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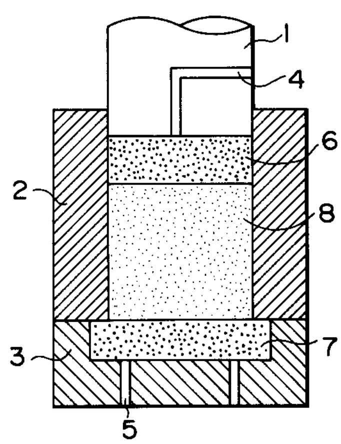
(54) **Process and mold for molding ceramics.**

(57) A process for molding ceramic slurry, which uses mold made wholly or partially of porous metal or ceramics, and a mold made wholly or partially of porous metal or ceramics for carrying out the above-mentioned molding process. Porous metal or ceramics 6 and/or 7 are placed between molds 2 and 3. Then the liquid is discharged through the porous materials by pressure slipcast molding and therefore the molding is carried out under the higher pressure compared with conventional art. Molded ceramic articles with high density and smoothed surface, could be surely made in a relatively short time.

FIG. I



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BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a molding process for various ceramic products, particularly to a pressure slipcast molding of ceramic slurry, and a mold used therefor .

2. Description of the Prior Art

In a pressure slipcast molding process, a mixture consisting of powder and liquid (hereinafter "slurry") is pressurized to discharge the liquid therefrom. In this process, the higher the pressure is, the more densely the powder is compacted. Thus, the resulting molded article has a high geometric stability and the liquid discharge from the slurry can be made in reduced time. In the conventional pressure slipcast molding, porous molds made from gypsum or plastics have been used for the liquid discharge, (e.g. Japanese Patent Publication No. 2-42321, Japanese Patent Laid-Open Nos. 60-70701, 63-3906 and 61-297103).

However, since these porous materials constituting the conventional molds do not have a sufficient strength, the molding pressure is, at most only 10 kg/cm^2 when a gypsum mold is used and about 50 kg/cm^2 when a plastics mold is used. If the molding pressure exceeding these upper limit is applied to the porous mold, such high pressure may bring about the breakage of the molds. Thus, there is limitation in improving the density of ceramic molded articles and it becomes impossible to mold in a short time, depending on the shape or the size. In the method of molding ferrite slurry and so on, a filter cloth 9 and a filter paper 10 are, as shown in FIG. 3, set at the frontal face of a metallic mold 3, which has holes of 1 - 3 mm inside diameter for dehydration. Only liquid (water) is discharged from the holes of the mold through the filter.

In the method as shown in FIG. 3, since the liquid discharge part consists of the filter cloth 9, filter paper 10 and mold 3 having the holes 4 for dehydration, a high molding pressure can be applied. However in this case, when pressure is applied, the powder in the slurry enters the holes for dehydration pressing on the filter paper or filter cloth and then it becomes protrusions 11 are formed on the surface of the molded product, corresponding to the holes as shown in FIG. 4. Therefore, an after-treatment is necessary to remove the protrusion from the molded product, thereby resulting in a high production cost.

SUMMARY OF THE INVENTION

With the above in view, the present invention was made to overcome the above and other problems encountered in the prior art.

It is an object of the present invention to provide a process for slipcast molding of ceramics with a smooth surface in which a higher pressure is applied as compared with a conventional process.

Another object of the present invention is to provide molds used for carrying out the above-mentioned molding process.

The basic idea of this invention is to enable the application of high pressure by using a mold made of a high-strength porous metal or ceramic material in a pressure slipcast molding process of a ceramic slurry.

To the above and other ends, the present invention provides a process for molding a ceramic slurry, in which a mold made wholly or partially of a porous metal or a porous ceramic is used.

The present invention also provides a mold made wholly or partially of a porous metal or a porous ceramic, for the purpose of molding ceramic slurry.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross-sectional view showing a casting method employing a casting mold according to an embodiment of the present invention.

FIG. 2 is a view similar to FIG. 1, showing a casting method employing a casting mold according to a modification of the present invention.

FIG. 3 is a view similar to FIG. 1 employing a conventional casting mold.

FIG. 4 is a vertical cross-sectional view showing a cast article obtained using the conventional casting mold.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The basic concept of the present invention consists in that, in pressure slipcast molding of ceramics, a casting mold made of metal or ceramic of a higher strength is employed to enable application of a higher pressure.

In case of using a material, whose main component is Fe, e.g. stainless steel, it becomes possible to develop a molding pressure of 100 kgf/cm^2. Even a pressure up to 1000 kgf/cm^2 can be developed depending on the mold's design. Metallic materials are not limited to Fe metals, Cu metals, Al metals and so on.

Similarly, in case of using a hard material, e.g. Al_2O_3 , a pressure not lower than 100 kgf/cm^2 may be developed. A pressure up to 1000 kgf/cm^2 is also possible depending on the mold's design. Ceramics materials are not limited to Al_2O_3 ceramics, Si_3N_4 ceramics, BN ceramics and so on.

Also, it is possible to polish the surface of porous metals and ceramics, to decrease their surface roughness, and to make it a mirror plane in some cases. Thus, when the smoothed surface is used for a mold touching the slurry, molded ceramic articles can be easily taken out of the mold and also be prevented from breaking. Furthermore, the surface appearance of the molded ceramic articles become excellent. In case of using ceramics for porous materials, ceramics have a high chemical resistibility against acid, alkali and so on. Ceramics are neither corroded nor rusted and have sufficient durability. And they are excellent in strength and toughness, compared with other materials, therefore they do not become fatigued and have sufficient durability mechanically too.

The larger the diameters of pores in the porous material are, the more easily liquid in the slurry is discharged. But if the pores are too large, ceramic powders in the slurry are carried away. Therefore the upper limit of the pores' size should be determined according to the diameters of ceramic powders in the slurry.

In the above-described casting method by the liquid discharge from the slurry, it is necessary that diameters of pores in the porous materials, which are components of a mold the wholly or partially, should be more than 0.1 μm so that dehydration and molding can be carried out in industrially practical time. If diameters of the pore are less than 0.1 μm, in case of using water for liquid of the slurry, the surface tension becomes higher, keeps the liquid (water) from flowing into pores of porous materials, and makes it difficult to discharge the liquid in the slurry through pores of porous materials.

The maximum diameter of the pores is twenty times as high as the diameter of the secondary particles of powders in the slurry and it can prevent the powders from flowing.

Namely, if the powders flow into pores in porous materials from the surface by the given pressure, the adherence between molded ceramic articles and porous materials becomes intense, by an anchor effect, and molded ceramic articles will be broken or chipped. When diameters of pores in the porous materials are less than twenty times as large as the diameter of the secondary particles in the slurry, we have confirmed that powders produce bridging and do not enter the inside of pores, and that the molding can be done in a short time and mold release can be easy.

When a surface roughness of the pore-free portion of porous metal or ceramics, whose surface touches the slurry, is more than 0.4 z, the adherence between molded ceramic articles and porous materials becomes intense by an anchor effect. Particularly in case of applying high pressure, the adherence between molded ceramic articles and porous materials becomes intense because of the pressure applied to the part and it makes mold release difficult.

When a surface roughness is less than 0.4 z, the adherence at the above-mentioned portions becomes weak to enable the molded articles to be released smoothly from the mold.

In the invention, it is also possible to set filter paper or filter cloth on the surface of porous metal or ceramics facing the slurry. Even if diameters of pores on the surface of porous metal or ceramics are so large as to let the powders in the slurry enter the pores, the filter prevents powders from entering them and makes release easier. And if the surface of porous metal or ceramics is rough, the filter does not bring about an anchor effect and makes release smooth. Because the filter, made of paper or cloth has high flexibility, therefore it is possible to release the filter from molded ceramic articles slowly without producing chips. Protrusions on the surface of ceramics, in the conventional method as shown in FIG. 4, do not enter pores of porous metal or ceramics through the filter and then molded ceramic articles have an excellent surface. In order to prevent powders in the slurry from passing through the filter and in order to get considerable speed for excluding the liquid, it is desirable that the average diameter of pores in the filter paper or filter cloth should be more than 0.1 μm and less than twenty times as large as the diameter of the secondary particles in the slurry. To discharge the liquid at satisfactory speed for industrial needs, the average diameter of pores needs to be more than 0.1 μm. If the average diameter is larger than twenty times as large as the average diameter of the secondary powder in the slurry, it causes efflux of powder, namely a permeation of the slurry through the filter for the same reason as discussed above. The paper filter may be formed of any material customarily employed for the paper filter, while the cloth filter may be formed of any material, such as synthetic fibers, e.g. polyester, nylon or acrylic fibers, or natural fibers, such as cotton, provided that such material can be woven or knitted to form a cloth.

It is also possible that water in the slurry is sucked dry through porous ceramics from the back and is discharged forcibly. In this case, filter paper and/or filter cloth could be placed on the surface of porous metal or ceramics facing the slurry. Such forcible suction makes it possible to shorten a stiffening time of powders in the slurry and is effective for a molded ceramic articles having an increased wall thickness.

The invention will be more clearly understood with reference to the following examples.

Example 1

A mixture of powders was made by adding Y_2O_3, Al_2O_3 as assistant agents to Si_3N_4 powder , having an average diameter of 0.7 μm, then mixing it in ethylalcohol. Water and binder were added to the mixture. Making use of a nylon ball mill, they were made into a slurry. The powder content of the slurry was set to be 40 vol.%.

Columns, having a diameter of 20 mm and a height of 20 mm, were molded out of the slurry. FIG. 1 shows a process for molding. Mold 3, having holes 5 for dehydration and attached to porous material 7, was set in mold 2 and the slurry was injected into it. The slurry was pressurized with a metallic pestle 1 fitted with a porous punch 6 at its terminal end. Water in the slurry 8 was discharged by applying pressure through porous materials 6, 7. As a result thereof, molded ceramic articles could be taken out.

A number of molded ceramic articles were made by this molding method under various conditions, changing porous materials and molding pressure. Table 1 shows results of the density of molded articles and molding time.

Table 1

No.	Porous materials	Molding pressure (kgf/cm^2)	Density of molded articles (%)	Molding time (sec.)
1	SUS 316	5	49.8	1000
2	SUS 316	20	50.7	250
3	SUS 316	100	61.6	45
4	SUS 316	1000	63.4	12
*5	gypsum	5	48.9	850
*6	gypsum	20	gypsum fractured	-
*7	resin	5	49.7	800
*8	resin	20	50.8	200
*9	resin	100	resin fractured	-

* indicates comparisons

Example 2

The slurry was made by mixing together Al_2O_3 powder having average diameter of 1 μm, distilled water using a ball mill and admixing with a binder. The powder content of the slurry was set to be 53 vol.%. Columns, having a diameter of 20 mm and a height of 20 mm, were molded out of the slurry using the molding method illustrated in FIG. 1.

Stainless steel, having different diameters of pores and surface roughness, was used as porous materials, and the molding pressure applied in this case was 200 and 800 kgf/cm^2.

The diameter of pores on the surface was determined by taking the average through observations under a microscope. Table 2 shows results of the density of molded articles, molding time and mold release properties with respect to the porous materials, under various conditions.

Table 2

No.	Molding pressure (kgf/cm^2)	Average diameter of pores of porous materials (μm)	Surface roughness of porous materials (Z)	Density of molded articles (%)	Molding time (sec.)	Status of mold release
1	200	0.07	0.2	-	not stiffened in 300	-
2	200	0.53	0.2	67.7	79	satisfactory
3	200	0.53	0.5	67.4	77	peeled off
4	200	4.8	0.3	68.8	53	satisfactory
5	200	4.8	0.6	68.7	54	peeled off
6	200	21.3	0.3	67.6	42	peeled off
7	800	0.07	0.2	-	not stiffened in 300	-
8	800	0.53	0.2	69.4	69	satisfactory
9	800	0.53	0.5	69.2	68	peeled off
10	800	4.8	0.3	70.7	47	satisfactory
11	800	4.8	0.6	70.5	45	peeled off
12	800	21.3	0.3	70.0	35	peeled off

Example 3

Y_2O_3, Al_2O_3 as assistant agents were added to Si_3N_4 powder having an average diameter of 0.5 μm. Then they were mixed in distilled water by making use of a ball mill. Some binder was added to the mixture and they were mixed further to make a slurry. The powder content of the slurry was 42 vol.%. Measurements of the particle size distribution indicated the mean particle diameter to be 0.53 μm.

Disks, having a diameter of 40 mm and a thickness of 5 mm, were molded out of the slurry.

FIG. 2 shows a process for molding. Conditions were changed variously; diameters of pores in the porous stainless steel, surface roughness and diameters of pores in the filter. Casting without filter and casting as illustrated in FIG. 3 were practiced for comparison. And molding pressure applied in this case was 300 kgf/cm^2.

Table 3 and 4 show how some conditions affect the molded ceramic articles and statuses of mold releasing. It may be seen from these Tables that satisfactory cast articles could be produced in accordance with the present invention.

Table 3

No.	Process	Filter present or none	Average diameter of pores of filter (μm)	Materials of filter	Average diameter of pores of metallic materials (μm)
1	FIG. 2	none	-	-	20.1
2	FIG. 2	none	-	-	72.2
3	FIG. 2	none	-	-	8.2
4	FIG. 2	filter	0.05	resin film	20.1
5	FIG. 2	filter	0.05	resin film	72.2
6	FIG. 2	filter	0.4	filter paper	20.1
7	FIG. 2	filter	0.4	filter paper	72.2
8	FIG. 2	filter	0.4	filter paper	8.2
9	FIG. 2	filter	5.0	filter paper	20.1
10	FIG. 2	filter	5.0	filter paper	72.2
11	FIG. 2	filter	5.0	filter paper	8.2
12	FIG. 2	filter	27.7	filter cloth	20.1
13	FIG. 2	filter	27.7	filter cloth	72.2
14	FIG. 2	filter	27.7	filter cloth	8.2 diameter of holes for the hydration
15	FIG. 3	filter	5.0	filter paper plus filter cloth	1200
16	FIG. 3	filter	5.0	filter paper plus filter cloth	2000
17	FIG. 3	filter	5.0	filter paper plus filter cloth	2400

Table 4

No.	Surface roughness of porous metallic materials (Z)	Density of molded articles (%)	Molding time (sec.)	Status of molded articles and mold releasing
1	0.2	62.3	24	peeled off on mold releasing
2	0.3	63.4	25	peeled off on mold releasing
3	1.0	62.2	30	peeled off on mold releasing
4	0.2	59.9	359	took long time in dehydration
5	0.3	59.8	354	took long time in dehydration
6	0.2	64.1	21	satisfactory
7	0.3	64.3	22	satisfactory
8	1.0	64.0	21	satisfactory
9	0.2	63.9	19	satisfactory
10	0.3	64.2	20	satisfactory
11	1.0	64.1	18	satisfactory
12	0.2	59.9	18	slurry permeated the filter
13	0.3	59.9	18	slurry permeated the filter
14	1.0	59.7	19	slurry permeated the filter
15	-	63.2	20	protrusions (about 1 mmϕ) formed on the molded articles
16	-	63.1	19	protrusions (about 1.7 mmϕ) formed on the molded articles
17	-	63.2	20	protrusions (about 2 mmϕ) formed on the molded articles

Example 4

A mixture of powders was made by adding Y_2O_3, Al_2O_3 as assistant agents to Si_3N_4 powder having an average diameter of 0.8 μm, mixing it, in ethylalcohol and by drying it. Deionized water and a binder were added to the mixture. Making use of a nylon ball mill, they were made into slurry. The powder content of the slurry was set to be 40 vol.%.

Columns, having a diameter of 10 mm and a height of 25 mm, were molded out of the slurry. The process for molding was the same as Example 1, as shown in FIG. 1. Molded ceramic articles were made under various conditions, using different kinds of porous materials and changing molding pressure in the process. Table 5 shows results of the density of molded articles and molding time.

Table 5

No.	Porous materials	Molding pressure (kgf/cm^2)	Density of molded articles (%)	Molding time (sec.)
1	Al_2O_3	2	50.5	840
2	Al_2O_3	20	51.3	220
3	Al_2O_3	200	63.5	32
4	Al_2O_3	950	64.7	9
*5	gypsum	2	49.2	720
*6	gypsum	20	gypsum fractured	-
*7	resin	2	49.9	720
*8	resin	20	51.2	200
*9	resin	200	resin fractured	-

*indicates comparisons

Example 5

Using a ball mill, containing balls of Al_2O_3, the slurry was made by mixing together Al_2O_3 powder having an average diameter of 1 μm, distilled water and some binder. The powder content of the slurry was to be 53 vol.%. Columns, having a diameter of 10 mm and a height of 20 mm, were molded out of the slurry. The process for molding was the same as Example 1, as shown in FIG. 1.

Al_2O_3, with different diameters of pores and surface roughness, was used. The cavity rate of the Al_2O_3 was 38 vol.%, and the molding pressure applied in this case was 200 and 800 kgf/cm^2.

The surface pore diameters were measured by observation with a microscope (SEM and optical microscope) and determined in terms of a mean value. Table 6 shows results of density of molded articles, molding time and mold release properties with respect to the porous materials under various conditions.

Table 6

No.	Molding pressure (kaf/cm^2)	Average diameter of pores of porous materials (μm)	Surface roughness of porous materials (z)	Density of molded articles (%)	Molding time (sec.)	Status of molded articles and mold releasing
1	200	0.07	0.2	-	not stiffened in 300	-
2	200	0.71	0.2	68.2	72	satisfactory
3	200	0.71	0.7	67.9	69	peeled off
4	200	8.7	0.3	69.3	50	satisfactory
5	200	8.7	0.7	69.2	51	peeled off
6	200	24.4	0.3	68.1	35	peeled off
7	800	0.07	0.2	-	not stiffened in 300	-
8	800	0.71	0.2	69.5	65	satisfactory
9	800	0.71	0.5	69.9	62	peeled off
10	800	0.71	0.7	69.7	64	peeled off
11	800	8.7	0.3	71.2	37	satisfactory
12	800	8.7	0.5	71.0	36	peeled off
13	800	8.7	0.7	71.0	33	peeled off
14	800	24.4	0.3	70.5	28	peeled off

Example 6

Y_2O_3 and Al_2O_3 as assistant agents were added to Si_3N_4 powder having an average diameter of 0.5 µm. Then they were mixed in distilled water by making use of a ball mill. Some binder was added to the mixture and they were mixed further to make the slurry. The powder content of the slurry was 42 vol.%. The average diameter was indicated to be 0.53 µm by measurement of the size distribution.

Disks, having a diameter of 40 mm and a thickness of 5 mm, were molded out of the slurry through the process for molding as shown in FIG. 2.

The porous material was Al_2O_3. And other conditions were changed variously; diameters and surface roughness of the porous materials and diameters of pores in the filter. Molding without the filter and molding as illustrated in FIG. 3 were also performed for comparison. And molding pressure applied in this case was 300 kgf/cm^2. Table 7 and 8 show how some conditions affect the molded ceramic articles and its status of molded articles and mold releasing. They also show that a satisfactory molded ceramic articles could be produced in accordance with the present invention.

Table 7

No.	Process	Filter present or none	Average diameter of pores of filter (µm)	Materials of filter	Average diameter of pores of ceramics materials (µm)
1	FIG.2	none	-	-	24.4
2	FIG.2	none	-	-	72.2
3	FIG.2	none	-	-	8.7
4	FIG.2	filter	0.08	resin film	24.4
5	FIG.2	filter	0.08	resin film	72.2
6	FIG.2	filter	0.6	filter paper	24.4
7	FIG.2	filter	0.6	filter paper	72.2
8	FIG.2	filter	0.6	filter paper	8.7
9	FIG.2	filter	0.6	filter paper	72.2
10	FIG.2	filter	4.0	filter paper	24.4
11	FIG.2	filter	4.0	filter paper	72.2
12	FIG.2	filter	4.0	filter paper	8.7
13	FIG.2	filter	4.0	filter paper	72.2
14	FIG.2	filter	23.2	filter cloth	24.4
15	FIG.2	filter	23.2	filter cloth	72.2
16	FIG.2	filter	23.2	filter cloth	8.7
17	FIG.3	filter	4.0	filter paper plus filter cloth	diameter of holes for the hydration 1400
18	FIG.3	filter	4.0	filter paper plus filter cloth	2000
19	FIG.3	filter	4.0	filter paper plus filter cloth	2500

Table 8

No.	Surface roughness of porous ceramics materials (Z)	Density of molded articles (%)	Molding time (sec.)	Status of molded articles and mold releasing
1	0.2	62.8	25	peeled off in releasing
2	0.3	63.9	24	peeled off in releasing
3	1.0	62.7	30	peeled off in releasing
4	0.2	60.4	370	took long time in dehydration
5	0.3	60.2	368	took long time in dehydration
6	0.2	64.6	21	satisfactory
7	0.3	64.8	19	satisfactory
8	1.0	64.5	21	satisfactory
9	5.0	64.2	19	satisfactory
10	0.2	64.4	22	satisfactory
11	0.3	64.7	18	satisfactory
12	1.0	64.6	23	satisfactory
13	5.0	64.6	18	satisfactory
14	0.2	60.4	19	slurry permeated the filter
15	0.3	60.4	19	slurry permeated the filter
16	1.0	60.2	20	slurry permeated the filter
17	-	63.7	19	protrusions (about 1.2 mmϕ) formed on the molded articles
18	-	63.6	19	protrusions (about 1.7 mmϕ) formed on the molded articles
19	-	63.7	18	protrusions (about 2.3 mmϕ) formed on the molded articles

Example 7

Using the same slurry as that of Example 6, columns, having a diameter of 10 mm and a length of 50 mm, were molded out of the slurry in the same way as shown in FIG. 2. Al_2O_3, having an average surface pore diameter of 24.4 µm and a surface roughness of 1.0 z, was used as porous ceramics. A filter paper having an average diameter of 1.0 µm, was used as filter. A vacuum pump (rotary) was connected with the dehydration holes in the upper mold 2, through a trap for catching water, and the pump sucked the water forcibly. Molding pressure applied in this case was 500 kgf/cm^2 and the sucking started simultaneously with the pressing. Table 9 shows the time and the states of molded ceramics.

Table 9

No.	Forcible sucking or none	Pressing time (sec.)	Density of molded articles (%)	Status of molded articles
1	forcible sucking	15	64.3	satisfactory
2	forcible sucking	45	64.5	satisfactory
3	forcible sucking	120	64.2	satisfactory
4	none	15	64.2 (only for stiffened portion)	not wholly stiffened, slurry partially left
5	none	45	64.4	satisfactory
6	none	120	64.3	satisfactory

As described above, by the invention, molded ceramic articles having a high density and a smoothed surface, could be surely produced in a relatively short time.

Claims

1. A process for molding ceramic slurry, which uses mold made wholly or partially of porous metal or ceramics.

2. A process as claimed in Claim 1 wherein the average diameter of pores, present wholly or partially in porous metal or ceramics touching the slurry, is more than 0.1 μm and less than twenty times the size of the average diameter of the secondary particles in the slurry.

3. A process as claimed in Claim 1 or 2 wherein the surface roughness of all or part of the surface of the porous metal or ceramics, touching the slurry, is less than 0.4 z.

4. A process as claimed in one of Claims 1 to 3 wherein paper filter and/or filter cloth is placed on the surface of the porous metal or ceramics facing the slurry.

5. A process as claimed in Claim 4 wherein the average diameter of the pores in the filter paper and/or filter cloth is more than 0.1 μm and less than twenty times the size of the average diameter of the secondary particles in the slurry.

6. A process as claimed in one of Claims 1 to 5 wherein water in the slurry is sucked dry from the back side of the porous ceramics through the porous ceramics.

7. A mold used for a casting process for a ceramic slurry, characterized in that the said mold is made wholly or partially of porous metal or ceramics.

8. A mold as claimed in Claim 7 wherein the average diameter of pores, present wholly or partially in porous metal or ceramics touching the slurry, is more than 0.1 μm and less than twenty times the size of the average diameter of the secondary particles in the slurry.

9. A mold as claimed in Claim 7 or 8 wherein the surface roughness of all or part of the surface of the porous metal or ceramics, touching the slurry, is less than 0.4 z.

10. A mold as claimed in one of Claims 7 to 9 wherein filter paper and/or filter cloth is placed on the surface of the porous metal or ceramics facing the slurry.

11. A mold having a mechanism for carrying out the process as claimed in Claim 5 or 6.

FIG. 1

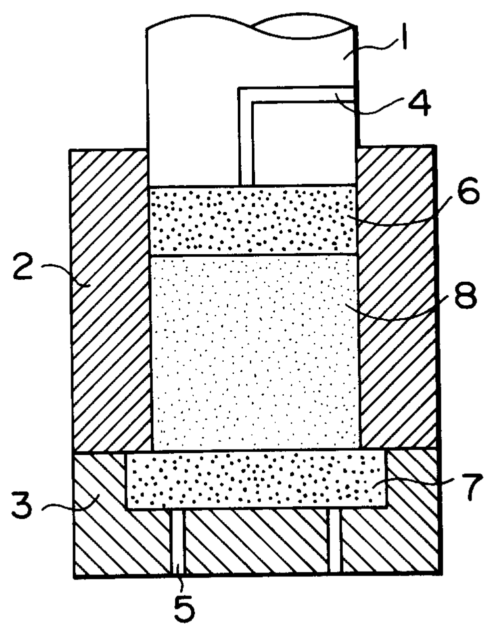


FIG. 2

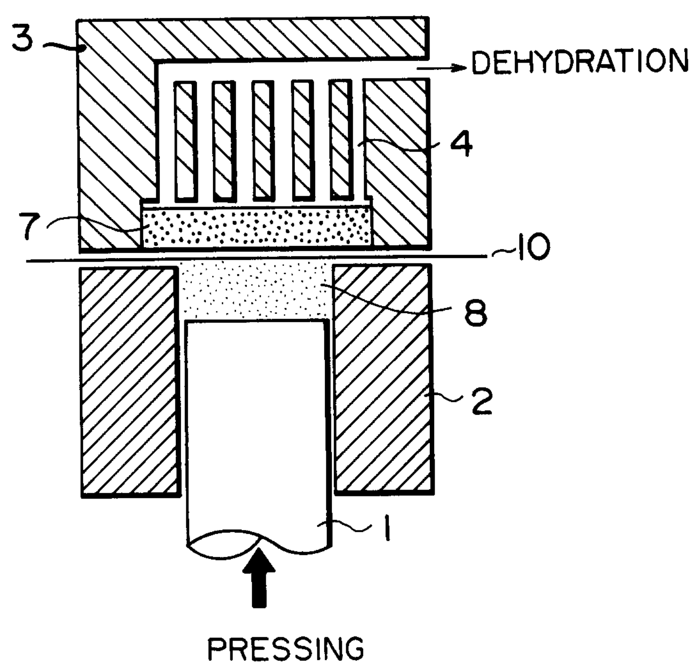


FIG. 3

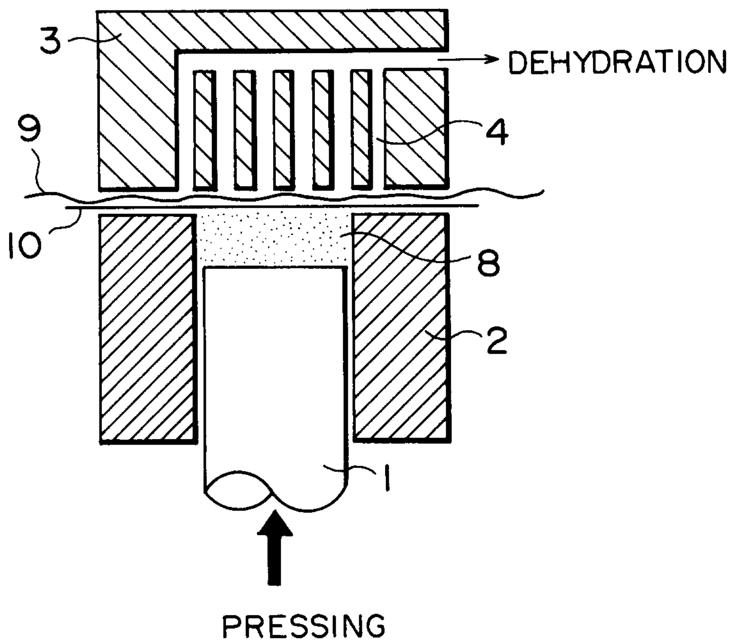
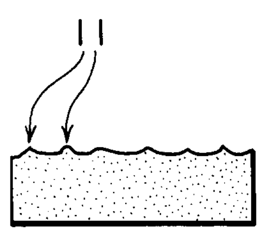


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 93 11 4497

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	LU-A-38 021 (SOCIETE FRANCAISE DE CERAMIQUE) * the whole document * ---	1,2,7,8	B28B1/26 B28B7/34
X	DE-A-37 41 002 (NGK INSULATORS LTD) * the whole document , in particular page 3 , line 28 - page 4 , line 34 * ---	1,4-7, 10,11	
X	EP-A-0 396 766 (KAWASAKI STEEL CORPORATION) * the whole document * ---	1,2,7,8	
X	DE-A-26 41 975 (R. GERSTETTER) * the whole document * ---	1,6,7,11	
X	FR-A-2 211 873 (J. WILDEN) * the whole document * ---	1,2,7,8	
A	DATABASE WPI Week 8030, Derwent Publications Ltd., London, GB; AN 80-52627C & JP-A-55 078 119 (NISSAN MOTOR KK) 13 June 1980 * abstract * ---	1,3,7,9	TECHNICAL FIELDS SEARCHED (Int.Cl.5) B28B
A	DATABASE WPI Week 9125, Derwent Publications Ltd., London, GB; AN 91-183034 & JP-A-3 112 605 (KUBOTA CORP) 27 September 1989 * abstract * --- -/--	1-3,7-9	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 November 1993	GOURIER, P

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	DATABASE WPI Week 8832, Derwent Publications Ltd., London, GB; AN 88-225002 & JP-A-63 160 802 (TOYOTA JIDOSHA KK) 4 July 1988 * abstract * ---	1-3,7-9	
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 52 (M-928)(3995) 30 January 1990 & JP-A-01 280 504 (SEKISUI CHEM CO LTD) 10 November 1989 * abstract * ---	1,4,7,10	
A	DE-B-11 27 781 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * the whole document * ---	1,4,5,7,10,11	
A,P	DATABASE WPI Week 9304, Derwent Publications Ltd., London, GB; AN 93-030828 & JP-A-04 357 003 (OKI ELECTRIC IND CO LTD) 10 December 1992 * abstract * & PATENT ABSTRACTS OF JAPAN vol. 017, no. 226 (M-1405)10 May 1993 & JP-A-04 357 003 (OKI ELECTRIC IND CO LTD) 10 December 1992 * abstract * -----	1,6	TECHNICAL FIELDS SEARCHED (Int.Cl.5)

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