Sept. 26, 1939. N. AHLMANN 2,174,066

PROCESS FOR SINTERING OR CALCINING RAW MATERIALS

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Fig. 1.

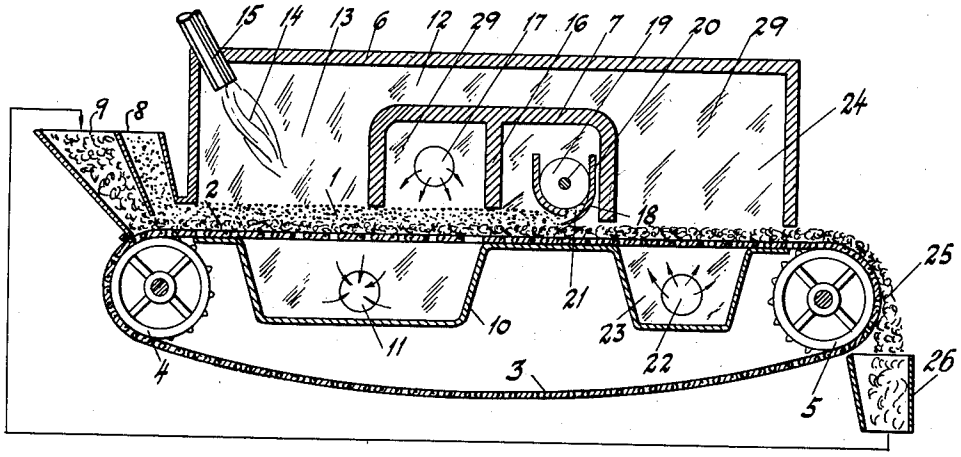


Fig. 2.

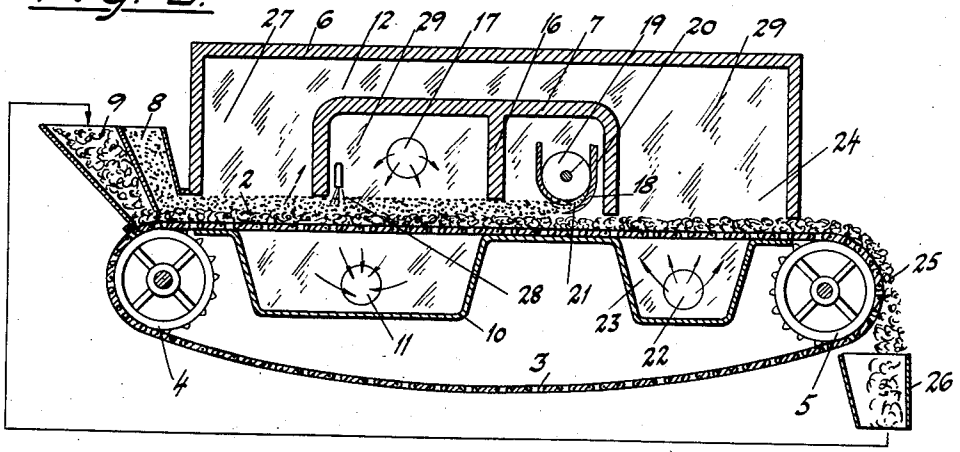
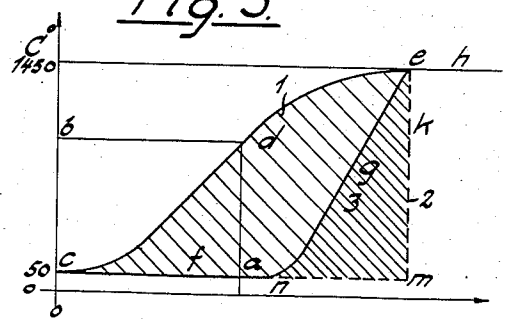


Fig. 3.



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PROCESS FOR SINTERING OR CALCINING RAW MATERIALS

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3 Claims. (Cl. 263—53)

This invention relates to the sintering or calcining of raw materials such as cement raw materials by means of gas which is caused to flow through a layer of the material, and the main object is to utilize part of the waste heat of the process whether the gas is itself so hot that it brings about the sintering or calcining, or whether it only supports the combustion of fuel in the layer.

To obtain the desired result the material to be sintered or calcined should be formed into a porous fine-grained layer having an average grain size of about 1 mm. Such a layer possesses certain important qualities as will appear from the following.

One characteristic of the layer is that the heat penetrates the layer with a sharp front, that is to say the distance in the layer between the material that is still cold and that which is already highly heated is small. The absorption of heat from the gas by the layer is indeed so great that the temperature of the gas leaving the layer will be very little above the temperature of the surrounding air during a considerable part of the time taken by the sintering or calcining process, and the more fine-grained and porous this layer the longer will the gas leaving the layer be at a low temperature. Sooner or later, however, towards the end of the process the temperature of the outgoing gas will rise rather suddenly, almost to the temperature at which the sintering or calcining takes place. This is illustrated graphically in Figure 3 of the accompanying drawing, in which the abscissae show the time that has elapsed from the beginning of the sintering or calcining process and the ordinates show the temperature of the gas leaving a layer of cement raw material in a process in which the burning of the cement raw material is effected by forcing gases through the layer at an initial temperature of 1450° C. If the layer of raw material is not very porous and fine-grained the variation in temperature is shown by the curve 1, that is to say, for example, after a time *a* has elapsed the temperature of the gas just as it leaves the layer is *b*. It will be appreciated that up to this moment the amount of heat supplied is proportional to the rectangle *c—b—d—a*, but that only the amount of heat proportional to the area *c—b—d* is effectively utilized and the remainder, proportional to the area *c—d—a*, is waste heat. The process is continuous until the point *e* is reached, and at this point also the proportion of heat that is wasted is substantial.

If the layer were ideal, that is to say, were porous and of infinitely fine grain, the curve 2 consisting of the two lines *f* and *k* would result and there would be no waste heat at all.

The curve obtainable in practice is indicated at 3 and is formed by the lines *f*, *g* and h. It will be seen that until the point *n* is reached there is substantially no heat wasted at all and that the inevitable waste heat is represented by the area *n—e—m*. The object of the invention is to make use of this waste heat.

According to one feature of the invention the gas leaving the layer of material to be sintered or calcined is caused to flow also through a layer beneath consisting of inert material with a view to take up during the later part of the sintering or calcining process some of the heat contained in the gas. In order to obtain the highest possible heat economy this second layer, the recuperative layer, should for the same reasons as stated above in connection with the first layer be formed of a porous, fine-grained material. The recuperative layer should be so thick and of such heat-absorbing capacity that substantially the whole of the waste heat in the gas is taken up by the layer and accumulated there, which is as a rule obtained when the two layers are almost equal in thickness and grain size.

When cement is being burnt the second or recuperative layer may thus conveniently be of the same thickness as the layer of raw material and consist of small clinker of the kind obtained by the burning of the first layer, but in this or other cases it may consist of other fine-grained inert material having the desired qualities as regards large surface and great capacity for heat.

The heat accumulated in the recuperative layer is utilized again by passing cold gas through it to take up the heat and use the gas in the sintering or calcining process.

A protective layer is often provided between a grate and material which is to be sintered on the grate with a view to protect the grate against the hot gases. It should be noted that such protective layer in contradistinction to a recuperative layer need not be as fine-grained or of such heat capacity as stated above, because the same thermal requirements to be fulfilled by a recuperative layer are not required by a protective layer. The temperature of the gas leaving the recuperative layer should not exceed 150° C.

The process according to the invention may be carried out in two ways depending on whether the sintering or calcining is effected by the hot gas or by fuel contained in the raw material layer.

In the first case cold gas may be caused to flow through the layer in the same direction when the burning or sintering is complete, to transfer the heat remaining in the layer to the recuperative layer, and the burnt or sintered layer may then be removed before the cold gas flows through the recuperative layer to take up heat from it.

If, however, the layer contains fuel it is first preheated by passing gas of such low temperature through the layers that the fuel is not ignited. When the preheating is complete the ignition takes place and the combustion is supported by cold air which is now passed through the layers whereby the first layer is cooled and the waste heat transferred to the recuperative layer. Then the first layer is removed and cold gas is passed through the recuperative layer to take up the heat which is utilized to preheat new raw material.

In practice the process may advantageously be carried on continuously and in such a case a continuously advancing grate may be used. Two layers of material may then be spread on this grate, that is to say, a layer of recuperative material on the grate itself, and a layer of material to be burnt or sintered on the layer of recuperative material.

Two somewhat differing apparatus for carrying out the two modifications of the process mentioned above are illustrated diagrammatically in the accompanying drawing, but it will be understood that any appropriate apparatus capable of carrying out the process may be used. In order that the invention may be clearly understood and readily carried into effect two modifications of the process in accordance therewith will now be described by way of example with reference to the drawing, in which

Figure 1 is a longitudinal section of an apparatus capable of carrying out one modification of the process;

Fig. 2 is a longitudinal section of an apparatus capable of carrying out the other modification of the process; and

Fig. 3 is an explanatory chart which has been previously referred to and described.

In Fig. 1 it is assumed that the layer to be sintered or calcined does not contain any fuel. The layer in question is numbered 1 and is spread on the recuperative layer 2 which again rests on the travelling grate 3 running over drums 4 and 5 supported by bearings not shown and being advanced by some external driving means, which is not to be seen either. Various rooms and passages are arranged above the layers the limitations being the constructions 6 and 7 and the partition 16 as well as the side-walls of which the one to be seen in the figure is numbered 29. The whole construction is made of fireproof brickwork. The layer to be heat-treated and the recuperative layer are supplied to the grate through the hoppers 8 and 9, and during the travelling of the grate the layers enter first the sintering or calcining zone in which hot gas is passed downwards through the layers and the grate to the room beneath limited by a housing 10 communicating with a pipe 11. This pipe is connected to the suction side of a fan, not shown, whereas the pressure side leads to a stack. Hot gas comes from the channel 12 and enters the combustion chamber 13 where it serves as preheated secondary combustion air for an oil-burner, the flame of which is indicated by numeral 14, and to which oil together with compressed primary air is introduced through the pipe 15 into the chamber 13, in which the gases attain a temperature sufficient for bringing about the sintering or calcining process.

When the sintering or calcining is substantially completed the grate has advanced the layers so far that the next zone is reached. This zone is limited by the front wall of the casing 7 and the partition 16. A pipe 17 carries cold air into the room above the layer, and as the room under the grate is also under the influence of the suction through the pipe 11 the cold air is sucked through the two layers and the grate transferring thereby the heat remaining in the layer which has been sintered or calcined from this layer into the recuperative layer.

In the next zone limited by the partition 16 and the rear wall of the casing 7 the removing of the sintered or calcined layer which is now cold takes place by means of a curved metal plate 18 acting as a plough and separating the two layers so that the sintered or calcined layer is peeled off and lifted. The cold finished material is next seized by a worm conveyor 19 rotating in a trough 20 so that the material is moved in a direction at a right angle to its previous movement on the grate. The material is discharged at the end of the worm conveyor which projects through the side wall 29. It is to be understood that there is a slot in the bottom of the trough 20 as indicated at 21 through which the material enters the trough.

It may sometimes be expedient to replace the plough 18 and the worm conveyor by some other means, for example a chain conveyor, capable of separating the two layers and of discharging the first layer.

The recuperative layer 2 which now contains the waste heat is travelling further alone and reaches a zone where it is passed by cold air which takes up the heat. The atmospheric air is flowing in through the pipe 22 due to the suction action exterted through the pipe 11. First the chamber 23 below the grate is reached, and after the passage through the grate and the recuperative layer the air passes the chamber 24 and further the channel 12, whereafter the air is used in the sintering or calcining process as described above. The recuperative layer which is now cooled down almost to the temperature of the surroundings falls off the grate at 25 due to the action of gravity when the grate passes the drum 5 and drops into the chute 26. The same recuperative layer may be used several times and is therefore returned to the hopper 19 as indicated by the arrow.

In Fig. 2 it is assumed that the layer to be sintered or calcined contains itself the fuel to carry through the process. The apparatus illustrated in this figure is similar to the apparatus according to Fig. 1, and the corresponding parts in the two figures are therefore marked with the same reference numerals. The two layers are first preheated in the preheating zone 27 by being traversed by warm gas subjected to sucking through the pipe 11. The next zone is the sintering or calcining zone in which the fuel is ignited by means of a small flame 28, whereafter to support the combustion of the fuel atmospheric air is passed through the layers and the grate to be led away through the pipe 11. When the process is completed the layer will be cold and can be removed in the next zone exactly as indicated in the description to Fig. 1. The heat accumulated

in the recuperative layer is in this case used to preheat the material in the zone 27.

I claim:

1. A process for sintering or calcining raw material which comprises forming a layer of porous fine-grained heat recuperative material on a traveling gas-pervious support, forming on top of said first named layer a porous fine-grained layer of the material to be sintered or calcined, passing a heated gas transversely through the layers as at least a part of the sintering or calcining operation, thereafter passing downwardly through the layers an unheated gas which transfers the heat contained in the top layer of the material to the underlying heat recuperative layer, then removing the top layer of material from the underlying layer, thereafter passing a cooling gas through the recuperative layer from which the top layer has been removed to absorb in said gas the heat in the recuperative layer, and utilizing said last mentioned gas as the first mentioned heated gas which is used as part of the sintering or calcining operation.

2. A process for sintering or calcining raw material which comprises forming a layer of porous fine-grained heat recuperative material on a traveling gas-pervious support, forming on top of said first named layer a porous fine-grained layer of the material to be sintered or calcined, passing transversely through the layers a gas whose temperature is that at which the sintering or calcining takes place to thereby sinter or calcine the material in the top layer, thereafter passing downwardly through the layers a cold gas which transfers the heat contained in the top layer of the material to the underlying heat recuperative layer, then removing the top layer of material from the underlying layer, thereafter passing a cold gas through the recuperative layer from which the top layer has been removed to absorb in said gas the waste heat in the recuperative layer, and utilizing said last mentioned gas in the sintering or calcining operation.

3. A process for sintering or calcining raw material which comprises forming a layer of porous fine-grained heat recuperative material on a traveling gas-pervious support, forming on top of said first named layer a porous fine-grained layer of a mixture of the material to be sintered or calcined and solid fuel, passing a heated gas transversely through the layers to preheat the material to be sintered or calcined, igniting the fuel in the top layer, passing downwardly through the layers a cold gas to support combustion of the fuel in the top layer and to transfer the heat contained in the top layer of the material to the underlying heat recuperative material, then removing the top layer of material from the underlying material, thereafter passing a cold gas through the recuperative layer from which the top layer has been removed to absorb in said gas the heat in the recuperative layer, and utilizing said last mentioned gas in said preheating operation.

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