FIG. 1

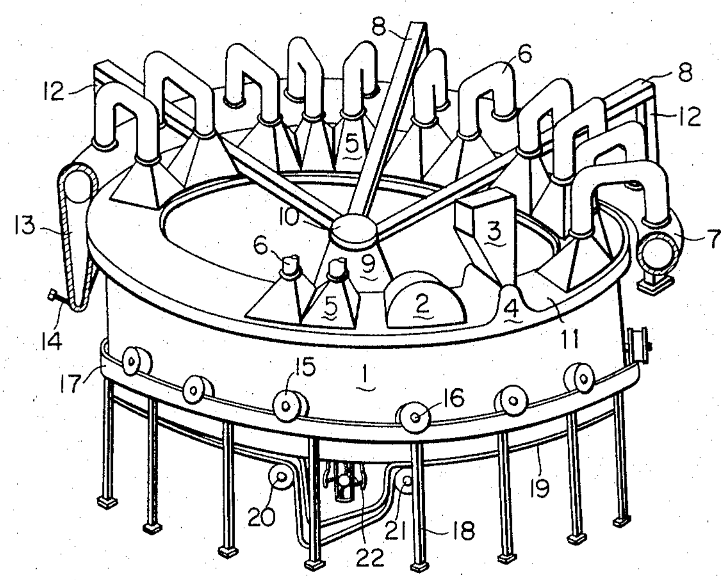

FIG. 2

A – A

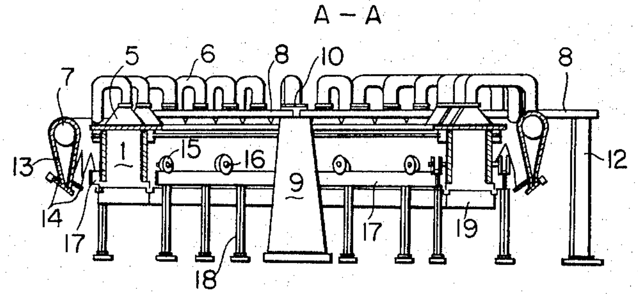

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FIG. 3

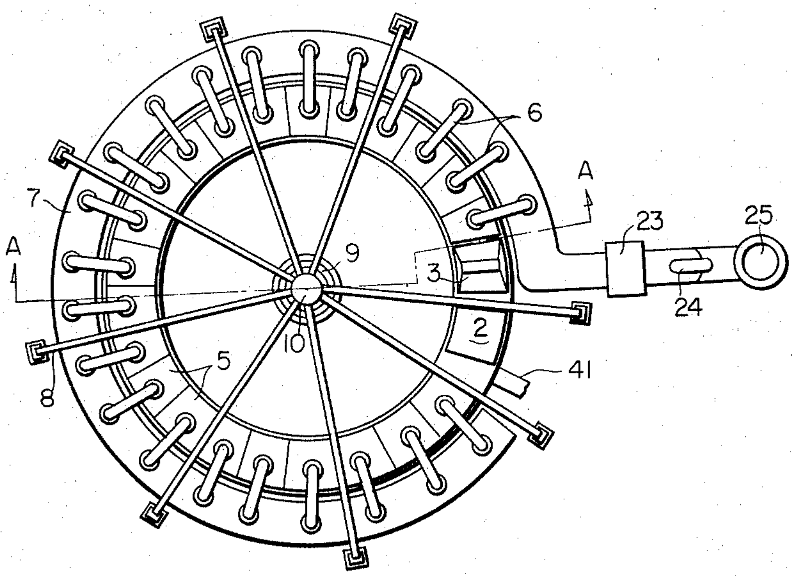

FIG. 4

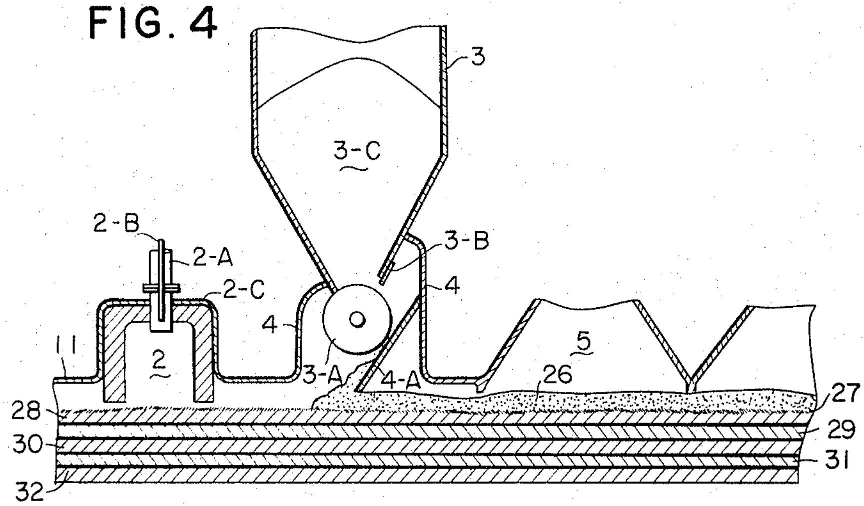

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FIG. 5

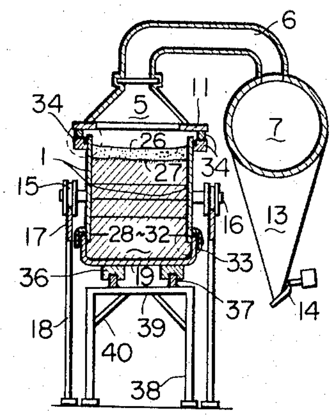


FIG. 6

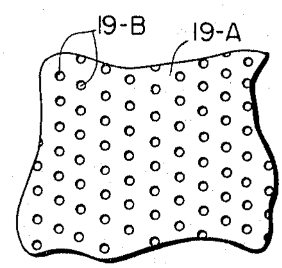


FIG. 8

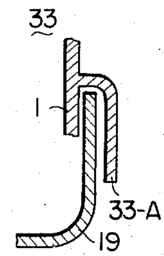


FIG. 9

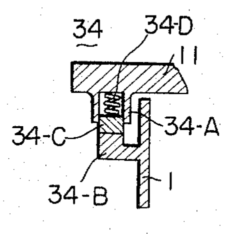


FIG. 10

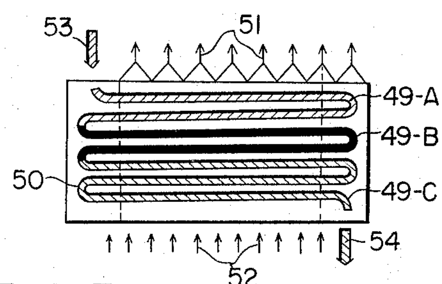
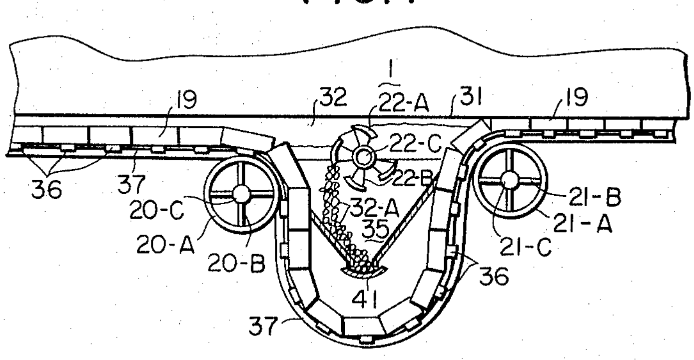


FIG. 7



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3,370,937

PROCESS FOR CONTINUOUS BAKING OF POWDERED OR GRANULAR RAW MATERIALS FOR PRODUCING IRON

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Claims priority, application Japan, Sept. 22, 1964, 39/54,264
5 Claims. (Cl. 75—5)

This invention relates in general to a process for continuous baking of powdered or granular materials and more particularly to a process for continuous baking of such raw materials for producing iron as powdered ores and pellets.

The heretofore widely known apparatus for sintering powdered or granular raw materials; for example, powdered iron ores, are of the Dwight Lloyd type, the Greenawalt type, and so on. Almost all of these types of apparatus employ the baking process based on downward suction, accordingly being large in heat loss: That is to say, when the raw material charge consisting of a powdered ore containing a fuel is introduced onto the grate in one of the sintering machines and is ignited by an igniting furnace and the gas is exhausted by downward suction, air passes downwardly through said raw material charge and causes the fuel contained in the raw material to burn thus sintering the powdered ore. The sintering is completed when said burning has reached the surface of the grate, and then, the sinter is discharged. However, some of the sintered ore in the lower layer remains red hot, thus giving rise to a considerable amount of heat loss. On the other hand, the conventionally known furnaces for baking pellets and the like are a shaft furnace and a moving grate type furnace, which is similar to the above stated sintering apparatus. Nevertheless, the prior, pellet baking processes are basically the same as the sintering process in the aforesaid sintering apparatus and discharge the sintered pellets in a red hot state, with consequent great heat loss.

The present invention is to overcome such a defect as mentioned above for efficient baking of powdered or granular matter and aims to provide a process for baking powdered or granular raw materials for iron production, specifically, powdered ores, pellets, and so forth, in an exceedingly heat-economical and continuous manner by the use of an annular rotary furnace.

The present invention is characterized in that a powdered or granular material is continuously charged in an annular rotary furnace in such a way that the powdered or granular material charge forms a plurality of layers continuously and spirally by virtue of the revolution of the rotary furnace; the plurality of charge layers are baked and cooled while successively and continuously descending in accordance with the rotation of the furnace, said baking being carried out by keeping a nearly middle part of said plurality of material layers as burnlayers by means of upward draft fed from the lower part of the furnace; and the baked material layers, after being cooled while descending in accordance with the revolution of said rotary furnace, are cut out by means of a conveyer provided on the periphery of the bottom of the rotary furnace so as to be inclined at some angle and to move synchronously with the furnace rotation and a cutting device set between the starting and ending points of the above-mentioned inclination of the conveyer, and thus the present invention makes it possible to produce baked ores very efficiently.

The features of the present invention will be more fully

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understood from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an oblique view showing an apparatus embodying the present invention,

FIG. 2 is a cross-sectional view taken on the line A—A in FIG. 3,

FIG. 3 is a plane view of the apparatus shown in FIG. 1,

FIG. 4 is a schematic sectional view illustrating the material charging device, igniting device, wind boxes, charged material layers, and so forth in the apparatus embodying the present invention,

FIG. 5 is a cross-sectional view of the baking furnace in the embodiment of this invention,

FIG. 6 is a schematic fragmentary view of the conveying pallet in the embodiment of this invention.

FIG. 7 is a schematic sectional view illustrating the apparatus for breaking and scraping the material baked in the above stated furnace,

FIG. 8 is a cross-sectional view showing the junction of the pallet side plate and the furnace body side plate in the embodiment of this invention.

FIG. 9 is a cross-sectional view of the seal portion between the furnace body and hood in the embodiment of this invention, and

FIG. 10 is a schematic sectional view illustrating the baking process according to the present invention.

The present invention aims to bake mainly a powdered or granular raw material such as a powdered ore, about 0.25 mm. to 3 mm. in particle diameter, suitable as a sintering material, or pellets, several millimeters in grain size, made of a finely powdered ore which is below 0.25 mm. in particle diameter so as to be suitable as a pelletizing material, and the apparatus embodying the principle of this invention is a vertical and annular rotary furnace for continuous baking due to upward draft.

Referring now to the drawings, and particularly to FIG. 10, the material to be charged is put, as indicated by an arrow **53**, into a cylindrical furnace body **50** so as to form spiral layers.

The number of the spiral material layers is preferably 3 to 12 but should not be limited thereto. The layer number must be decided after full inquiry into both draft resistance and productivity.

FIG. 10 shows seven material layers for the sake of simplicity. Considering all the charged material layers, the upper layers are indicated as **49**–A and the middle layers, which constitute burning layers, are shown as **49**–B.

The lower layer, indicated at **49**–C, is cooled so that the material temperature decreases as the layer position descends, and the layer just under the burning layers is in a red hot state.

It is usually desirable in the furnace of this invention to adjust the temperature of the lowest baked material layer just before the discharge to 300° C. or below. The present invention is characterized by the draft forced upward as shown by arrows **52** in FIG. 10 or the gas suction directed upward as shown by arrows **51**, and the cold air passes through the layers of the ore baked as described above, cooling the baked ore layers, namely, being heated by said layers, and therefore, the temperature of the air thus heated is fairly high when the air reaches the burning layers. Consequently, the thermal efficiency is very high and the fuel consumption is remarkably low. In addition, the fuel-contained material to be baked has only to be ignited once around the annulus, and insofar as the staying position of the burning layers is always adjusted so as not to allow the fire to be extinguished, it is not necessary to repeat ignition. Therefore, the igniting fuel needs to be used only at the beginning of the burning so that the fuel consumption is markedly low. Moreover, the upward draft system allows the fan ventilating pressure to be low, and further the cylindrical furnace shape requires only a narrow plant site; thus, the present invention contributes greatly also to the improvement of furnace equipment and installation.

As will be understood from the foregoing description, the process according to the present invention is entirely different from the conventional ones and remarkably high in efficiency. An exemplary apparatus of this invention will hereunder be outlined in connection with FIGS. 1 to 3. The reference numeral 1 represents a rotary cylindrical furnace body, 2 denotes an igniting device, 3 indicates a charging hopper, 4 refers to a charging device, 5 stands for wind boxes, 6 for suction branch pipes, 7 for a main exhaust pipe, and 8 for beams for suspending the wind boxes and a furnace hood 11. The numeral 9 designates a central strut supporting the beams 8, and a metal part 10 serves to fix the beams 8 to the strut 9. Pillars 12 support the beams 8. The numera 13 denotes a primary dust collector, 14 refers to dust discharging flap valves, 15 represents guide rollers and concurrently drive rollers for supporting and rotating the furnace body 1, 16 indicates the roller shafts, and 17 stands for roller guide rails, which are supported by struts 18. The numeral 19 denotes a conveyer, 20 is a head drum for driving the conveyer 19, 21 is a tail drum for the conveyer 19, and 22 represents a product breaking device. The numeral 23 stands for a secondary dust collector, 24 for a fan, 25 for an exhaust stack, and 41 for a conveyer for carrying out the baked and broken ore.

FIG. 4 is a cross-sectional view illustrating the arrangement of the material charging device, wind boxes, charged material layers, and so forth in the embodiment of this invention to clarify the baking process. The reference numeral 3 represents a material charging hopper, and 3–C is the material. A gate 3–B is provided for adjusting the charging rate, and 3–A denotes a drum feeder for charging the material. The numeral 4 indicates the cover of the charging device, 4–A refers to a material flow-down board, 11 stands for a furnace body hood, 5 for the wind boxes, and 2 for an igniting furnace (heating furnace). An air pipe 2–A and a gas pipe 2–B constitute an ignition burner. The numeral 26 designates a charge layer to be baked, 27 is a burning surface of a material layer, 28 is a baked material layer still in a red hot state, and 29, 30, 31 and 32 refer to baked material layers, which are cooled to temperatures different decreasingly in the sequence.

FIG. 5 is a cross-sectional view of the baking furnace in the embodiment of this invention. The wind boxes 5 are connected to the main exhaust pipe 7 by means of the connecting pipes 6. The numeral 13 denotes the primary dust collector, 14 indicates the dust discharging flap valves, and 34 designates a sealing device provided between the furnace body 1 and the fixed furnace hood 11. The numeral 26 refers to the charged material layer to be baked, 27 stands for the burning material layer, and 28 to 32 represent the baked material layers. The numeral 15 stands for the guide and drive rollers, 16 for the shafts of the rollers, 17 for the guide rails, 18 for the struts supporting the guide rails, 19 for the conveyer, 33 for the fitting portions of the conveyer and the furnace body, 36 for recessed sliding members fixed to the bottom of the conveyer, 37 for stationary protrusive members, 38 for conveyer supporting struts, 39 for conveyer bearing beams, and 40 for beams reinforcing the struts 38 and beams 39.

FIG. 6 shows the bottom plate 19–A of the conveyer 19. The plate has holes 19–B, through which the air required for baking is forced or sucked upward.

FIG. 7 shows the device for breaking and scraping the baked ore on the conveyer in the embodiment of this invention. The numeral 19 represents the conveyer, 36 denotes the recessed sliding members attached to the conveyer, 37 designates the stationary protrusive sliding members, 20–A stands for the tire of the driving wheel, 20–B refers to the spokes of the driving wheel, and 20–C indicates the shaft thereof. The numeral 32 refers to the baked ore layer subjected to final cooling, 32–A stands for the baked ore fragments, 35 indicates a baked-ore receiving hopper, 41 denotes the baked-ore conveyer, 22–A designates the blades of the breaking device, and 22–B represents the spokes and shaft thereof, respectively. The numeral 31 denotes the baked ore left unscraped, and 21–A, 21–B and 21–C, stand, respectively, for the tire, spokes, and shaft of the tail drum.

FIG. 8 illustrates the details of the engaging portions of the furnace body and the conveyer 19, and 33–A indicates a cover for the conveyer 19, the cover being integral with the furnace body 1.

FIG. 9 details the sealing device 34 between the fixed furnace hood 11 and the rotary furnace body 1, and 34–A denotes the sealing cover, 34–C designates a bar having a sliding surface, 34–D indicates springs forcing the bar 34–C, and 34–B is a sliding bar fixed to the furnace body 1. The bar 34–B slides in air-tight contact with the bar 34–C.

The baking process of the present embodiment, so constructed as described above, will be explained hereinafter in conjunction with FIG. 4. The material to be baked is first put into the charging hopper 3 and introduced, through the rotating drum feeder 3–A and the material flow-down board 4–A, into the furnace body 1 rotated by the guide and drive rollers 15. (Refer to FIGS. 1 and 2.) Normally, the thickness of the newly charged material layer is preferably 200 to 250 mm. The thickness, however, should be determined in accordane with the baking speed and the furnace rotating speed (which is variable and normally about four turns per hour). Since the newly charged material forms a layer having a thickness of about 200 to 250 mm. over the layer of the material charged during the previous turn of the furnace, and because of the employment of upward draft, the burning of the preceding layer shifts to the subsequent layer so that the burning layers always keep their levels, thus allowing the charged material layers to be baked continuously.

Next, when the ore baked and cooled has rotated around the furnace center one turn while in contact with the conveyor 19, which, as shown in FIGS. 1 and 7, is inclined by a slight angle in the peripheral direction and fixed to the furnace body 1 so as to revolve together with the furnace body, the baked material reaches the breaking device 22 in such a state as said material projects downwardly below the bottom of the furnace body 1 by about 200 to 250 mm. The material projection indicated at 32 is broken and scraped by means of the rotating breaking machine 22. The pieces of the broken material drop into the collecting hopper 35 and are assembled on the conveyor 41, which carries the product out of the furnace.

The baked material 31 remaining after the scraping of the projecting layer 32 again rides on the conveyor 19 and makes a round, and accordingly projects downward by 200 to 250 mm. just as in the case of the foregoing baked material layer 32. The projection is again scraped. By such scraping as mentioned above, the uppermost material layer is lowered by the thickness (200 to 250 mm.), and therefore, the material to be baked can be added, as the furnace rotates, so as to form the layer 26 having the same thickness. Thus, the furnace always has a uniform thickness of material layers all along the periphery.

Although the thickness of the scraped material has been specified above as about 200 to 250 mm., the thickness is not to be restricted to the exemplary values but to be determined in view of the thickness of the charged material layers. Besides, as to the relation between the charging position and the breaking and scraping position, the practical embodiments suggest, in a non-limitative sense, that it is most preferable to provide the breaking device just in front of the charging device in the rotational direction. However, it is necessary to separate devices sufficiently apart from each other for the charged material to be free from direct transmission of the vibration due to the breaking operation.

The fan **24** is positioned as shown in FIG. 3 to let out the exhaust gas: The suction of the fan **24** causes the air to pass through the holes **19–B** bored in the bottom plate **19–A** of the conveyor **19** and through the baked material layers **28** to **32**, which heats the air up to a high temperature. The hot air having reached the burning material layers **27** causes the material layers to burn, and the combustion gas passes the material layer **26**. The exhaust gas, at 100° C. or below, is sucked through the wind boxes **5**, the connecting pipes **6**, the exhaust main pipe **7**, the primary dust collector **13** and the secondary dust collector **23**, into the fan **24** and exhausted through the stack **25**.

As is apparent from the foregoing description, the present invention contemplates charging the baking material continuously, and breaking and scraping the baked material at the bottom of the furnace, and further enabling the air to flow upward through the hot baked material so that, while cooling the material, the air is heated to a high temperature before entering the burning layers; thus contributing greatly to fuel saving.

The apparatus embodying the present invention, with the above described construction and operation, has the following effects and advantages as compared with the conventional sintering equipment or pellet baking facilities (of the moving grate type, the grate kiln type, and the like).

(a) The building cost is low. (No cooler is necessary.)

(b) The igniting fuel needs to be supplied only while the furnace makes one revolution at the beginning of the operation.

(c) The area of the plant building site may be small.

(d) No cooling equipment is needed, and the air directed toward the burning material layers gets hot while cooling the baked material; therefore, it is possible to economize baking fuel remarkably.

(e) The yield of the baked material can be increased greatly: In the conventional furnaces, the yield of material from the surface layer is reduced markedly and, in addition, the quality (concerning the strength, desulfurization, and so on) is low whereas the furnace of the present invention allows no surface layer to form, thus being free from such defects as mentioned above.

(f) The present invention necessitates no equivalent to the grate bars in the conventional furnaces, and the floor plate of the conveyor in the furnace of this invention is equivalent to the floor grating of the cooler. Thus, the present invention gets rid of the burden of the expensive grate bars.

(g) Since the burning material layers are always covered with the newly charged material and therefore never have the upper surface exposed during the operation (it being desirable, of course, to perform automatic operation so as to keep the condition), the temperature at the entrance to the fan is always below 100° C., which is much lower than the conventional fan entrance temperature of 150 to 200° C. This fact is very profitable in view of furnace design and fan efficiency. Accordingly, the price of the fan to be purchased may be markedly low.

Thus, the present invention is widely advantageous and serves for reduction of cost.

What is claimed is:

1. A process for the continuous baking of powdered granular raw materials for producing iron comprising steps of continuously charging a powdered granular raw material into an annular rotary furnace, continuously forming a plurality of spiral layers of said powdered granular material with said charging, keeping a nearly middle part of said plurality of charged layers as burning layers by means of a draft directed upward from the bottom of the furnace while said plurality of charged layers are made to descend in accordance with the revolution of the furnace, and continuously cutting out the baked material from the layer which has reached the bottom of the rotary furnace after being subjected to burning and then cooled while descending to said bottom in accordance with the rotation of the furnace.

2. A process for the continuous baking of powdered raw materials for producing iron comprising steps of continuously charging a sintering powdered ore mixed with fuel into an annular rotary furnace, continuously forming a plurality of spiral layers of said sintering powdered ore with said charging, keeping a nearly middle part of said plurality of charged layers as burning layers by means of a draft directed upward from the bottom of the furnace while said plurality of charged layers are made to descend in accordance with the revolution of the furnace, and continuously cutting out the baked material from the layer which has reached the bottom of the rotary furnace after being subjected to burning and then cooled while descending to said bottom in accordance with the rotation of the furnace.

3. A process for the continuously baking of granular raw materials for producing iron comprising steps of continuously charging pellets with fuel into an annular rotary furnace, continuously forming a plurality of spiral layers of said pellets with said charging, keeping a nearly middle part of said plurality of charged layers as burning layers by means of a draft directed upward from the bottom of the furnace while said plurality of charged layers are made to descend in accordance with the revolution of the furnace, and continuously cutting out the baked material from the layer which has reached the bottom of the rotary furnace after being subjected to burning and then cooled while descending to said bottom in accordance with the rotation of the furnace.

4. A process for continuously baking powdered granular raw materials for producing iron comprising steps of continuously charging a powdered raw material into an annular rotary furnace, continuously forming seven spiral layers of said powdered material with said charging, keeping the third and fourth layers from the top of said charged seven layers as burning layers by means of a draft directed upward from the bottom of the furnace while said charged seven layers are made to descend in accordance with the revolution of the furnace, and continuously cutting out the baked material from the layer which has reached the bottom of the rotary furnace after being subjected to burning and then cooled while descending to said bottom in accordance with the rotation of the furnace.

5. A process according to claim **1** wherein the number of the charged material layers is 3 to 12.

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