United States Patent [19]

Kohl et al.

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[45] **Feb. 20, 1973**

[54] **DRY PRESSING CERAMIC DISK IN MOLD HAVING A MULTI-PART FEMALE DIE**

[75] Inventors: **Lou Kohl**, Palatine; **Daniel Joseph Shea**, Fox River Grove, both of Ill.

[73] Assignee: **American Can Company**, Greenwich, Conn.

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[21] Appl. No.: **124,062**

[52] **U.S. Cl.** **264/56**, 264/109, 425/412, 425/425

[51] **Int. Cl.**.....**B28b 7/02**, C04b 33/24

[58] **Field of Search** .....264/56, 87, 109; 25/27, 28; 18/16 R, 42 R; 425/412, 425

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Primary Examiner—Philip E. Anderson
Assistant Examiner—John H. Miller
Attorney—Robert P. Auber, George P. Ziehmer, Leonard R. Kohan and Lawrence E. Sklar

[57] **ABSTRACT**

A method for forming a uniformly compacted ceramic dish having at least one angled sidewall comprising the use of a multiple section female die having a dish-shaped mold designed to produce a dish with a sidewall having a thinner upper edge and a slight foot at its base. One or more bottom, intermediate, movable, sidewall punches are employed in the die to obtain a more uniform fill and a more uniform compaction ratio.

3 Claims, 2 Drawing Figures

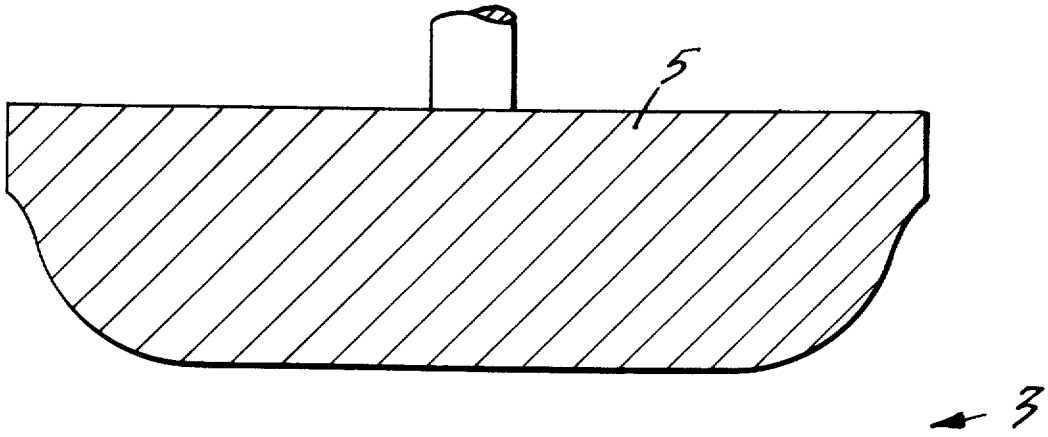
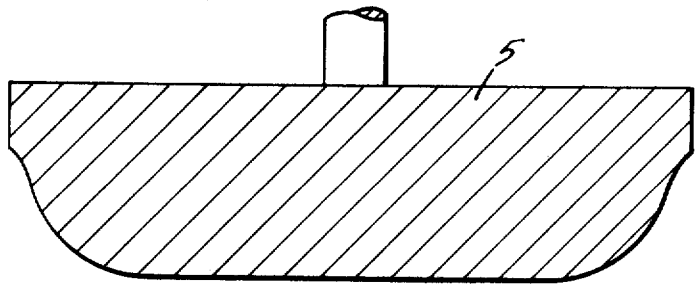


Fig. 1



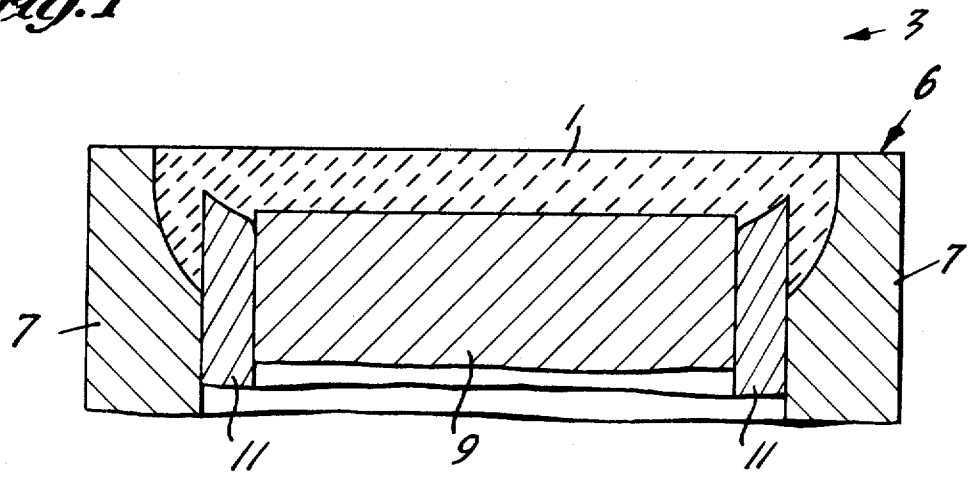
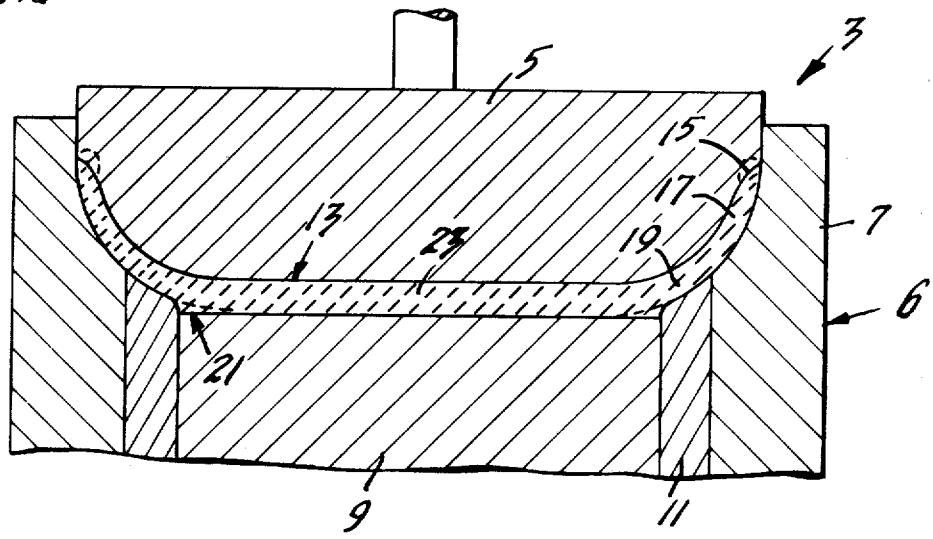


Fig. 2



INVENTORS
LOU KOHL
DANIEL JOSEPH SHEA
BY
ATTORNEY

DRY PRESSING CERAMIC DISK IN MOLD HAVING A MULTI-PART FEMALE DIE

BACKGROUND OF THE INVENTION

The instant invention relates to a ceramic dish, and more particularly to a pressed ceramic dish having an angled sidewall.

It is known in the ceramic art to form certain shapes by means of pressing. The shapes commonly pressed are refractories, tiles, special electrical and magnetic ceramics, spark plug insulators, technical ceramics and a variety of products for which large numbers of simple shapes are required. The water content of the pressing mixture is low — about 5 to 15 percent by weight, and the forming pressure is high — several thousand pounds per square inch. The shapes amenable to pressing are generally simple, with uniform cross sections to make it easier to obtain uniform compaction and therefore uniform density. See Kingery, Introduction to Ceramics, 43–45, 1960. FIG. 3.10 at page 43 of Kingery shows the right and wrong designs for dry pressing, the third figure from the left illustrating that a dish shape should have only horizontal and vertical walls, not angled walls. Consequently, dish shapes with angled sidewalls ranging from plates to casseroles are generally formed by the jiggering process, Ram process or plastic pressing, all of which are very slow and costly methods of forming.

In dry or damp pressing (as opposed to plastic pressing) it is essential to control fill of the mold in order to control compaction, uniform compaction and uniform density being the goal. The most satisfactory compaction ratio will vary from about 2:1 to about 4:1, depending upon the specific formulation and method of body mixing. Low compaction results in weak, poorly formed bodies. Excessive compaction results in body defects such as blisters, and the formed article sticking to the mold. In extreme cases of excess powder mix in one area, the press would be unable to close. A small amount of variation in compaction ratio in an article, perhaps 10–20 percent, is commercially acceptable.

If one attempts to press (dry or damp) a dish or casserole shaped part in the simplest possible two-piece mold, compaction ratios will vary from about 7:1 (through the horizontal base) to less than 2:1 (through the upper edge of the sidewall), a completely unacceptable variation in compaction ratios. This mold could be improved by providing a movable lower punch in the area of the horizontal base portion of the dish, which could then be raised in the fill position and lowered in the press position to produce less variation in compaction ratios throughout the body. This technique does not, however, improve the uniformity of the sidewall.

In present practice, these problems are overcome in one of two ways, each having serious shortcomings. Either the body composition is altered to permit plastic pressing and therefore higher manufacturing costs, or the design of the part is changed to facilitate damp or dry pressing. Changing the geometry of the part permits manufacture by a low cost process, but with a complete loss of the aesthetics required for ceramic dishware (e.g. completely rectangular, vertical sidewalls).

The problems encountered in pressing a uniformly compacted, dish-shaped ceramic article are overcome by the instant invention.

SUMMARY OF THE INVENTION

The instant invention comprises charging a mixture of ceramic raw materials comprising 4 to 25 percent by weight water and sufficient clay to permit forming by pressing into a die comprising a dish-shaped mold and a top punch, said die including at least one angled sidewall, said sidewall having a thinner upper edge and a slight foot at its base, pressing the mixture with a reciprocable top punch and multiple, stepped, reciprocable, bottom punches to form a dish having sufficient wet strength to retain its shape and removing the dish from the die.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of the dish-shaped mold, top punch and powder mix in the fill position.

FIG. 2 is a vertical sectional view of the dish-shaped mold, top punch and powder mix in the pressed position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Throughout the following description, the word "-pressing" refers to dry or damp pressing, as opposed to plastic pressing.

The instant invention encompasses three features which result in uniform compaction (within commercially acceptable limits) throughout a dish-shaped, pressed, ceramic article with only minor changes in the geometry of the article, said changes not being accompanied by a loss of aesthetics. These changes include:

1. One or more intermediate movable punches is incorporated in the sidewall to provide fill control in the sidewall area. The number required is a function of the height of the article being formed. It is recognized that there is a gradation of compaction from the top section of sidewall (lower compaction) to the bottom section of sidewall (higher compaction) above each sloping section. The sidewall must be divided into enough increments to reduce the variation to within commercially acceptable limits. In the case of a typical 1 inch or 1 ½ inch high casserole, one intermediate punch is sufficient.
2. The upper punch is modified to make the article thinner at the upper edge of the sidewall, normally the point of lowest compaction, yet also where use requires the highest strength. This modification results in increased compaction, thereby effecting increased strength.
3. A very slight foot at the base of the sidewall is created by increasing the length of the bottom side of the horizontal base wall. The base of the sidewall is most likely to be a point of excessive compaction, and thus creation of the foot reduces the excessive compaction remaining at the base of the sidewall.

Note that if techniques 2 and 3 are used alone without technique 1, uniform compaction could be achieved, but a very ungainly wall with extreme

thickness variations would result. Such an article would also be difficult to further process because of the thickness variability.

We refer now to the drawings to describe a preferred embodiment of the instant invention. A mixture 1 of ceramic raw materials comprising 8 to 25 percent by weight water is charged into a die generally designated 3 located in a press not shown. The die consists of top punch 5, and a mold 6 comprising exterior lower punch 7, interior movable lower punch 9 and intermediate movable lower punch 11. Both movable punches 9 and 11 are movable with respect to punch 7 and each other. When charging the die, movable punches 7 and 9 are in the up position to provide fill control in the sidewall area, as shown in FIG. 1. If the highest point of each successively interior bottom punch is higher than the lowest point of the adjacent exterior bottom punch, uniform fill of the die may be effected. Thus, punch 9 is higher than the lowest point of punch 11, since punch 9 is more interior than punch 11. This arrangement illustrated in FIG. 1 may be referred to as stepped punches.

In the design of the tooling for a specific shape and a specific batch formulation, the compaction ratio of the specific batch with which the mold is to be charged must be considered. For example, if material with a 2 ¼ :1 compaction ratio is being used, the geometry of the tooling is developed so that the volume of the region above each lower punch is 2 ¼ times the final volume of the part formed above that punch in the pressed position.

In practice, due to the imperfect flow characteristics of the damp powder, it is recognized that the theoretically correct positions of the lower positions may not result in the desired amount of material collecting above each punch. Utilizing the arrangement of the stepped punches of the instant invention, such minor, systematic errors in fill control may be compensated for. For example, total fill above punches 9 and 11 may be adjusted by controlling the degree of stepping, i.e. how much the highest point of each successively interior bottom punch is higher than the lowest point of the adjacent, exterior, bottom punch. The fill above exterior lower punch 7 is controlled by adding or removing filler plates from its top surface.

In FIG. 2 the die is shown in the press position revealing the dish-shaped article 13. Lower punches 9 and 11 are in the down position, as well as upper punch 5. The dotted lines shown at the upper edge 15 of angled sidewall 17 and the base 19 of sidewall 17 indicate the geometry of a dish with uniformly thick walls not modified according to the instant invention. The thinner design of upper edge 15 is derived from the design of the upper punch, while the thickening created at the base 19, referred to as a foot 21, is achieved through modifications in the bottom punches 9 and 11. The foot 21 is defined as any thickening in the area of base 19 of sidewall 17. If a smoother appearance in the area of the foot 21 is desired, the sidewall 17 may be blended into the bottom wall 23 of the dish-shaped article 13. After pressing, the article is removed from the die for further processing.

The following batch was pressed utilizing the method and apparatus of the instant invention:

Material	Pounds
Kentucky-Tennessee No. 6 Bond Clay	20
M & D Ball Clay	20
Wollastonite P-1	10
Nytall No. 99 Talc	10
Kona F4 Feldspar	30
Silcosil No. 390 Flint	10
Water	12½

The above batch was pressed at a pressure of about 400 pounds per square inch and experiences a uniform compaction ratio of about 2 ¼ :1.

The apparatus and method of the instant invention may be used for forming any ceramic batch formulation containing clay.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the article and that changes may be made in the steps of the method described and their order of accomplishment without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

We claim:

1. A method of pressing a uniformly compacted, green, ceramic dish having at least one angled sidewall comprising:

providing a die designed to produce a dish having at least one angled sidewall, said sidewall having a thinner upper edge and a slight foot at its base, said die comprising a reciprocable top punch and a bottom mold comprising an exterior lower punch, an interior reciprocable lower punch and at least one intermediate reciprocable lower punch incorporated in the sidewall area, said reciprocable lower punches being movable with respect to the exterior lower punch and each other;

raising the reciprocable lower punches, prior to charging of the mold, to their up positions, wherein the highest point of each successively interior lower punch is higher than the lowest point of an adjacent, exterior, lower punch, whereby the lower punches are placed in a stepped arrangement;

charging a mixture of ceramic raw materials comprising 4 to 25 percent by weight water into said die; and

pressing said mixture by lowering said top punch relative to said exterior lower punch, by lowering said intermediate movable lower punch relative to said exterior lower punch, and by lowering said interior movable lower punch relative to said intermediate movable lower punch, to form said dish having sufficient wet strength to retain its shape during removal from said die.

2. The method of claim 1 wherein all sidewalls of said dish are angled.

3. The method of claim 1 wherein the ceramic raw materials are pressed to a uniform compaction ratio of about 2 ¼:1.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,717,693 Dated February 20, 1973

Inventor(s) LOU KOHL and DANIEL JOSEPH SHEA

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover page, in Line 1 of the Title of the Invention, read "DISK" as ---DISH---.

Column 1, Line 1 of the Title of the Invention, read "DISK" as ---DISH---.

Signed and sealed this 10th day of July 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

Rene Tegtmeyer
Acting Commissioner of Patents

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.