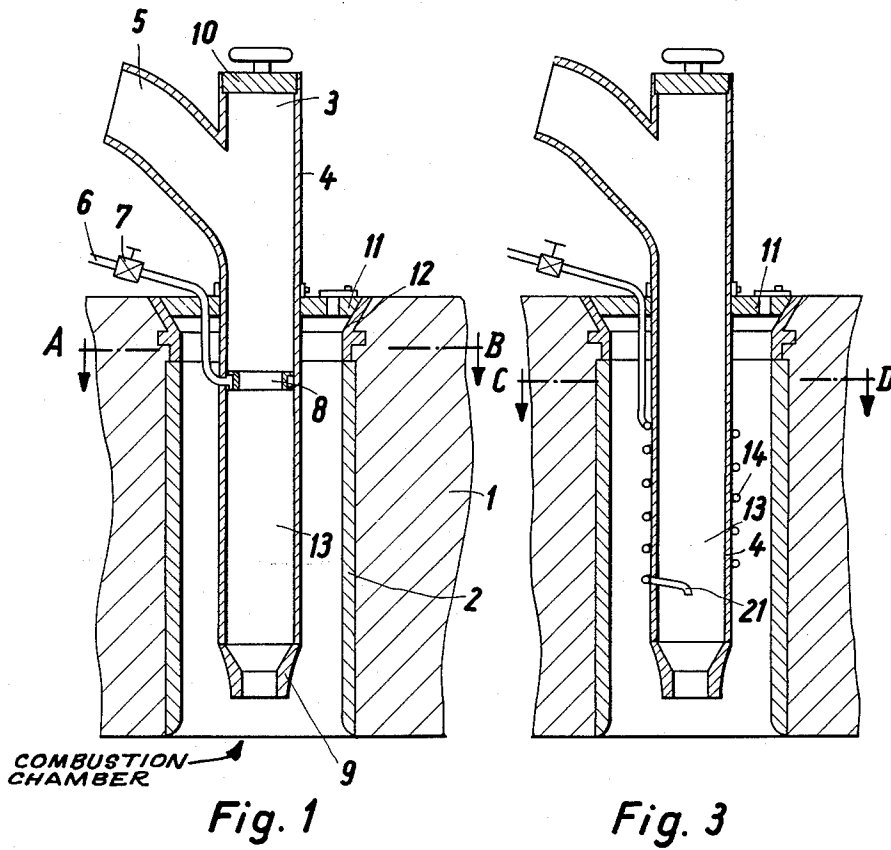
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3,207,202

BURNER FOR FURNACES

Filed Sept. 5, 1963

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

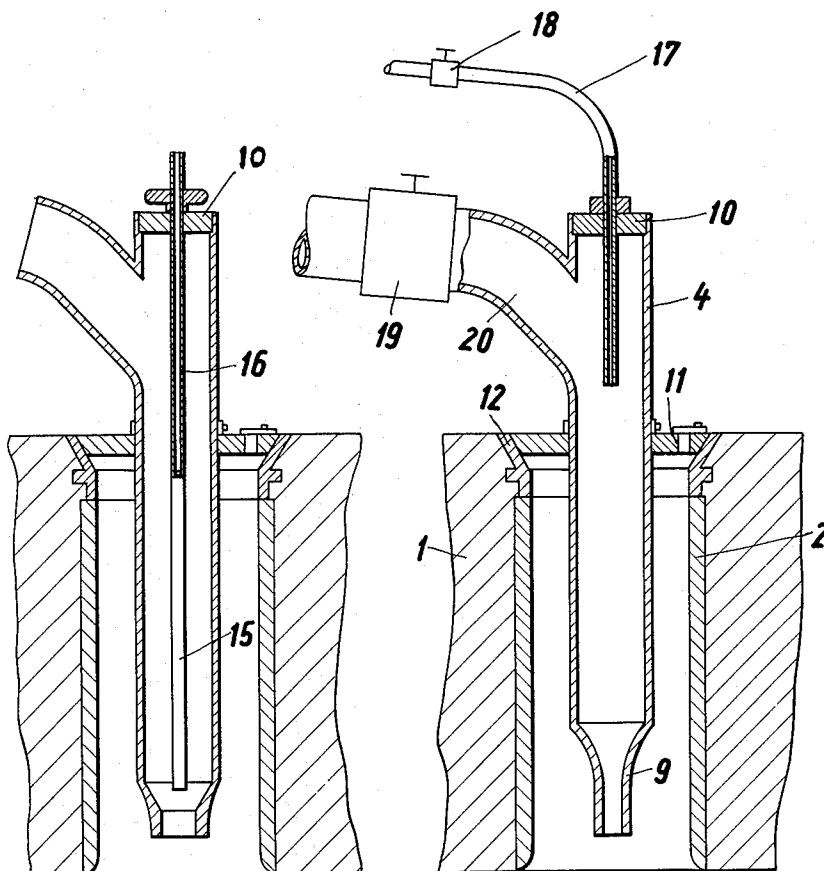


Fig. 5

Fig. 7

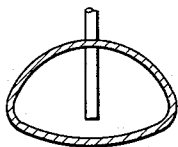


Fig. 6

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BURNER FOR FURNACES

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L 43,711

10 Claims. (Cl. 158-4)

This invention relates to a furnace for use in kilns, preferably of the ceramic industry, and it relates more particularly to an oil burner for such furnace. However, the invention is also useful in furnaces with burners which employ gaseous fuels. In this connection, the term "gaseous fuel" is to include combustible gases as well as other types of fuel, as for example, pulverized coal.

In furnaces which are purely the oil type, the fuel oil is vaporized or atomized and a combustible mixture is then formed in the combustion space or chamber of the kiln by means of an air stream. Several systems are known for producing such combustible mixture. For example, pressureless feeding of the fuel oil to the combustion space or chamber, allowing the oil to drip into the kiln, has been employed. Combustion then takes place on a pan disposed within the combustion space or chamber which, therefore, is heated to a high temperature.

The disadvantage of this system lies in the fact that the fuel oil is inadequately distributed so that it can burn only superficially and incompletely. As a result, an excessive amount of fuel is required, with heavy soot formation and local overheating in the combustion chamber taking place.

In another known type of burner, the fuel oil is injected through nozzles into the combustion space or chamber at a greater or lesser pressure. In such burners, the injection nozzle is, as a rule, surrounded by a concentric nozzle through which the air of combustion is supplied. In this known type of burner, the oil is mixed with the air of combustion outside of the burner during the combustion process, in the combustion space or chamber itself. As a result, the nature of the combustion process varies along the length of the flame, because a sufficiently homogeneous gas-air mixture cannot be produced in the combustion space or chamber. Aside from its uneven composition, the flame of such a burner is also characterized by considerable differences in temperature.

As a matter of fact, the use of a burner of this type in kilns of the ceramic industry involves great disadvantages, due to the fact that the firing process of the wares placed in the kilns is not a heating and drying process alone; rather, chemical processes take place at the same time in the wares being fired. Depending on the analysis and nature of the wares to be fired, there are involved either oxidation or reduction processes, for which the composition of the burning mixture is decisive. Any change in the composition of said mixture, its homogeneity or the flame temperature entails an undesirable change in the ware being fired or at least, its surface. Even under the most favorable conditions, uneven firing of a product results, and in most instances such uneven firing leads to an undesirable amount of rejects.

The disadvantages are still greater in the burners referred to as impulse type burners, which have been introduced in order to permit the use of larger nozzles in intermittent, as against continuous, service. Although these burners are less susceptible to trouble than burners of the continuous type which use smaller nozzles, they have considerable difficulty where a uniform temperature throughout a zone of substantial length is to be obtained by distributing a major number of burners in the combustion space or chamber.

In addition, such burners have the disadvantage that the variations in the firing atmosphere are aggravated still more

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by the fact that the fuel oil is supplied intermittently and the oxygen continuously, such that the flame may vary from a purely reducing to a purely oxidizing condition.

In summing up, the disadvantage of all these known types of burners is that the changes in the flame condition and temperature as described above are due to the fact that the fuel and the air of combustion are mixed only in the combustion space or chamber proper. Therefore, most of the fuel oil will have already burned during its free fall into the combustion space or chamber, while part of it will burn where it impinges on the ware being fired. Thus, uniform firing with the desired chemical processes involved cannot be accomplished with the known types of burners.

The present invention has as its object to provide a burner and hence, a furnace for kilns of the ceramic industry in which the above-mentioned disadvantages are avoided.

Used as a basis is a burner for use with furnaces of the ceramic industry employing a liquid or gaseous fuel, which in other words is fluid, said burner consisting of a burner tube serving to supply both the fuel and the air of combustion. According to the invention, said burner tube is introduced into the combustion space or chamber to a depth where its open end is heated by the radiation of the incandescent combustion space or chamber. Furthermore, at least the heated end of said burner tube forms a chamber for thoroughly mixing the fuel and the air of combustion.

Thus, the burner tube of the burner is disposed sufficiently close to the combustion space or chamber of the furnace to ensure enough heating of the end of the burner tube in which the mixing of the fuel and the air of combustion takes place. Only then is the intimate fuel mixture forced into the combustion space or chamber. Thus, a uniform flame of constant temperature and a homogeneous composition of the fuel mixture is obtained. The disadvantages inherent in the known types of burners are thereby avoided.

In carrying out the invention it is recommended that the burner tube be provided at its end facing the combustion space or chamber with an outlet nozzle through which the fuel-air mixture enters the combustion space or chamber. Conveniently the straight burner tube, which projects into the combustion space or chamber, is provided with a removable cover at its end opposite the outlet nozzle. This has the advantage that the burner tube is relatively easy to clean from the outside.

The supply lines for the air of combustion and, if necessary, the fuel, enter the burner tube laterally. The points of entry of said lines must be located before the heated zone of the combustion space or chamber.

Moreover, the burner tube is conveniently surrounded by a coaxial fire tube mounted permanently in the wall of the combustion space or chamber. It is advisable to make at least the burner tube end facing the combustion space or chamber of heat-resistant material, especially steel or ceramic material.

If a burner according to the invention is designed for use with liquid fuels, particularly oil, a fuel supply line according to a further development of the invention is provided, said fuel supply line entering the burner tube section between the outlet nozzle and the combustion air supply. Within the burner tube, means are provided at this point to effect even distribution of the liquid fuel over all of the inner surface of the burner tube. Said means may consist, for example, of a distributor ring incorporated in the burner tube at the point of entry of the liquid fuel.

With this embodiment of the invention, accurate control of the fuel oil supply is possible by supplying the fuel

oil to the burner at low pressure with the use of nozzles, and by distributing the oil as a film over the inner surface of the burner tube, said film in flowing toward the heated end of the burner tube being heated to the point of vaporization and taken over by the air stream being introduced into the burner tube. The air stream is likewise heated in the burner tube, so that a perfect mixture with the combustible vaporized oil is obtained. At the tube end, said mixture is blown into the combustion space or chamber for combustion through a nozzle-like, necked-down portion of the burner tube. Thus, vaporization of the fuel oil and simultaneous addition of the heated air within the burner tube permits perfect preparation of the combustible mixture.

In another embodiment of the invention, the fuel supply line may also envelop the burner tube in the form of a coil with the end of said coil entering the burner tube before the outlet nozzle, so that uniform mixing of air of combustion and vaporized oil is again ensured.

Where gaseous fuels are employed, it is advisable to provide a supply pipe introduced into the burner tube through the end cover, said supply pipe being of sufficient length to have its outlet opening directly before the heated zone of the burner tube.

Generally, the burner tube, whether operated with liquid or gaseous fuels, is mounted in a cover plate so as to be axially movable. In this manner, adjustment of the burner relative to the combustion space or chamber and hence adjustment of the temperature of the heated burner tube section, is possible.

The simplicity of construction of burners according to the invention and of the entire firing system enables a larger number of burners to be used, as they are relatively low priced and absolutely dependable in operation. Said burners may be conveniently incorporated in the ceiling of the combustion space or chamber so that the combustion gases are blown vertically from the ceiling to the floor and thorough circulation of the firing gases in the combustion space or chamber is accomplished. At the same time, by providing a large number of burners uniform heating of a large firing zone is obtained, a condition essential in mass production in a ceramic industry.

The invention is described more particularly in connection with the accompanying drawings which show embodiments of the burner according to the invention in which:

FIGS. 1, 3, 5 and 7 are longitudinal sectional views of burners incorporated in the ceiling of a combustion space or chamber, FIGS. 1, 3 and 5 showing burners operated with liquid fuel such as oil, and FIG. 7 showing a burner operated with gaseous fuels;

FIG. 2 is a cross-sectional view taken along the line A-B of the burner tube shown in FIG. 1;

FIG. 4 is a cross-sectional view taken along the line C-D of the burner tube shown in FIG. 3; and

FIG. 6 is a cross-sectional view of another modification of a burner tube in accordance with the invention.

In the embodiment shown in FIG. 1, a fire tube 2, through which the burner tube 4 extends, is incorporated in the kiln ceiling 1, only part of which is shown. The air supply pipe 5 enters the upper section 3 of the burner tube 4. The upper end of the burner tube 4 is provided with an end cap 10 permitting easy cleaning of the burner. The fuel oil is supplied through a line 6 incorporating a control cock 7. The fuel line 6 enters the burner tube 4 shortly before the heated zone thereof. In order that the oil fed through the line 6 be evenly distributed, an oil distributor ring 8 is provided so that the oil supplied flows along the inner surface of section 13 of the burner tube 4 in an evenly distributed condition. The burner tube 4 itself is carried in a cover plate 11 fitted in a mounting flange 12 and is adapted to be moved in the direction of its axis so that it projects just sufficiently into the fire tube 2 for the lower section 13 of the burner tube to be heated sufficiently. The oil heated up in this

manner as it flows along the tube inner wall, is vaporized and simultaneously mixed with the air of combustion supplied through the pipe 5.

The intimately mixed product is then blown into the combustion space or chamber through the nozzle 9.

In the embodiment shown in FIG. 3, the fuel oil is fed in a different manner, but aside from this the construction corresponds to that of FIG. 1. In this case the fuel oil is fed through a supply coil 14 enveloping the lower section 13 of the burner tube 4 with the end 21 of coil 14 entering section 13 near the lower end of the burner tube 4. Thus, oil which has already been vaporized in coil 14 enters the space 13 and, as in the embodiment shown in FIG. 1, is intimately mixed in said lower section with the air of combustion supplied.

In the embodiment shown in FIG. 5, fuel oil is supplied through a supply pipe 16 extending through the burner tube end cap 10. Said supply pipe ends approximately in the central section of the burner tube. Provided adjacent to, and axially of, the supply pipe outlet opening is a rod 15, along whose outer surface the oil exuding from the pipe 16 can flow thereby vaporizing in the burner tube lower section. The air supply is controlled in the same manner as in the embodiments shown in FIGS. 1 and 3, so that in like manner, the oil vapor is well mixed with the air of combustion in the burner tube lower section.

Conveniently the burners of the type described above are operated by inserting the burner tube into the heated combustion space or chamber through the fire tube 2 sufficiently for the burner tube lower end to be heated to the most favorable operating temperature. The oil supply is next opened and the amount of oil supplied adjusted to the value required for obtaining a favorable mixture for combustion. Simultaneously, the air supply is opened. Depending on the size of the combustion space or chamber, the air is supplied at a gauge pressure of approximately 4" to 20" of water (H_2O) in order to obtain a blowoff rate ensuring dependable circulation of the emerging combustion gases from the kiln ceiling to the bottom of the combustion space or chamber. In this manner, uniform combustion throughout the cross-sectional area is obtained.

The burner system described can be employed also in conjunction with horizontal injection into the combustion space or chamber. Conveniently used in this connection is a burner tube corresponding to the cross-sectional view of FIG. 6, said burner tube being of flattened construction in order to offer a sufficiently large heating surface for the fuel oil flowing to the blow-off point in the inclined burner tube. By arranging the nozzle in suitable manner, the fuel and air may be blown off horizontally or at any desired other angle.

FIG. 7 illustrates a burner system which is to be used with gaseous fuels. For this purpose a feed pipe 17 is provided, said feed pipe being introduced into said burner tube through the end cover 10 thereof. The feed pipe 17 contains a valve 18. As in the aforesaid examples combustion air is introduced through a pipe 20 with a valve 19.

It seems convenient where several burners are employed to reduce the output thereof in the interest of uniform firing. Overheating of individual zones is thus excluded and a particularly favorable firing pattern for ceramic products is obtained.

In conclusion, it is pointed out that while this invention is intended specifically for kilns as used in the ceramic industry, it can be applied also to furnaces as used, for example, in steel mills, heat treating shops, etc.

What is claimed is:

1. A burner for a furnace having heat-insulating walls of substantial thickness defining a combustion chamber, comprising a fire tube disposed through a wall of said combustion chamber, a burner tube which is closed at one end and has a restricted nozzle at its outlet end for

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feeding both fuel and air of combustion simultaneously to said combustion chamber, said burner tube being mounted within said fire tube in circumferentially spaced relation therewith, the outlet end of said burner tube terminating within said fire tube adjacent the inner surface of said furnace wall such that the outlet-end section of said burner tube is heated by radiation from the fired combustion chamber, whereby said outlet-end section of said burner tube forms a heated mixing chamber for the intimate mixing of the fuel and air prior to being forced through said nozzle into said combustion chamber, fuel supply means connected to said burner tube and terminating therein upstream of said nozzle, an air duct connected to said burner tube for furnishing air thereto under pressure, and means including a support member adjacent the outer end of the fire tube for adjustably mounting said burner tube for movement axially within said fire tube in order to regulate the temperature of the combustible mixture of fuel and air within the heated outlet-end of said burner tube.

2. A burner as claimed in claim 1, wherein said burner tube is straight and is provided with a removable end cover at its end opposite said combustion chamber.

3. A burner as defined in claim 1, wherein said air duct enters said burner tube laterally for feeding the air of combustion into said burner tube.

4. A burner as claimed in claim 3, wherein said fuel supply means includes a supply line for a gaseous fuel extending into said burner tube through its end opposite said combustion chamber, said fuel supply line being of sufficient length for its outlet opening to be located intermediate said air supply duct and the combustion chamber end of said burner tube.

5. A burner as defined in claim 1, wherein the fuel employed is a liquid and which further includes fuel distributor means arranged within said burner tube in cooperation with said fuel supply means for distributing said liquid fuel over the inner surface of said burner tube.

6. A burner as claimed in claim 5, wherein said distributor means comprise a ring incorporated within said burner tube at the point of entry of said fuel supply means.

7. A burner as claimed in claim 1, wherein said fuel supply means includes a fuel supply line disposed around said burner tube in the form of a coil, with the end of said coil entering said burner tube intermediate its ends.

8. A burner as claimed in claim 1, wherein said burner tube is of flattened, approximately elliptic cross section.

9. A burner as claimed in claim 1, wherein the fuel employed is a liquid and a fuel supply line is introduced into said burner tube through the end thereof opposite its outlet end, a rod being provided at the outlet of said sup-

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ply line extending along the heated zone of the burner tube such that the exuding liquid fuel flows along the circumference of said rod and is vaporized while being simultaneously mixed with the air of combustion.

10. A furnace arrangement for a ceramic kiln having heat-insulating walls of substantial thickness defining a combustion chamber, a plurality of burners mounted in the walls of said combustion chamber, each of said burners having a fire tube disposed through a wall of said combustion chamber, a burner tube which is closed at one end and has a restricted nozzle at its outlet end for feeding both fuel and air of combustion simultaneously to said combustion chamber, said burner tube being mounted within said fire tube in circumferentially spaced relation therewith and with the outlet end of said burner tube terminating within said fire tube adjacent the inner surface of said furnace wall such that the outlet-end section of said burner tube is heated by radiation from the fired combustion chamber, whereby said outlet-end section of said burner tube forms a heated mixing chamber for the intimate mixing of the fuel and air into a combustible gas mixture prior to being forced through said nozzle into said combustion chamber, fuel supply means connected to each of the burner tubes of said burners and terminating within each burner tube upstream of its nozzle, an air duct connected to each of said burner tubes for furnishing air thereto under pressure, and means including a support member adjacent the outer end of the fire tube adjustably mounting each of said burner tubes for movement axially within its fire tube in order to regulate the temperature of the combustible mixture of fuel and air within the heated outlet-end section of said burner tube, the blow-off pressure of said gases of combustion from said burners being set for said gases to flow completely throughout said combustion chamber.

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