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[54] **METHOD AND APPARATUS FOR HEAT TREATMENT OF MATERIALS**
8 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **263/36, 263/27**
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[50] **Field of Search** 263/27, 29, 30, 36, 39

[56] **References Cited**

UNITED STATES PATENTS

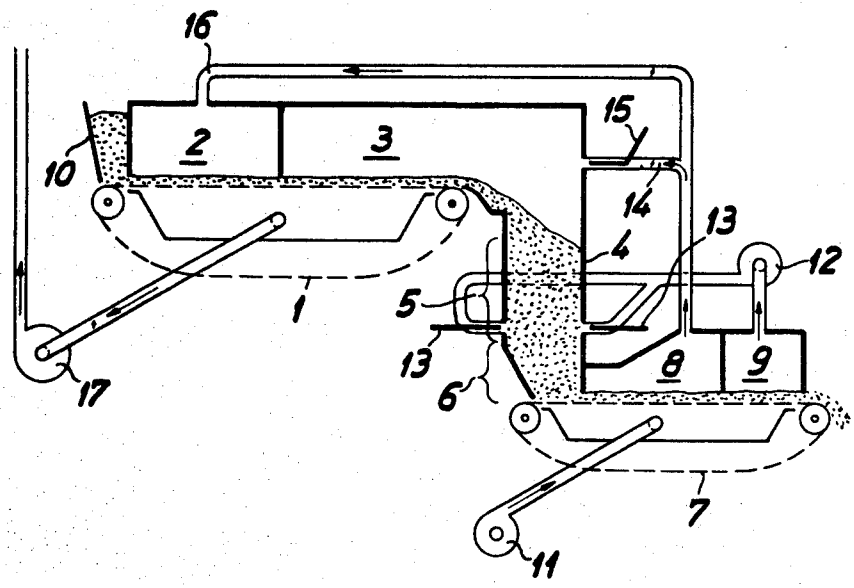
3,445,550	5/1969	Hoad	263/53

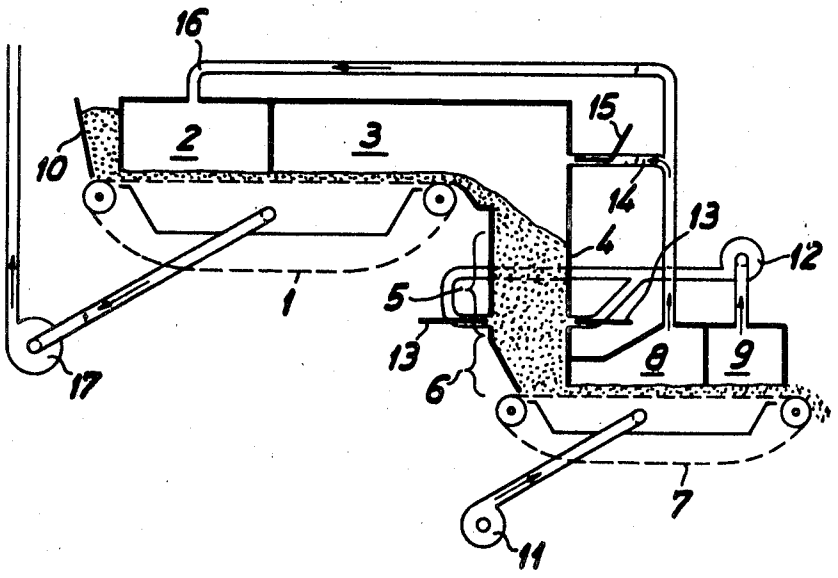
FOREIGN PATENTS

606,667	8/1948	Great Britain	263/30

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ABSTRACT: A continuous method and apparatus for heat treating granular and pelleted materials, in which the material is dried and then heated on a traveling grate, and is then discharged into a stationary vertical kiln, in which it is fired. The heating of the material on the traveling grate is sufficient to dry the material and to preheat it to such a degree that a uniform temperature is maintained throughout the horizontal cross section of the kiln.




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METHOD AND APPARATUS FOR HEAT TREATMENT OF MATERIALS

BACKGROUND OF THE INVENTION

The invention relates to a process as well as an apparatus for heat treatment of various materials which are granular or are to be processed into briquettes, such as ore, phosphate, raw materials for cement, dolomite, magnesite, limestone, clay or the like, wherein the material is first dried and preheated, then fired and finally cooled.

It is known to carry out the heat treatment of granular material, or material which is to be processed into briquettes, for example iron ore, in a kiln to which is supplied the moist (for example granulated) raw material. Thereupon the drying, preheating, firing and cooling of the material takes place in the kiln.

Practical experience with this known process shows, however, that the heating of the kiln cannot be so controlled as to provide uniform distribution of heat throughout the entire cross section of the kiln. The heating gases tend to seek preferred channels in the material, more particularly in the drying and preheating zones of the kiln, which leads to substantial nonuniformity in the heat treatment of the material and thus to a considerable reduction in the quality of the finished material.

It is also known to carry out the heat treatment of materials in such a manner that drying and preheating take place on a traveling grate and the firing takes place in a rotary kiln. If the material used in this process is granular, pellets of uniformly good hardness are produced; however, the outer layer of the pellets is substantially compressed by the tumbling action in the rotary kiln, which causes loss of the porosity which is valuable for many applications (for example for the smelting of iron ore pellets in a blast furnace).

A further substantial disadvantage of this known process consists in that the material undergoes a very nonuniform hardening upon the traveling grate. The briquettes which are present in the uppermost layers are brought to the highest range of temperature by the kiln gases which are drawn downward through the layers, while the briquettes that are present in the lowermost layers still come into contact only with gases which already have been substantially cooled. Accordingly, in the known process the pellets enter the rotary kiln in some cases too hard and in some cases too soft. The hard pellets act during the tumbling action in the rotary kiln as grinding bodies upon the soft pellets. This causes abrasion, which can lead to a very troublesome deposit in the rotary kiln, and also increases the dust content of the gases leaving the rotary kiln.

Attempts have been made to equalize the nonuniform treatment of the individual layers of material on the traveling grate by means of supplemental heating. Aside from the fact that in this manner the disparity between the hardening of the briquettes in the uppermost layers and in the lowermost layers is not completely eliminated, such supplemental heating of the traveling grate creates the necessity to manufacture the grate elements from very expensive, heat-resistant steel, which substantially increases the cost of the machine.

Finally, it is also known to conduct the entire heat treatment, i.e. drying, preheating, sintering and cooling, upon a single traveling grate. In this manner, a finished product of higher porosity can indeed be obtained. However, because of the unavoidable difference in the heat treatment of the pellets which are present in the upper layers and in the lower layers, there is a substantial difference in the hardness of the finished material and therefore also a substantial production of dust in the further transport of the sintered material. If the layers of material which are present on the traveling grate are sintered throughout as strongly as possible then the thermal loading of the elements of the grate is increased, which therefore must be made of very expensive steel.

SUMMARY OF THE INVENTION

The invention accordingly is based upon the proposition of eliminating the difficulties which have been described by providing a process which produces a finished product of uniform hardness and good porosity, requires only a relatively small expenditure for heat-resistant steel, and is distinguished by great operating reliability (particularly in preventing operating difficulties from formation of deposits and rings in a rotary kiln).

This object is achieved in accordance with the invention in that the material is dried upon a traveling grate while being preheated to such an extent that during the final firing in a kiln there is a uniform distribution of heat throughout the cross section of the kiln.

The invention is based upon a surprising discovery:

As extensive tests have shown, the nonuniform distribution of heat throughout the cross section of a kiln, which usually occurs in the prior processes (with feeding of more or less moist raw material) is completely eliminated, if a dried and presintered material is supplied to the kiln. In the pelletizing of iron ore, for example, it has proved to be sufficient if the internal temperature of the pellets entering the kiln is about 700° C.

This surprising discovery may perhaps be explained in the following manner:

When the drying of the moist raw material takes place in the upper zone of the kiln, the water vapor which is driven off must find or form channels through the layers of material. Since more or less sharp variations in moisture content generally occur within the layer of material, there is a nonuniform distribution of the channels throughout the cross section of the kiln. The hot gases flowing through the drying zone of the kiln follow mainly the channels which have been formed by the water vapor which was driven off. There results a nonuniform distribution of heat throughout the cross section of the upper zone of the kiln, which also results in the lower zone of the kiln as the material travels downward.

However, if in accordance with the process of the invention material which is already dried and presintered is supplied to the kiln, the effect which has been described is practically eliminated. As a result, a very uniform distribution of heat over the entire cross section of the kiln is attained, as shown by numerous tests.

Accordingly, the finished product produced in accordance with the process of the invention possesses a very uniform hardness. Since rotary motion does not take place in the firing zone, the finished product also exhibits the desired high porosity.

On the traveling grate which is used for drying and presintering, as well as during delivery from the traveling grate into the kiln, the material is handled very gently and is not subjected to any appreciable mechanical stress. Also, since the mechanical stresses to which the material is subjected in the kiln are substantially less than those to which it is subjected in a rotary kiln, the presintering on the traveling grate in the process according to the invention does not need to be carried nearly as far as in the known process which employs a rotary kiln following the traveling grate. Accordingly, the present process involves a lesser thermal loading of the elements of the traveling grate, which therefore may be made of cheaper material.

By the elimination of a rotary kiln, the operating difficulties (deposits and formation of rings of material) which are connected with a rotary kiln are also eliminated.

The heat which is required in the individual zones of the heat-treating apparatus permits the local heat requirements to be accommodated in an optimal manner—as will be explained hereinafter in more detail in connection with an embodiment of the invention—so that a very favorable heat balance is provided.

The process according to the invention can be employed for the heat treatment of material which is to be produced in the form of particles or briquettes (for example granules or pellets), of all kinds, e.g. for the firing or sintering of the materials hereinbefore named, and also for the puffing of clay or the like.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a diagrammatic view of a preferred form of apparatus for practicing the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus for carrying out the process according to the invention which is illustrated in the drawing comprises a traveling grate **1** with a drying chamber **2** and a presintering chamber **3**, as well as a kiln **4** with a final firing zone **5** and a soaking zone **6**, together with a traveling grate **7** with two cooling chambers **8** and **9**.

The raw material which is fed by a hopper **10**, for example a granulated material, is first dried in the chamber **2** of the traveling grate **1**, and is then presintered in the chamber **3** of the traveling grate to such an extent that there is a uniform distribution of heat over the entire cross section of the kiln **4** in the zone **5** during the final firing. The material remains at the final firing temperature for awhile longer in the soaking zone **6** of the kiln **4**, and is then cooled in the chambers **8** and **9** of the traveling grate **7**.

The cooling air is supplied to the traveling grate **7** by a blower **11**, and flows upward through the layer of material which is present on the traveling grate **7**. The cooling air discharged from the chamber **9** is supplied by a blower **12** to the burners **13** of the kiln **4**, which are located at about half the height of the kiln.

The gases exhausted from the kiln **4** flow to the chamber **3** of the traveling grate **1**.

This chamber **3** is also supplied through a pipe **14** with a portion of the stream of cooling air exhausted from the chamber **8** of the traveling grate **7**, which serves as combustion air for the burner **15**, which is provided for supplemental heating of the presintering chamber **3** of the traveling grate **1**.

A further portion of the stream of cooling air exhausted from the chamber **8** is supplied through a duct **16** to the drying chamber **2** of the traveling grate **1**. The gases which are drawn downward in the chambers **2** and **3** of the traveling grate **1** through the layer of material are withdrawn by a blower **17**.

By means of the dampers indicated in the drawing, the following approximate pressure conditions are maintained in the individual pressure and suction chambers of the apparatus:

Drying Chamber **2**	about −20 mm. of water
Presintering Chamber **3**	about −50 mm. of water
Cooling Chambers **8** and **9**	about −10 mm. of water
Suction Zone under the Chambers **2** and **3**	about −100 mm. of water
Pressure Zone under the Cooling Chambers **8** and **9**	about +150 mm. of water
Pressure of the Blower **12**	about +1,000 mm. of water

The soaking zone **6** which is provided beneath the final firing zone **5** of the kiln **4** serves, on the one hand, to prolong the dwell of the material at the final firing temperature, and on the other hand to prevent the burning gases which are introduced into the kiln **4** in the region of the burners **13** from being discharged into the cooling zone.

If the thickness of the bed of material and thus the resistance to flow of gas above and below the burners **13** is approximately equal, then it will be assured, with the pressure conditions in the apparatus which have been specified, that the streams of gas and air will travel in the desired directions.

The heat balance of the apparatus is exceptionally favorable, because heat losses can be kept very low by an insulating lining of the traveling grate chambers and the kiln, as well as by external insulation of the ducts, because the sensible heat of the fired material, up to about 70 percent, is returned to the system by utilization of the cooling air, and because the exhaust gas temperature at the blower **17**, depending upon the moisture content of the raw material, can be maintained between 100° and 200° C.

I claim:

1. A continuous method of heat treating granular and pelleted materials, comprising the steps of heating moist raw material to a temperature of at least 700° C. on a traveling grate, discharging the material at such temperature directly from the traveling grate into the top of a vertical shaft portion of constant cross section having a firing zone therein, maintaining such shaft portion filled with the material, while causing the material to settle therein by withdrawing material continuously below such shaft portion, and firing the material in such shaft portion, whereby a uniform temperature is maintained throughout the cross section at each level in such shaft portion.

2. A method according to claim **1** comprising the step of causing the material to settle through an unheated soaking zone below the vertical shaft portion.

3. A method according to claim **1** comprising the step of cooling the material on a second traveling grate as it is withdrawn.

4. A method according to claim **3** comprising the step of firing a burner to heat the material on a portion of the first traveling grate.

5. A method according to claim **4** comprising the steps of supplying cooling air to cool the material on the second traveling grate, and conducting the spent cooling air partly as combustion air to the vertical shaft portion, partly as combustion air for heating the material on a portion of the first traveling grate, and partly as a drying medium for drying the material on a preceding portion of the first traveling grate.

6. A method according to claim **5** comprising the step of supplying the products of combustion from the vertical shaft portion to heat the material on the first traveling grate.

7. Apparatus for heat treating granular and pelleted materials, comprising a first traveling grate which travels through a drying zone and then through a heating zone, a vertical shaft portion of constant cross section, arranged to permit material to fall directly off the end of the first traveling grate into the top of the vertical shaft portion, a soaking zone below such shaft portion, a second traveling grate which is arranged to withdraw material at the lower end of such soaking zone and which travels through a cooling zone, a burner which fires into the lower end of such shaft portion, of constant cross section above the soaking zone, and means for supplying products of combustion to the heating zone of the first traveling grate to preheat the material to such a degree that a uniform temperature is maintained throughout the cross section at each level in the vertical shaft portion.

8. Apparatus according to claim **7** comprising a supplemental burner which fires into the heating zone of the first traveling grate, and air passages for supplying cooling air to the second traveling grate and for conducting the spent cooling air partly as combustion air to the vertical shaft portion, partly as combustion air for the supplemental burner, and partly as a drying medium to the drying zone of the first traveling grate.