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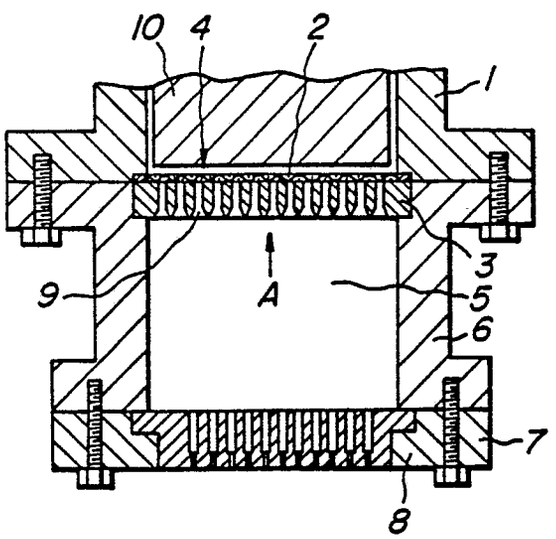
(54) Apparatus for refining moldable batch bodies and method of molding ceramic bodies by using the apparatus.

(57) An apparatus for refining moldable ceramic batch bodies is provided within a molding cylinder (1) upstream of a molding die (8). The refining apparatus comprises a screen (2) and a screen supporting perforated plate (3) having a plurality of body passages (9) therethrough. To avoid inclusion of air in the molded product due to separation of the noodles emerging from the perforated plate (3), each body passage (9) is tapered to diverge towards the body chamber (5) defined between the molding die (8) and the perforated plate (3). Thereby the noodles extruded through the passages (9) are urged towards each other by a component of force in the direction perpendicular to the extrusion direction.

FIG_1



EP 0 364 205 A2

APPARATUS FOR REFINING MOLDABLE BATCH BODIES AND METHOD OF MOLDING CERAMIC BODIES BY USING THE APPARATUS

The present invention relates to an apparatus for refining moldable ceramic batch bodies or the like and method of extrusion or injection molding ceramic green bodies by using such a refining apparatus.

Hitherto, an extrusion molding apparatus for molding ceramic green bodies has been known as disclosed in U.S. Patent No. 3,888,963 as an example. Such an extrusion molding apparatus is illustrated in Fig. 4 by a sectional view and comprises an extrusion cylinder 19 having a plunger 20 movable within an extrusion chamber 26 in which a flow homogenizer assembly 22 is provided upstream of an extrusion die 21 in order to refine and homogenize a batch body to provide ceramic green bodies having no faults. The homogenizer assembly 22 comprises a screen 23 and a screen supporting plate 24 which is positioned downstream of the screen and provided with a plurality of passages 25 extending therethrough. Each passage 25 is chamfered at its inlet end.

In the aforementioned extrusion molding machine, when an extrudable ceramic batch body is fed into the extrusion chamber 26 defined between the flow homogenizer assembly 22 and the extrusion die 21 through the passages 25 in the screen supporting plate 24, a component of force in the direction perpendicular to the extrusion direction is not generated between adjacent noodles of the batch body passed through the adjacent passages 25, since each passage 25 is straightly extended through the supporting plate 24. As a result, an interface is formed between the adjacent noodles which is carried into the extrusion die, resulting in the extruded body having air voids and the other faults. Accordingly, extruded bodies produced by using such a conventional extrusion molding apparatus are less reliable and particularly thus produced ceramic structural bodies will give rise to large problems.

It is an object of the present invention to eliminate the aforementioned disadvantages and to provide an apparatus for refining moldable ceramic batch body adapted for producing reliable molded bodies without faults and a method of molding ceramic green bodies by using said refining apparatus.

According to the present invention, an apparatus for refining moldable batch bodies is provided within a molding cylinder upstream of a molding die for molding ceramic green bodies. The apparatus comprises a screen and a screen supporting perforated plate having a plurality of body passages extending therethrough. Each body passage is tapered to diverge towards a body chamber defined between the molding die and the perforated plate.

According to the another aspect of the present invention, a method of molding ceramic bodies is characterized in that a moldable batch body is extrusion or injection molded by use of the apparatus for refining the moldable batch body comprising a screen and a screen supporting perforated plate having a plurality of body passages tapered to diverge towards a body chamber defined between a molding die and the perforated plate.

In the above arrangement according to the invention, the screen effects to remove foreign matters included in the batch body. The perforated plate is necessary for supporting the screen since the screen has a low mechanical strength itself. The body passages in the perforated plate are tapered to diverge towards the body chamber and as a result the batch body is extruded in the form of noodles through the body passages along the tapered inner surface of the body passages to generate a component of force in the direction perpendicular to the extrusion direction so that the noodles extruded from the body passages into the body chamber are pressed and united to each other. Therefore, the problems of air void and the other faults in the interface formed between the adjacent noodles which could not be dissolved in the convention refining apparatus can be greatly reduced to provide a high reliable molded bodies without faults. The screen preferably has a size of mesh as small as possible in order to remove the fine foreign matters included in the batch body and the size of mesh may be selected in corresponding to the kind of the batch body.

The taper angle of the tapered body passages may be 150~3°, preferably 90 ~10°. If the taper angle is larger than 150° or smaller than 3°, the component of force in the direction perpendicular to the extrusion direction may be small, respectively, so that an interface including voids and the other faults will be formed between the adjacent noodles, Moreover, it is preferable that the adjacent tapered body passages are overlapped to each other at the outlet end on the side of the molding die as shown in Fig. 2a in order to improve the pressing of noodles or unoverlapped flat regions 9-2 in Fig. 2b is less than 30%, preferably 10% of the total area of the tapered regions and flat regions. If the unoverlapped regions are larger than 30%, clearances may occur between the adjacent noodles resulting in interfaces including faults.

The invention will hereinafter be described

more in detail with reference to embodiments in the accompanying drawings.

Fig. 1 is a schematic sectional view illustrating an embodiment of an extrusion molding apparatus according to the present invention;

Figs. 2a and 2b are bottom views of different perforated plates according to the invention, respectively, taken in a direction shown by an arrow A in Fig. 1;

Fig. 3 is an enlarged sectional view of the perforated plate illustrating the configuration of body passages with tapered outlet portion; and

Fig. 4 is a schematic sectional view of a prior art extrusion molding apparatus.

Referring to Fig. 1 illustrating a schematic sectional view of an embodiment of an extrusion molding apparatus according to the present invention, an extrusion molding cylinder 1 includes a plunger 10 movable in the axial direction thereof and a homogenizing assembly 4 fixed at an open end of the extrusion cylinder 1 which is connected to a cylindrical side wall 6 defining a body chamber 5. The homogenizer assembly 4 for refining and homogenizing a batch body comprises a screen 2 of Tyler Standard screen scale 80 for removing foreign matters and a perforated plate 3 for supporting and reinforcing the screen 2 and is interposed between the extrusion cylinder 1 and one end of the cylindrical side wall 6. To the other end of the cylindrical side wall 6 is secured an extrusion molding die 8 by means of a die retaining ring 7. The perforated plate 3 has a plurality of body passages 9 extending therethrough. Each body passage 9 is tapered at the outlet portion on the side of the body chamber 5 to diverge towards the body chamber.

Figs. 2a and2b are bottom views of different embodiments of perforated plate 3 according to the present invention taken in a direction shown by an arrow A in Fig. 1. In the embodiment shown in Fig. 2a, each body passage 9 is tapered in all portion thereof to provide a tapered region 9-1. In the another embodiment shown in Fig. 2b, each body passage has a tapered region 9-1 similar to Fig. 2a and a flat region 9-2.

Fig. 3 is a sectional view of the perforated plate 3 illustrating the configuration of the body passages and their tapered regions.

Example

An extrusion molding machine was provided with the refining apparatus shown in Fig. 1 with the perforated plate shown in Fig. 3. Batch bodies having a chemical composition consisting of silicon nitride, silicon carbide and the like were loaded within the extruding cylinder 1 and extruded by means of the plunger 10. Foreign matters included in the extruded batch bodies were removed by the screen 2 of Tyler Standard screen scale 80. Each batch body was continuously fed in the form of a plurality of noodles into the body chamber 5 through the body passages 9 in the perforated plate 3 and after compacted the batch body was molded through the molding die 8 to a green body of predetermined shape.

The yield of green bodies extruded by the extrusion molding machine according to the present invention was as high as 98% and faults were scarcely occurred. On the other hand, the yield of green bodies extruded by the conventional extrusion molding machine as shown in Fig. 4 was as low as 30% and faults of 0.2~5 mm caused by unsufficient pressing between adjacent noodles were detected in an amount of one to fifteen per each green body.

Furthermore, the present invention also was applied to an injection molding machine and obtained similar effects.

It will be seen from the above description that according to the apparatus for refining moldable batch bodies of the present invention and the method of molding the ceramic molded bodies by using the refining apparatus, the batch bodies are refined through the screen to remove the foreign matters included in the batch bodies and the noodles are passed through the body passages diverging towards the body chamber to thereby be pressed together to be united without formation of interfaces and as a result high reliable molded green bodies having no faults are obtained.

Claims

1. An apparatus for refining moldable batch bodies which is provided within a molding cylinder upstream of a molding die for molding ceramic green bodies, said apparatus comprising a screen and a screen supporting perforated plate having a plurality of body passages extending therethrough, each body passage being tapered to diverge towards a body chamber defined between said molding die and said perforated plate.

2. An apparatus claimed in claim 1, wherein a taper angle of the tapered body passage is 150~3°.

3. An apparatus claimed in claim 1, wherein a taper angle of the tapered body passage is 90~10°.

4. An apparatus claimed in any one of claims 1 to 3, wherein adjacent tapered body passages are overlapped to each other at their outlet end on the side of the molding die.

5. An apparatus claimed in claim 4, wherein the

adjacent tapered body passages are overlapped to each other at their outlet end on the side of the molding die such that unoverlapped flat regions are less than 30% of the total area of the tapered regions and flat regions.

6. An apparatus claimed in claim 5, wherein the unoverlapped flat regions are less than 10% of the total area.

7. A method of molding ceramic bodies comprising a step of molding by extrusion or injection-molding using the refining apparatus claimed in any one of claims 1 to 6.

FIG_1

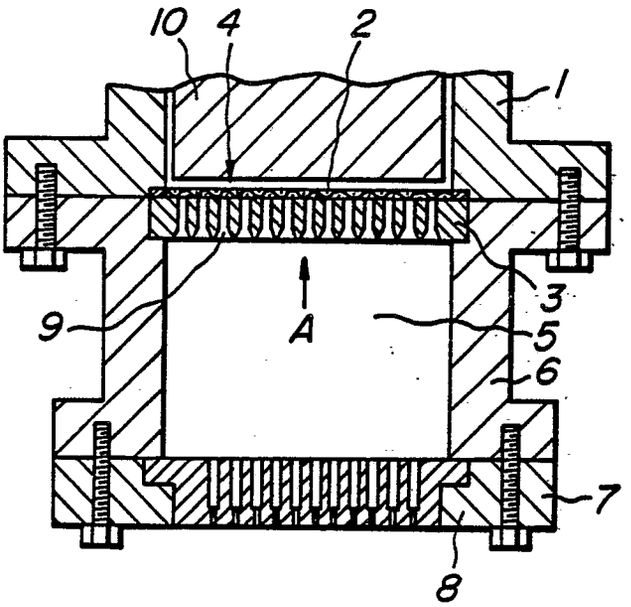


FIG_2a

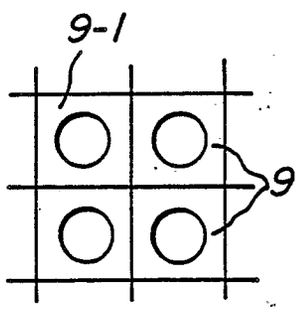


FIG_2b

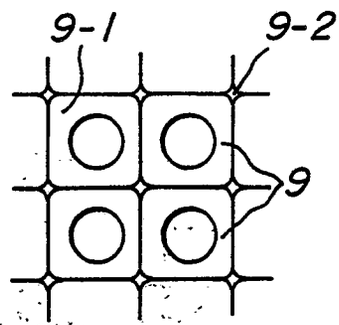


FIG_3

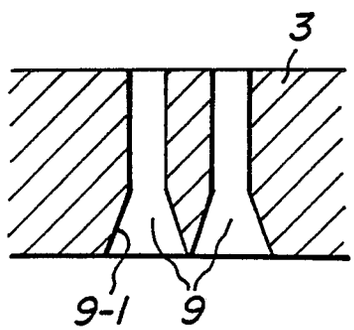


FIG_4