(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 209 433 A2

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**29.05.2002 Bulletin 2002/22**

(51) Int Cl.[7]: **F27D 17/00**, F27B 17/00

(21) Application number: **01127369.5**

(22) Date of filing: **21.11.2001**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR**
Designated Extension States:
**AL LT LV MK RO SI**

(30) Priority: **23.11.2000 IT MO000251**

(71) Applicant: **IFT S.r.l.**
**41100 Modena (IT)**

(72) Inventor: **Gerardi, Elio**
**41100 Modena (IT)**

(74) Representative: **Modiano, Guido, Dr.-Ing. et al**
**Modiano Gardi Patents,**
**Via Meravigli, 16**
**20123 Milano (IT)**

## (54) Intermittent combustion kiln, particularly for ceramic articles

(57) An intermittent combustion kiln, particularly for ceramic articles, comprising a chamber (C) for thermal treatment of the articles, which is provided with a plurality of first burners (2), with a circuit for aspirating and evacuating the exhaust gases generated during the thermal treatment, and with at least one second regenerative-type burner (3) with heat recovery of the exhaust gases of the chamber, which is adapted to introduce in the chamber (C) hot combustion gases and to aspirate from the chamber the exhaust gases, recovering their residual heat, the second regenerative-type burner being provided with at least one regenerative exchanger which is connected to the chamber, which is associable with at least one intake (7) for comburent air and with at least one outlet (8) for the cold exhaust gases, and is adapted to be crossed alternately by the exhaust gases of the chamber, accumulating their residual heat, and by the incoming comburent air, transferring thereto the accumulated heat.

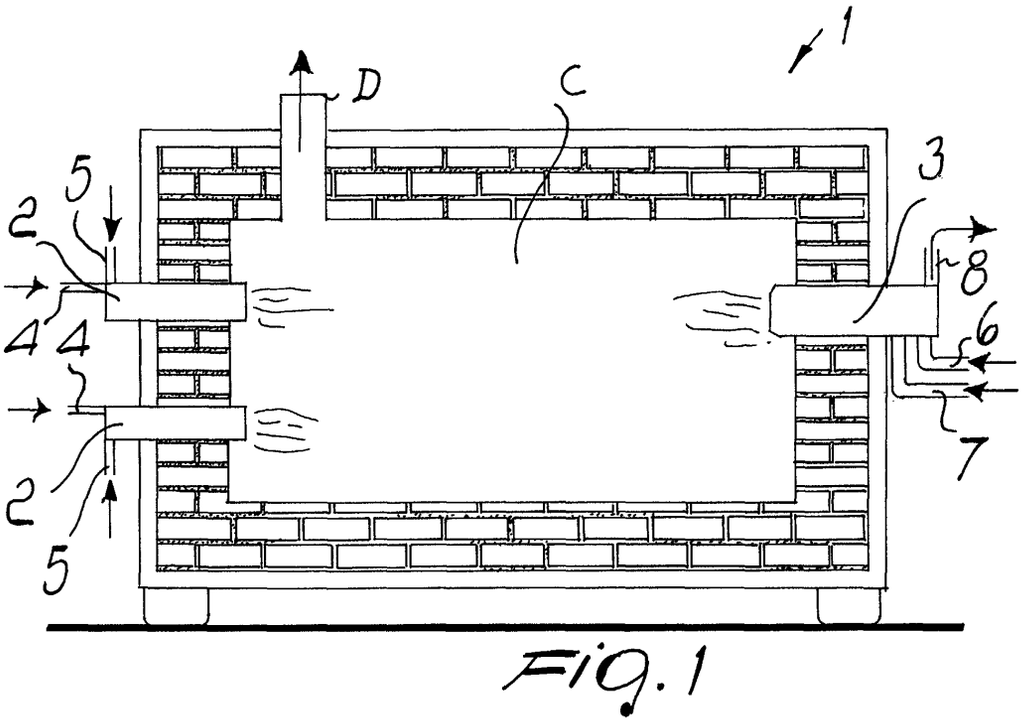


Fig. 1

EP 1 209 433 A2

## Description

**[0001]** The present invention relates to an intermittent combustion kiln, particularly for ceramic articles.

**[0002]** Intermittent combustion kilns, also termed "discontinuous" or "periodic" kilns, are known; their operation is, in other words, interrupted in order to perform loading and unloading of the articles to be subjected to a same thermal treatment and in which all the articles placed in the kiln are affected simultaneously by the same treatment stage.

**[0003]** Known intermittent kilns are constituted by a supporting box-like structure that internally supports refractory walls, which delimit a chamber in which the thermal treatment of the loaded articles is performed.

**[0004]** The chamber has lateral openings through which the articles, arranged on movable trucks, are inserted and extracted; such openings are closed by hermetic doors, and the chamber is provided with a plurality of burners, which are distributed on its end and/or side walls, and with a system for aspirating and evacuating the combustion products by means of a stack.

**[0005]** The burners currently in use include those with premixing of fuel and comburent air, which is aspirated, and those of the forced-draft type, which include the so-called "high-speed" ones.

**[0006]** Premixing burners are substantially composed of a nozzle for introducing the fuel, an opening for introducing the comburent air, a duct for mixing the fuel and the air and an outlet beyond which the mixture ignites and the flame is generated; the incoming fuel generates a negative pressure, which draws the air.

**[0007]** In high-speed burners, the air is not aspirated but blown; said burners have a mixing duct, in which the fuel and the comburent air are injected and forced under pressure, and a combustion chamber, in which the mixture burns: the combustion gases produced in the combustion chamber exit from the burner through a nozzle, which introduces them directly in the kiln chamber.

**[0008]** The exhaust gases are aspirated and evacuated from the chamber of the kiln by means of a suitable stack; the gases discharged into the atmosphere are still hot, and therefore a considerable amount of energy is lost with them.

**[0009]** These known types of intermittent kiln are not devoid of drawbacks, including the fact that they do not utilize fully the heat of the combustion gases of the burners, they require constant aspiration and evacuation through the stack of the exhaust gases from the chamber of the kiln, and have disadvantageously high energy consumptions.

**[0010]** In order to obviate these drawbacks, it is known to provide intermittent kilns with burners that have a unit for recovering the heat of the exhaust gases; such unit is used to preheat the incoming comburent air.

**[0011]** These burners comprise a combustion chamber into which a cylinder leads; the cylinder is designed to guide the incoming air and is arranged coaxially and internally with respect to a pipe for the outflow of the exhaust gases; the annular chamber formed between the cylinder and the pipe is divided by a heat exchanger into an outer chamber, through which the exhaust gases of the kiln flow, and an inner chamber, through which the incoming air flows; the two separate fluids flow continuously and in countercurrent, striking the opposite walls of the exchanger through which they exchange heat.

**[0012]** Such burners are further provided with a fuel intake duct, which is arranged coaxially inside the air guiding cylinder and leads into the combustion chamber.

**[0013]** However, even these intermittent kilns with known types of heat recovery burner have very high energy consumptions and are susceptible of further improvements.

**[0014]** The aim of the present invention is to eliminate the above noted drawbacks of known types of intermittent kiln by providing an intermittent combustion kiln, particularly for ceramic articles, which allows to increase the utilization of the heat of the combustion gases of the burners, to reduce the volumes of gas to be discharged through the stack, and to contain energy consumption.

**[0015]** Within this aim, an object of the present invention is to provide a structure that is simple, relatively easy to provide in practice, safe in use, effective in operation, and relatively low in cost.

**[0016]** This aim and this and other objects that will become better apparent hereinafter are achieved by the present intermittent combustion kiln, particularly for ceramic articles, comprising a chamber for thermal treatment of articles, which is provided with a plurality of first burners and with a circuit for aspirating and evacuating the exhaust gases generated during the thermal treatment, characterized in that it comprises at least one second regenerative-type burner with heat recovery of the exhaust gases of said chamber, which is adapted to introduce in said chamber hot combustion gases and to aspirate from said chamber said exhaust gases, recovering their residual heat, said second regenerative-type burner being provided with at least one regenerative exchanger which is connected to said chamber, which is associable with at least one intake for comburent air and with at least one outlet for the cold exhaust gases and is adapted to be crossed alternately by the exhaust gases of said chamber, accumulating their residual heat, and by the incoming comburent air, transferring thereto the accumulated heat.

**[0017]** Further characteristics and advantages of the present invention will become better apparent from the detailed description of a preferred but not exclusive embodiment of an intermittent combustion kiln, particularly for ceramic articles, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a schematic sectional view of a kiln according to the invention;

Figure 2 is a schematic sectional view of a further embodiment of the kiln according to the invention.

**[0018]** With reference to the figures, the reference numeral 1 generally designates an intermittent combustion kiln, particularly for ceramic articles.

**[0019]** The kiln 1 comprises a chamber C made of refractory material, inside which the ceramic articles loaded therein, arranged on appropriate trucks, not shown because they are of the conventional type, are subjected to thermal treatment.

**[0020]** A generic operating cycle of the kiln 1 provides for the following steps: loading of the unfired articles, preheating, high-temperature firing, cooling and unloading of the fired articles.

**[0021]** On the walls of the chamber C there are provided first burners 2 of the type traditionally used in the ceramics sector and at least one second burner 3 of the regenerative type with heat recovery of the exhaust gases of the chamber C.

**[0022]** The chamber C is further provided with a circuit for aspirating and evacuating the exhaust gases generated during the thermal treatment, which leads into a stack D.

**[0023]** The first burners 2, of the aspirated or forced-draught type, have a duct 4 for supplying the comburent air and a duct 5 for supplying the fuel.

**[0024]** Each regenerative burner 3 comprises multiple regenerative exchangers with periodically complementary operation, which are distributed radially around the body of said burner 3, are connected to the chamber C and are associable with an intake for comburent air and with an outlet for the cold exhaust gases.

**[0025]** Each regenerative exchanger is constituted by stacked lamination packs, between which channels remain; the hot exhaust gases that arrive from the chamber C and the incoming cold comburent air alternately flow through said channels.

**[0026]** Initially, the hot exhaust gases that arrive from the chamber C flow between the laminations, and heat accumulates in the exchanger; then the exchanger is crossed by the incoming cold air, to which the accumulated heat is transferred; the exhaust gases are therefore cold when they exit from the regenerative burner 3, while the incoming comburent air is preheated.

**[0027]** The regenerative exchangers with which the individual regenerative burner 3 is provided have a periodically complementary operation, i.e., while some of them are being crossed by the hot exhaust gases that arrive from the chamber C, the remaining exchangers are crossed by the incoming cold comburent air, and vice versa.

**[0028]** The reference numeral 6 designates the fuel supply duct, the reference numeral 7 designates the comburent air supply duct, and the reference numeral 8 designates the duct for the discharge of the cold exhaust gases of the regenerative burners 3.

**[0029]** As an alternative, each regenerative burner 3 is provided with a single regenerative exchanger with alternating operation: in a first step, the exchanger is crossed by the hot exhaust gases that arrive from the chamber C and recovers and accumulates their residual heat; in a second step, the exchanger is crossed by the incoming cold comburent air, to which it transfers the previously accumulated heat.

**[0030]** In this last case, the kiln 1 is provided with pairs of regenerative burners 3, the burners of each pair having a periodically complementary operation: one burner introduces in the chamber C the hot combustion gases, and its respective regenerative exchanger is crossed by the incoming comburent air, to which it transfers heat, while the other burner draws the exhaust gases from the chamber C and its respective regenerative exchanger is crossed by the exhaust gases, from which it removes heat, accumulating it, and vice versa.

**[0031]** Figure 1 illustrates a kiln 1 provided with a regenerative burner 3 of the type that comprises a plurality of regenerative heat exchangers with periodically complementary operation; accordingly, the burner 3 has an independent and autonomous operation.

**[0032]** In a further embodiment, Figure 2 illustrates a kiln 1 provided with two regenerative burners 3 (designated by the reference numerals 3a, 3b) of the type with a single regenerative exchanger.

**[0033]** In this embodiment, the regenerative burners 3 (3a, 3b) are opposite one another and operate in an alternately complementary manner: the burner 3a introduces in the chamber C the hot combustion gases, the respective exchanger being crossed by the incoming comburent air, while the other burner 3b aspirates from the chamber C the exhaust gases, the respective exchanger being crossed by the exhaust gases, the heat of which it recovers and accumulates, and vice versa.

**[0034]** Advantageously, the regenerative burners 3 operate efficiently at temperatures above a minimum temperature between 800 and 1300°C; this interval corresponds to the stage for firing at high temperature of the entire thermal treatment to which the articles are subjected.

**[0035]** The operation of the invention is as follows.

**[0036]** During the initial step for preheating the articles placed in the kiln in the chamber C, i.e., during the time interval when the temperatures inside the chamber C are lower than said minimum temperature, only the first burners 2 are active, while the regenerative burners 3 are in the passive operating step and the exhaust gases are aspirated and evacuated by the stack D.

**[0037]** Once the minimum temperature (close to 800°C) at which the regenerative burners 3 operate has been reached, the first burners 2 are shut down, while the regenerative burners 3 enter the active operating step; the regenerative burners 3 are therefore active when the first burners 2 are passive, and vice versa.

**[0038]** The regenerative burners 3 are active during the step for the so-called firing of the articles loaded in the kiln 1, when the articles are kept, for a preset time interval, at the highest temperatures provided by the thermal treatment.

**[0039]** Advantageously, during firing the stack D is

disconnected from the chamber C (Figure 2); the exhaust gases are in fact aspirated and evacuated by means of the regenerative burners 3.

**[0040]** Conveniently, the burners 2 and the regenerative burners 3 can be incorporated in a single block.

**[0041]** In practice it has been found that the described invention achieves the proposed aim and objects, i.e., to provide an intermittent combustion kiln that allows to utilize fully the residual heat of the combustion gases and allows to limit consumption and energy costs.

**[0042]** The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

**[0043]** All the details may further be replaced with other technically equivalent ones.

**[0044]** In practice, the materials used, as well as the shapes and the dimensions, may be any according to requirements without thereby abandoning the scope of the protection of the appended claims.

**[0045]** The disclosures in Italian Patent Application No. MO2000A000251 from which this application claims priority are incorporated herein by reference.

**[0046]** Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

## Claims

1. An intermittent combustion kiln (1), particularly for ceramic articles, comprising a chamber (C) for thermal treatment of the articles, which is provided with a plurality of first burners (2) and with a circuit for aspirating and evacuating the exhaust gases generated during the thermal treatment, **characterized in that** it comprises at least one second regenerative-type burner (3) with heat recovery of the exhaust gases of said chamber, which is adapted to introduce in said chamber hot combustion gases and to aspirate from said chamber said exhaust gases, recovering their residual heat, said at least one second regenerative-type burner (3) being provided with at least one regenerative exchanger which is connected to said chamber, which is associable with at least one intake (7) for comburent air and with at least one outlet (8) for the cold exhaust gases and is adapted to be crossed alternately by the exhaust gases of said chamber (C), accumulating their residual heat, and by the incoming comburent air, transferring thereto the accumulated heat.

2. The kiln according to claim 1, **characterized in that** said chamber comprises at least one pair (3a, 3b) of said second regenerative-type burners (3) with periodically complementary operation, one burner (3a) being adapted to introduce in said firing chamber (C) the hot combustion gases, the respective regenerative exchanger being crossed by the incoming comburent air, the other burner (3b) being adapted to aspirate said exhaust gases from said chamber, the respective regenerative burner being crossed by said exhaust gases.

3. The kiln according to one or more of the preceding claims, **characterized in that** said second regenerative-type burners are in the active step of operation at temperatures of said treatment that are higher than a preset minimum temperature.

4. The kiln according to one or more of the preceding claims, **characterized in that** said minimum temperature is between 800 and 1300°C.

5. The kiln according to one or more of the preceding claims, **characterized in that** said first burners (2) and said second burners (3) of the regenerative type are respectively in the active and passive operating step when the temperatures inside said chamber are lower than said minimum temperature and in the passive and active operating step when the temperatures within said chamber are higher than said minimum temperature.

6. The kiln according to one or more of the preceding claims, **characterized in that** said aspiration and evacuation circuit is adapted to be disconnected, the exhaust gases of said chamber (C) being aspirated by said second regenerative-type burners (3) in the active step.

7. The kiln according to one or more of the preceding claims, **characterized in that** said cold exhaust gases have an average temperature between 100 and 300°C.

8. The kiln according to one or more of the preceding claims, **characterized in that** said second regenerative-type burner (3) comprises at least one first said regenerative exchanger and one second said regenerative exchanger with periodically complementary operation, the first exchanger being crossed by said exhaust gases and the second exchanger being crossed by said incoming comburent air and vice versa.

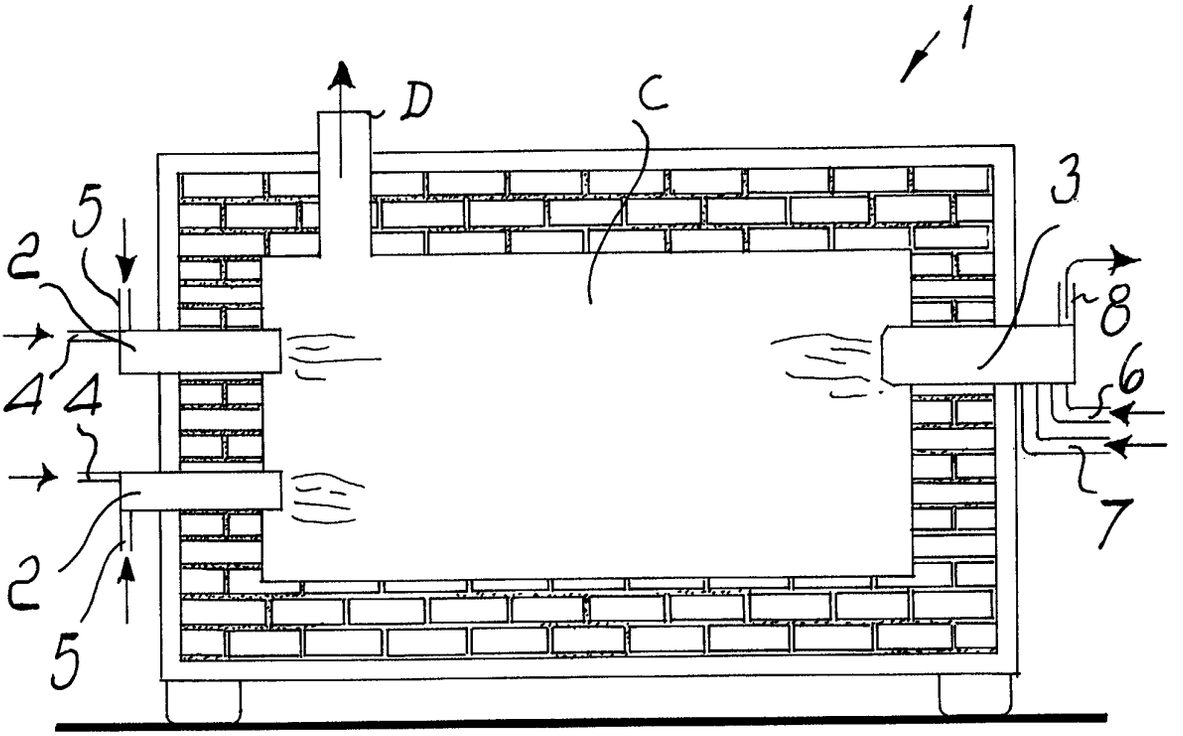


Fig. 1

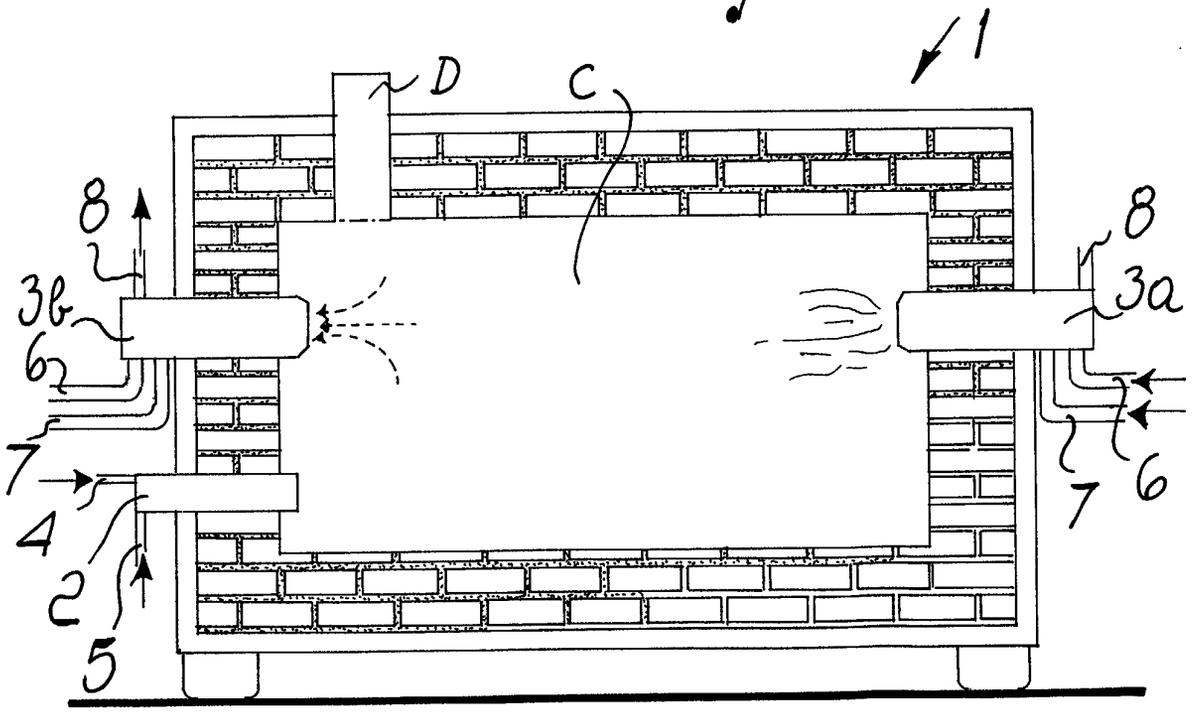


Fig. 2