May 2, 1961 E. W. DRAKENGREN 2,982,530

DEVICE FOR OPERATING CERAMIC KILNS

Filed Feb. 27, 1957 3 Sheets-Sheet 1

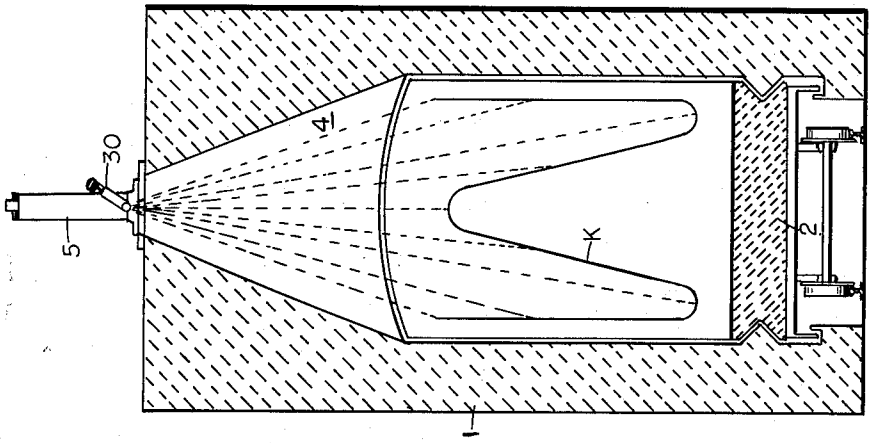

FIG. 2

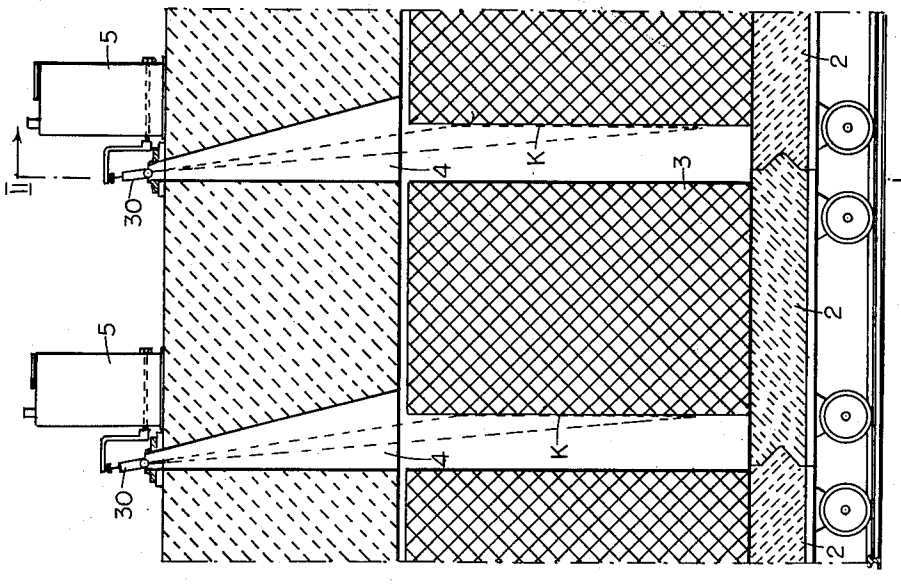

FIG. 1

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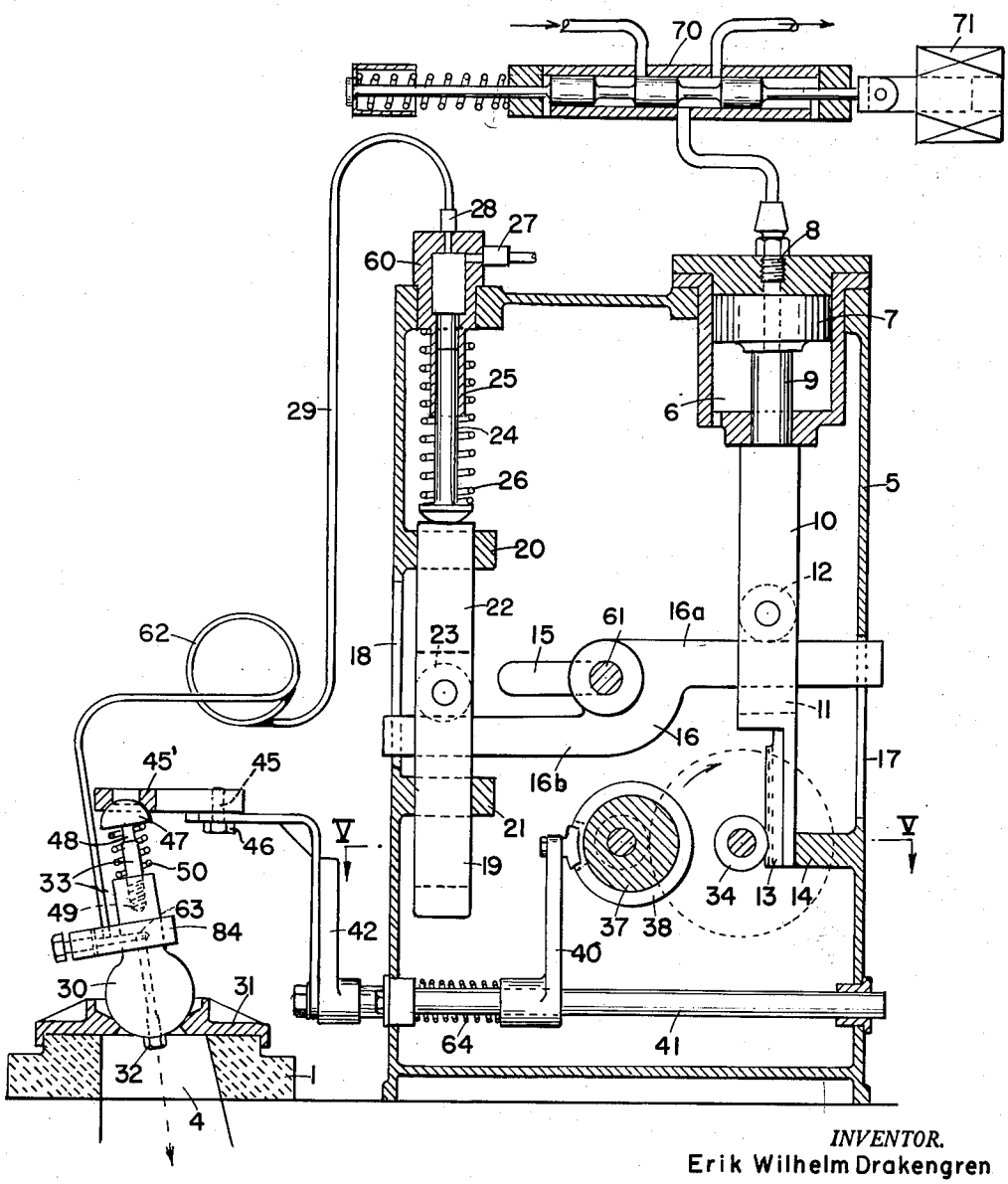

FIG. 4

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DEVICE FOR OPERATING CERAMIC KILNS

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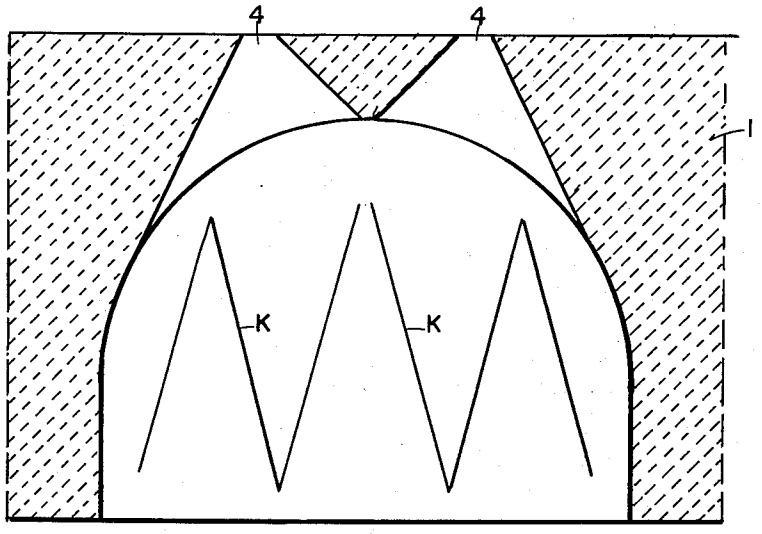

FIG. 3

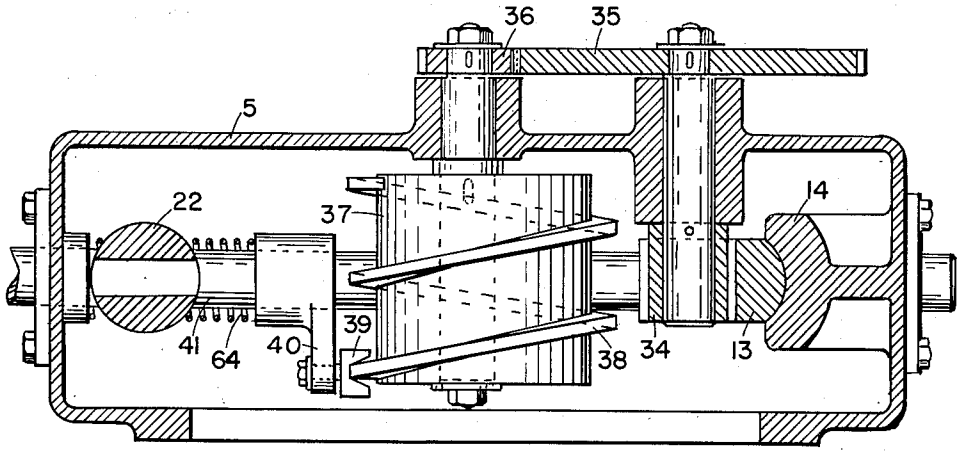

FIG. 5

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DEVICE FOR OPERATING CERAMIC KILNS

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Claims priority, application Sweden Mar. 3, 1956

6 Claims. (Cl. 263—28)

This invention relates to ceramic kilns, and specifically to the devices of supplying and distributing the fuel which is necessary for operating such kilns.

It is known by prior art in the ceramic industry to use kilns with direct injection of liquid fuel to the ceramic articles to be burnt. This liquid fuel is injected into the kiln, which may be either a tunnel kiln or an annular kiln, onto the articles which are preheated beyond the flash point of the fuel.

In kilns of this kind preferably burners are used which are disposed in the ceiling of the kiln and to which the fuel is supplied under a suitable pressure and through which the fuel is injected into the kiln, whereby it is finely dispersed and ignited. The heat thus generated is transmitted to the articles in the kiln, whereby the burning of said articles is achieved. Burners of this kind, however, have the disadvantage, that the heat is not distributed uniformly over the entire area of the kiln and that zones will appear in which the articles are unsatisfactorily burnt, thus causing rejections and waste. In order to avoid these disadvantages it has been proposed to arrange a plurality of burners, each of which must be adjusted manually so that the fuel spray from the various burners may strike the articles in various directions.

It is achieved by the present invention that the fuel and thus the generated heat approximately are equally distributed in the kiln, but on the other hand, the substantially increased costs for providing the necessary amount of burners in such plants are a disadvantage, disregarding the increased operating expenses due to the manual adjustment of the burners.

An object of the present invention is to provide for new and improved means to avoid the disadvantages of the high costs of installing a plurality of stationary burners and to avoid the high labor costs of operating the kiln, without abandoning the advantages of burners which are adjustable in various directions.

Another object of the invention is to provide for contrivances for automatically and intermittently injecting fuel in kilns of the kind in question.

Yet another object of the invention is to provide for fuel injection means for spraying said fuel at each injection onto the ceramic articles at a continuously varying angle or sequence of directions, whereby each cycle of injection will have the same sequence of directions as the preceding injection.

Furthermore, the invention has for its object to provide for means which are easily operated and supervised.

Various further and more specific purposes, features and advantages will clearly appear from the detailed description given below taken in connection with the accompanying drawings which form part of this specification and illustrate merely by way of example one embodiment of the device of the invention.

The invention consists in the novel parts, construction arrangements, combination and improvements herein shown and described.

In the following description and in the claims, parts will

be identified by specific names for convenience, but such names are intended to be as generic in their application to similar parts as the art will permit. Like reference characters denote like parts in the several figures of the drawings, in which:

Fig. 1 shows a longitudinal section of a tunnel kiln equipped with the fuel injection means;

Fig. 2 is a section along the line II—II in Fig. 1;

Fig. 3 shows a section of an annular kiln;

Fig. 4 is a vertical section of a preferred embodiment of a burner arrangement according to this invention;

Fig. 5 is a horizontal section along the line V—V in Fig. 4.

Referring now in more detail to the drawings illustrating a preferred embodiment by which the invention may be realized, there is in Figs. 1, 2 and 3 a kiln having a ceiling **1**, in which, in a known manner, ceramic articles **3**, for example bricks piled on trucks **2**, are carried through. These articles are preheated beyond the flash point of the liquid fuel which is injected into the kiln. In the ceiling of said kiln, burner openings **4** are provided which have a trapezoidal shape in the section extending lengthwise of the kiln, whereby the long basis line of the trapeze is in the plane of the ceiling. The walls of said openings extending in the direction of the movement of the tunnel trucks are arranged at right angles with the basis line, while the opposite walls form an angle less than 90° with the basis line, so that the burner opening is tapered in the upward direction. The basis line is somewhat longer than the distance between two piles of bricks loaded on two consecutive trucks. In the transversal direction of the tunnel kiln the burner opening extends over the entire width of the kiln and is tapered upwardly in a way similar to the other direction.

The burner openings of which two only may be needed, are arranged in such way that the distance between the vertical walls of the openings corresponds to approximately the length of one tunnel truck. In annular kilns, according to Fig. 3, two burner openings also are provided which have the shape of upwardly tapered oblique cones.

Figs. 4 and 5 illustrate how the burners are placed above the burner openings including the device for the automatic supply of the liquid fuel. A cylinder **6** is provided in a housing **5**, in which cylinder a piston **7** slides up and down by means of a pressure medium supplied through an orifice **8**. The piston rod **9** of the piston **7**, which is guided at the lower end of the cylinder **6**, extends outside of the cylinder into a downwardly directed rod **10** which has a longitudinal slot **11** extending approximately over half its length, said slot holding rotatably a roller **12**. On its lower end the rod **10** is provided with a rack **13** which is guided by a bearing **14** inside the housing **5**. When the piston is operated by a pressure medium entering through the orifice **8**, supplied by any one of the well known hydraulic or pneumatic pumps (not shown in the drawings), controlled by a hydraulic or pneumatic valve means **70** operated by a solenoid **71** which may be actuated by any of the well known adjustable timer means (not shown in the drawings), the piston rod **9** will move downwards together with the rod **10**, whereby the roller **12** will move a double-arm lever **16** which is pivotally mounted on a stud **61** which is movable in slots **15** in the side walls of the housing **5**. The arm **16***a* of the double-arm lever is inserted into the slot **11** of the rod **10**. The other arm **16***b* cooperates with a fuel pump **60**. The lever arms **16***a* and **16***b* also are guided in vertical slots **17** and **18**, respectively, arranged in the walls of the housing **5**.

The lever arm **16***b* extends into a slot **19** of a rod **22** which is axially movable in bushings **20** and **21** on the inside of housing **5**. The lever arm **16***b* is operated by means of a roller **23** rotatably held in the slot **19** of the

rod 22. The upper end of the rod 22 is in contact with the lower end of a piston 24, the upper end of which operates in a fuel pump cylinder 25 which is located in the upper part of the housing 5. The piston 24 is urged downwardly by a compression spring 26. The pump piston 24 will be moved upwardly against the force of said spring 26 by the lever arm 16*b* in the pump cylinder 25 into which liquid fuel is supplied through a pipe line 27 from a fuel tank (not shown in the drawings).

By the upward movement of the pump piston 24, fuel will be supplied to the burner via a pressure valve 28 and a pipe line 29. The said spring 26 serves for moving the entire mechanism back to its original starting position upon the release of the pressure medium in cylinder 6 effected by the aforementioned timing controls of the hydraulic or pneumatic drive means.

The said burner comprises a spherical portion 30 which is closely fitted in a socket bearing 31 which in turn is firmly connected to the ceiling of the kiln. The spherical portion holds a fuel nozzle 32 directed into the burner opening 4. On the other side of the spherical portion 30 is an extension 33 around which a ring 84 is fitted which has internal passages 63 leading to the nozzle 32 and to a connection to a pipe line 29 connected to the pressure valve 28 of the fuel pump. The pipe line is wound to a loop 62 so that it easily may follow the movements of the burner parts 30, 33. These movements are caused by the piston 7, the rod 10 and the rack 13 in the following way.

When the rack 13, which is in mesh with a gear 34 rotatably located on a side wall of the housing 5, is moved in a downward direction by the piston 7, the gear 34 will rotate in the direction of the arrow, and with it a gear 35 mounted on the same shaft as the gear 34. The gear 35 meshes with a gear 36 located on the side wall of the housing 5. On the shaft of said gear 36 a barrel cam 37 is fixed which is eccentric relative to the gear 36. Thus the movement of the rack 13 is transmitted to the barrel cam 37 for a rotational, or more correctly, for an oscillating movement. The said barrel cam 37 has a helical ridge 38 which serves as a guiding means for a grooved shoe 39 which is held rotatably on the end of a lever 40, said lever being keyed to a shaft 41 which is arranged rotatably and axially movable in the housing 5. A compression spring 64 is provided on the shaft between the bushing in the housing and the lever 40, said spring forcing the grooved shoe 39 to bear upon the helical ridge 38 on the barrel cam 37.

When the barrel cam 37 performs its eccentric rotational movement which is limited by the length of the stroke of the piston 7, the lever 40 will by means of the grooved shoe 39 which is guided by the ridge 38 on the barrel cam 37, not only perform a swinging, but also a reciprocating movement in the axial direction of the shaft 41, which movements are compounded to an oscillating movement which is transmitted from the shaft 41 to the fuel nozzle 32 as follows:

On the free end of the shaft 41 which projects through the wall of the housing 5, there is a lever 42 similar to the lever 40 which, at a distance from the center of the shaft equal to the length of the lever 40, is bent at a right angle. On this right-angle portion of said lever 42 a slot 45 is provided, and on the upper side of said extension a bar 45′ is mounted which by means of a bolt 46, slidably arranged in said slot 45, may be adjusted to various distances from the lever 42. On the underside of its free end the bar 45′ has a spherical bearing seat in which a semispherical member 47 is rotatably held, which is provided with a stem 48 inserted in a bore 49 in the extension 33 of the burner 30, the said extension being coaxial with the fuel nozzle 32. In order to maintain a satisfactory contact between the member 47 and the spherical bearing seat on the bar 45′ there is a compression spring 50 between the underside of the member 47 and an abutment on the extension 33.

It will be understood that the oscillating movement of the lever 40 which is guided by the barrel cam 37, is transmitted by means of the lever 42 and its extension 45′ to the burner which is resiliently held by said spring 50 between the burner seat 31 and the said extension 45′, so that a corresponding oscillating movement is imparted to the axis of the fuel nozzle 32 and thereby to the fuel spray, and that the fuel spray covers the areas within the confines "K" indicated in Figs. 2 and 3 during the injection, while the fuel spray also may penetrate the spaces between the tunnel trucks.

The fuel quantity supplied by the fuel pump 25 may be adjusted by displacing the pivot axis of the double lever 16 in the slots 15. Thereby, the piston 24 will have a shorter or longer stroke which, however, always will start and end together with the movement of the operating piston 7, the stroke of said piston being invariable.

If required, the nozzle 32 may be water-cooled.

The advantages obtained by the installation of the device may be summed up as follows:

One single apparatus according to the invention does the work of a plurality of devices as hitherto used, whereas the costs of an apparatus according to this invention are reasonably low. By means of the apparatus of the invention the liquid fuel will be better gasified, and consequently the combustion will be improved, since the fuel spray constantly changes its direction during the entire process of injection. The improved gasification will have the effect that the articles, which have to be burnt and which are touched by the fuel spray, never will be cooled, which offers the advantage that the articles never will be discolored, since they do not come in touch with fuel in a liquid state.

Furthermore, the fuel gases will be distributed satisfactorily within the kiln space so that damage to the articles due to local superheating are avoided. The combustion air entering from the cooling zone in the kiln is preheated and equally distributed over the kiln section, and consequently the fuel will be more uniformly distributed in the kiln, so that the kiln may be operated at a higher speed or its dimensions may be reduced obtaining the same production as in a larger kiln. Thus the costs for the erection of the kiln are reduced.

The fuel quantity for each injection may be adjusted by means of the apparatus within a wide range. Equally the angles under which the liquid fuel is injected into the kiln may be easily adjusted.

It is understood that the invention is not to be limited to the embodiment herein described and shown in the drawings as a preferred embodiment which gives satisfactory results, but the details may be varied and combined in various ways without limiting or surpassing the scope of the claims. Thus the means 7 and 8 which operate the rack 13, may be substituted by any other mechanical or electrical means, which are adapted directly or indirectly to influence the barrel cam in the necessary intervals in order to transform the required intermittent and eccentric movement into an oscillating movement of the fuel nozzle 32.

What I claim as new and wish to protect by Letters Patent is:

1. In a kiln in which ceramic articles are moved to be burnt, an apparatus comprising a plurality of burners having burner nozzles located along and directed toward the path of movement of said articles in the kiln, means for mounting each of said burner nozzles for permitting a universal movement of said nozzles, means for periodically oscillating each of the burner nozzles to periodically change the axial direction thereof, each of said burner nozzles oscillating means comprising a lever mounted for rotary oscillation and reciprocation longitudinally of its axis of rotation, means connecting the lever to the burner nozzle to produce a component of angular movement of the burner nozzle in a plane transverse to the direction of movement of said articles upon rotary oscillation of

said lever and to produce a component of angular movement of the burner nozzle in a plane parallel to the direction of movement of said articles upon reciprocation of said lever on to axis of rotation, power drive means, transmission means connecting said power drive means and said lever for effecting said rotary oscillation and axial reciprocation, and means for projecting fuel from each of said burner nozzles toward said path of movement for a timed interval during the oscillation of each burner whereby said fuel is relatively evenly distributed over said articles during their movement through the kiln.

2. Apparatus according to claim 1, said transmission means comprising a rotary eccentric cam driven by said power drive means, and a cam follower on said lever in following engagement with said cam.

3. Apparatus according to claim 2, wherein said cam is provided with peripheral convolutions in leading engagement with said follower to effect said rotary oscillation.

4. Apparatus according to claim 1, said fuel-projecting means comprising pumps connected in fluid communication with each of said burner nozzles, and adjustable transmission means between said power drive means and each of said pumps for operating the latter, said adjustable transmission means being arranged for varying the stroke of said pumps.

5. Apparatus according to claim 4, said transmission means each comprising a lever between said power drive means and the adjacent pump and having an adjustable positionable fulcrum for changing the lever ration between said power drive means and said pump.

6. Apparatus according to claim 1, said mounting means for each of said burner nozzles including ball and socket bearing means.

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