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PROCESS FOR HEATING SOLID MATERIALS, PARTICULARLY FOR THE CALCINATION OF LIMESTONE

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Fig. 1

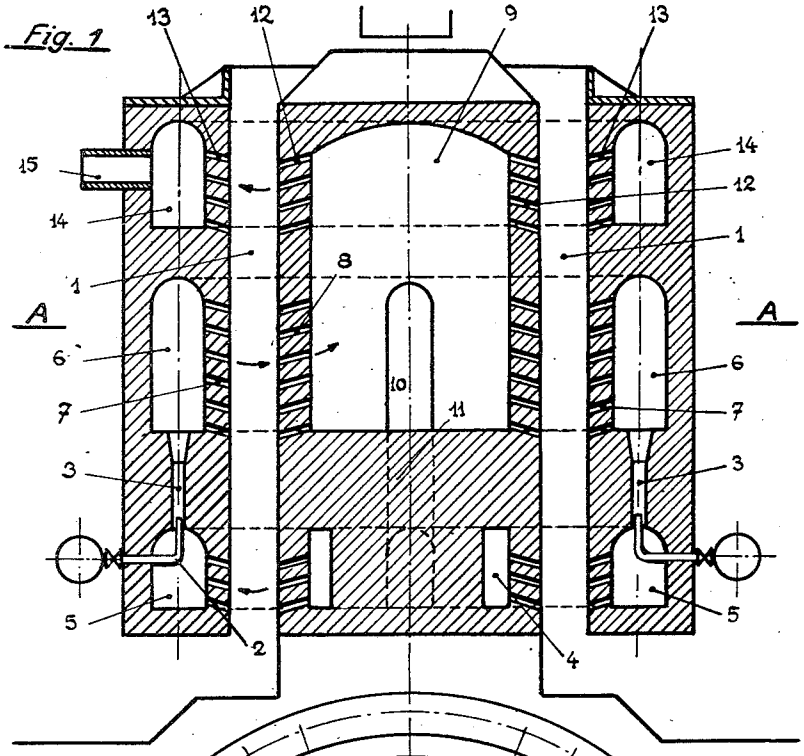
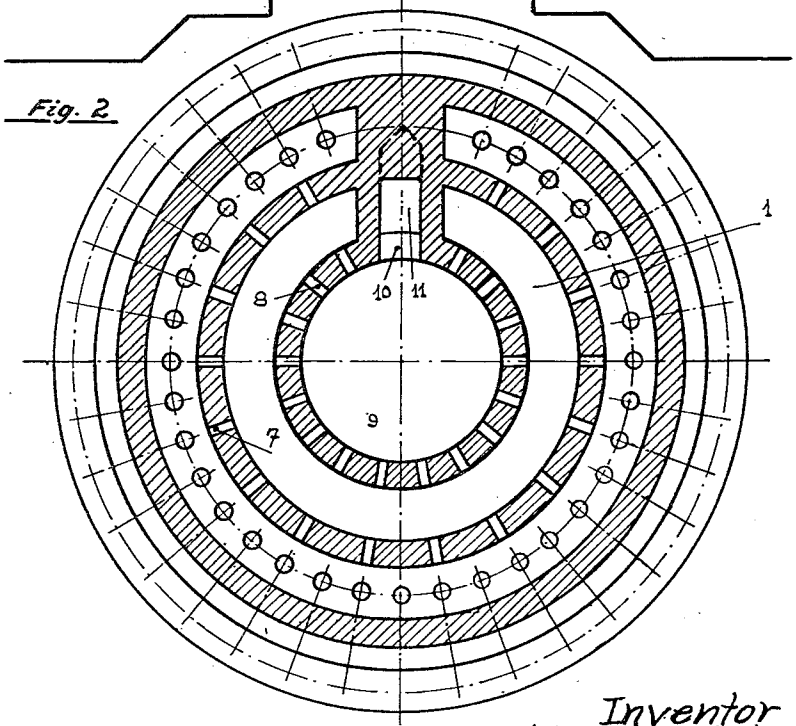


Fig. 2



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PROCESS FOR HEATING SOLID MATERIALS, PARTICULARLY FOR THE CALCINATION OF LIMESTONE

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4 Claims. (Cl. 263—53)

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The shaft furnace is a heat exchanger of great efficiency, because the heating gas licks nearly all of the surface of the material to be heated. The quantity of heat which can be transmitted to the material, all conditions being unchanged, is increased proportionally to the decrease of the size of the grains, and becomes about ten times higher if the size of the fragments is reduced from 200 mm. to 25 mm. The time needed for the heating falls down even faster than the quantity of transmitted calories increases, because the heating of fragments of small size may be carried out with small differences of temperature between the surface of the outer part and the central part of the fragments. Therefore, the quantity of transmitted calories becomes twenty times higher when the size of the fragments is reduced from 200 mm. to 25 mm. Crushed lime stone of 25 mm., for instance, are calcinated twenty times faster than a fragment of 200 mm. The efficiency of a shaft furnace could therefore become twenty times higher, but, in such a case, the quantity of heat supplied must also become twenty times larger and this could not be realized with the conventional shaft furnace in which the solid materials are drawn out of the oven, as the increase of the heating calls for a corresponding increase of the speed of the gases passing through the shaft. The resisting effect of pile of products loaded in the shaft furnace, when compared with an empty furnace, brings down the speed of the gases passing through the furnace to 0.05 to 0.10 m. per second in case of a natural draught and to about 0.20 m. per second, in case of a normal forced draught. With such speeds, only a small supply of heat can be obtained, about 20,000 calories per hour and per cubic meter of the capacity of the furnace in the conventional lime shaft-furnaces, which corresponds to a production of 10 to 20 kg. of lime per hour, and per cubic meter of the capacity of the furnace. If a twenty time larger production was contemplated with heating under favorable circumstances, the speed of the burned gases should be increased up to about four m. per second, thus bringing the pressure losses to a value four hundred times higher, amounting to about 0.4 atmosphere for each meter of height. Such pressures cannot be practically realized for the type of shaft-furnaces in which solid materials are drawn out of the oven. Furthermore, this increase in the supply of gas would not give satisfactory results, because such an intense heating calls for an accurate regulation of the heat of combustion without which deposits produced by overheating and scorification, may be formed in the shaft, thus compelling to place the furnace out of operation. This temperature regulation could become economical only if the principle of circulation of the burned gases would be adopted, this is to say in the case of an additional increase of the quantity of gases passing through the furnace.

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For these reasons, there has been no extension in the use of shaft furnaces in which the solid materials are drawn out of the oven, as their efficiency is contradictory with the good preliminary conditions of heat exchange, as above indicated.

As the quantity of gas corresponding to the efficiency increase to be obtained, can only be forced through the materials piled in the furnace if the circuit of these gases is shortened, it is suggested, according to the invention, to carry out in the furnaces having a shaft or a chamber in which the material to be calcinated moves by gravity, a transversal heating of these materials. With this suggestion, the required increase of efficiency is reached, as the thickness of the layer of the material can be reduced to a few decimeters therefore gaining the advantage of the above mentioned requirements for heat exchange. In such a case, the delivery of gas may be increased in the ratio between the height of the shaft-furnace and the thickness of the layer of the material piled in the furnace, as the gas has no more to travel through the entire height of the furnace (10 to 20 m.), but only through a layer of material the width of which is only a part of said height.

The circulation of the burned gases, which is necessary for the carrying out of the invention, would highly increase the consumption of calories in the operation if said burned gases were, as usually, taken at the final stage of heat exchange. It is therefore suggested, according to the invention, to make use, for the circulation, only of the burned-gases coming from the zone of temperature essentially determinated in accordance with the heat consumption required to

carry out the operation, as for instance, in lime ovens, the burned gases issued from the baking zone, at about 900°. It is well known that it has already been suggested for the circulation, to take a portion of the burned gases under the throat of the conventional lime furnaces, but the heat of these circulating gases, 500 to 600° C. indicates that they are coming from the zone of preheating.

As an example, a ring-shaped shaft-furnace according to the invention is described hereafter and shown in the annexed drawings.

Fig. 1 is a vertical section of the shaft furnace and Fig. 2 is a cross section of Fig. 1 along line AA.

The furnace is provided with a ring shaped shaft in which the piled up materials come down in succession through the zone of precalcination, the zone of highest consumption of heat, (zone of calcination) and through the cooling zone.

The heating gas is introduced in the furnace through the injection 2, and it sucks up, by means of the discharge passage 3 of said injector, the combustion air which arrives in 4 and which, after being preheated in the cooling zone, passes into a lower chamber 5 or air main in which are disposed the injectors 5. The combustion is completed in the combustion chamber 6. The burned heating gas enters the shaft 1 through a number of perforations 7, passes through the material in the shaft and leaves the shaft 1, through perforations 8; it enters the middle chamber 9 from where it is conducted through the flue 10, and the vertical draught pipe 11 into the lower chamber 5.

The circulation of the large amount of burned gases issued from the combustion zone and mixed, in the lower chamber 5, with the air passing from 4 in said chamber 5, is also induced by the injector 2 discharging into the passage 3 the heating gas at a sufficient pressure to produce at the lower opening of said passage a suction. When the furnace is heated with solid fuel, the combustion air is partly utilized as means for the suction through the injector. The remaining portion of burned gases, not used for the circulation, is used for heating the preheating zone. This portion passes again in the shaft through holes 12, crosses in a perpendicular way the piled up materials and leaves the furnace through the holes 13, the flue chamber 14 and the pipe 15.

The transverse passage through the preheating zone may be omitted and the burned gas may cross in counter flow this zone if said zone is sufficiently low in the direction of movement of the material to be heated, to allow passage of the heating gas through the materials in said preheating zone in spite of the pressure existing in shaft.

What I claim is:

1. The process of calcining crushed limestone which comprises, establishing a vertical, downwardly-descending column of said limestone, charging fresh limestone at the top of said column and removing calcined limestone from the bottom of said column, providing a source of fresh combustion gases, introducing said combustion gases into said column at a point intermediate said top and said bottom of said column, passing said combustion gases transversely through said column and transversely withdrawing the combustion gases from said column at a point substantially horizontally opposite the point of introduction of said gases whereby said combustion gases create in said column adjacent said point of introduction a temperature zone of maximum heat consumption and said combustion gases are transversely withdrawn solely from said zone, passing a portion of the combustion gases from said zone of maximum heat consumption to a point in said column above said zone to create a pre-heating zone wherein the fresh limestone being charged to said column is pre-heated before it reaches said zone of maximum heat consumption, withdrawing said gases from said pre-heating zone, and re-circulating to said source of fresh combustion gases only combustion gases withdrawn transversely from said zone of maximum heat consumption, whereby said transversely withdrawn combustion gases are mixed with fresh combustion gases and the resulting mixture is introduced into said column for transverse passage therethrough.

2. A shaft furnace for the heat treatment of crushed limestone and like solid materials comprising, in combination, spaced-apart vertical walls defining a vertical channel for the continuous downward movement of the material being treated, said channel having an upper pre-heating portion, an intermediate heating portion, and a lower cooling portion, second wall means spaced apart with respect to one of said first-named walls, horizontal partition means connected to said second wall means and to said one of said first-named walls to define a combustion chamber opposite said intermediate heating portion, the wall separating said combustion chamber from said vertical chamber being provided with a plurality of apertures establishing communication between the intermediate heating portion of said vertical channel and the combustion chamber, partition means including the other of said first-named walls defining a gas receiving chamber on the side of said vertical channel opposite said combustion chamber, and said wall separating said vertical channel from said gas receiving chamber being provided with apertures establishing communication between the intermediate heating portion of said channel and said gas receiving chamber, whereby the apertures in said two walls are substantially opposite one another, means defining a combustion gas passageway having a discharge side communicating with said combustion zone and an opposite suction side, nozzles for supplying combustion gas disposed with their outlets in said passageway facing said discharge side, whereby a suction effect is developed on the suction side of said passageway upon introduction of combustion gas through said nozzles, air supply means communicating with said cooling zone for drawing in combustion air through said cooling zone, and conduit means providing communication between the suction side of said passageway and said gas receiving chamber, whereby combustion gases from said vertical channel are drawn into said gas receiving chamber and are then drawn into said passageway for admixture with combustion gases introduced through said nozzles for recirculation to said vertical channel containing the material being treated.

3. A shaft furnace for the heat treatment of crushed limestone and like solid materials comprising, in combination, spaced-apart vertical walls defining a vertical channel for the continuous downward movement of the material being treated, said channel having an upper preheating portion, an intermediate heating portion, and a lower cooling portion, second wall means

spaced apart with respect to one of said first-named walls, horizontal partition means connected to said second wall means and to said one of said first-named walls to define a flue gas collecting chamber opposite said upper pre-heating portion and a combustion chamber opposite said intermediate heating portion, the wall separating said combustion chamber from said vertical chamber being provided with a plurality of apertures establishing communication between the intermediate heating portion of said vertical channel and the combustion chamber, partition means including the other of said first-named walls defining a gas receiving chamber on the side of said vertical channel opposite said combustion chamber, and said wall separating said vertical channel from said gas receiving chamber being provided with apertures establishing communication between the intermediate heating portion of said channel and said gas receiving chamber, whereby the apertures in said two walls are substantially opposite one another, means defining a combustion gas passageway having a discharge side communicating with said combustion zone and an opposite suction side, nozzles for supplying combustion gas disposed with their outlets in said passageway facing said discharge side, whereby a suction effect is developed on the suction side of said passageway upon introduction of combustion gas through said nozzles, and conduit means providing communication between the suction side of said passageway and said gas receiving chamber, whereby combustion gases from said vertical channel are drawn into said gas receiving chamber and are then drawn into said passageway for admixture with combustion gases introduced through said nozzles for recirculation to said vertical channel containing the material being treated.

4. A shaft furnace for the heat treatment of crushed limestone and like solid materials comprising, in combination, spaced-apart concentric vertical circular walls defining a vertical annular channel for the continuous downward movement of the material being treated, said channel having an upper pre-heating portion, an intermediate heating portion, and a lower cooling portion, second wall means spaced apart with respect to one of said first-named walls, horizontal partition means connected to said second wall means

and to said one of said first-named walls to define an annular flue gas collecting chamber opposite said upper pre-heating portion and an annular combustion chamber opposite said intermediate heating portion, the wall separating said combustion chamber from said vertical chamber being provided with a plurality of apertures establishing communication between the intermediate heating portion of said vertical channel and the combustion chamber, partition means including the other of said first-named walls defining a gas receiving chamber on the side of said vertical channel opposite said combustion chamber, and said wall separating said vertical channel from said gas receiving chamber being provided with apertures establishing communication between the intermediate heating portion of said channel and said gas receiving chamber, whereby the apertures in said two walls are substantially opposite one another, means defining a combustion gas passageway having a discharge side communicating with said combustion zone and an opposite suction side, nozzles for supplying combustion gas disposed with their outlets in said passageway facing said discharge side, whereby a suction effect is developed on the suction side of said passageway upon introduction of combustion gas through said nozzles, and conduit means providing communication between the suction side of said passageway and said gas receiving chamber, whereby combustion gases from said vertical channel are drawn into said gas receiving chamber and are then drawn into said passageway for admixture with combustion gases introduced through said nozzles for recirculation to said vertical channel containing the material being treated.

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