May 23, 1972 C. R. WALLICK, JR., ET AL 3,664,799

POWDER COMPACTING PRESS

Filed Nov. 4, 1969 2 Sheets-Sheet 1

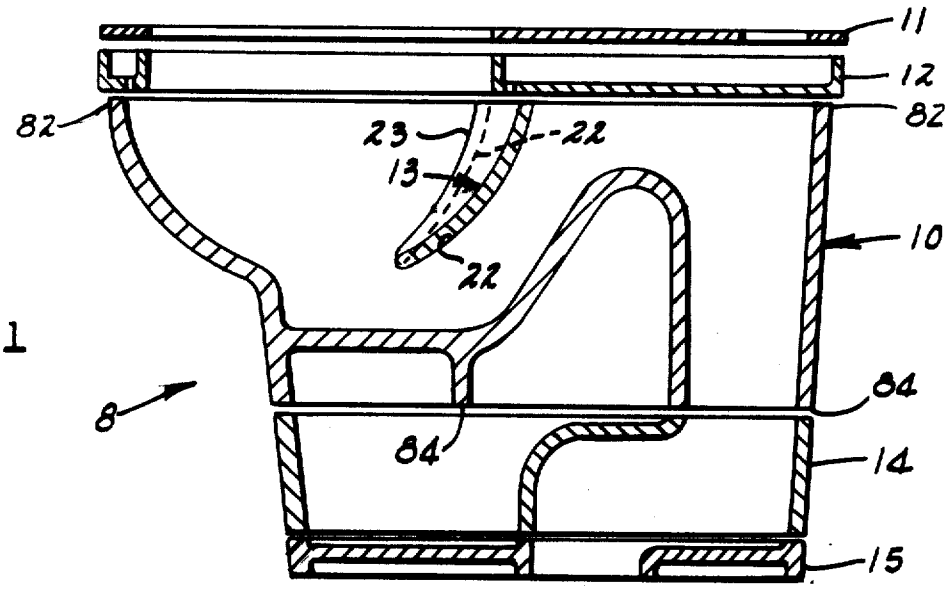


FIG_1

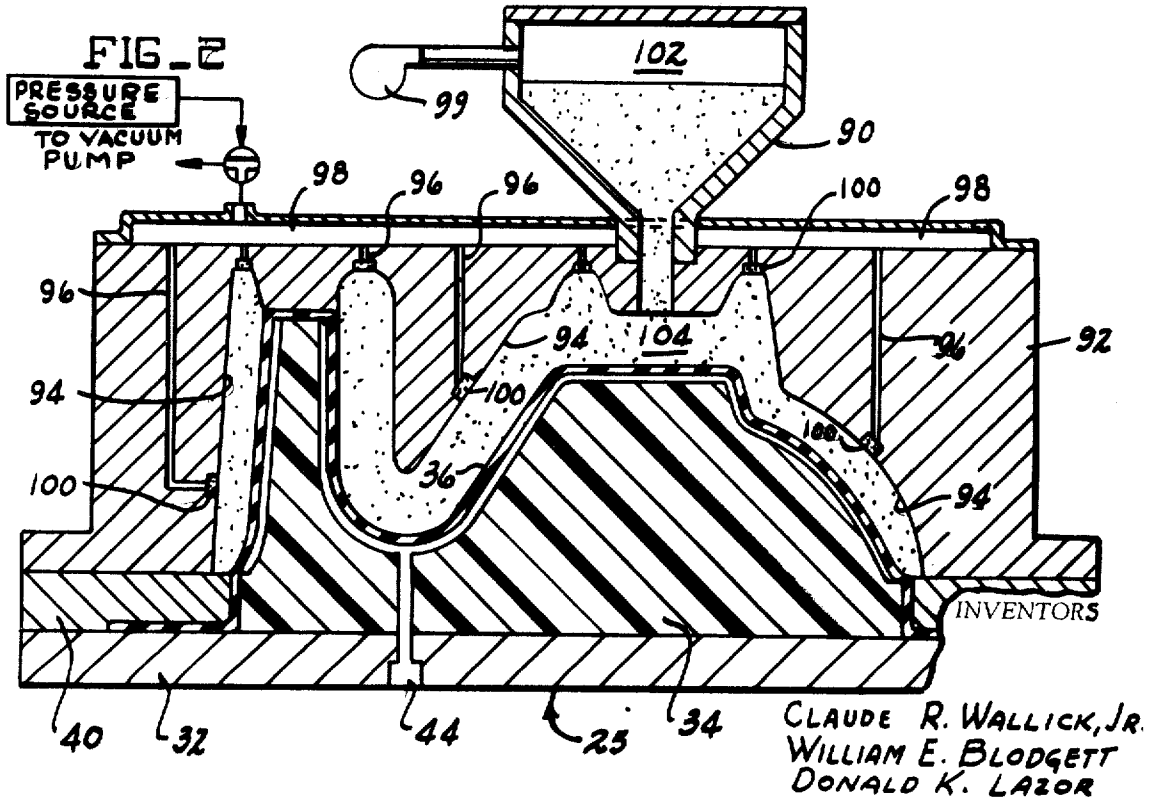


FIG_2

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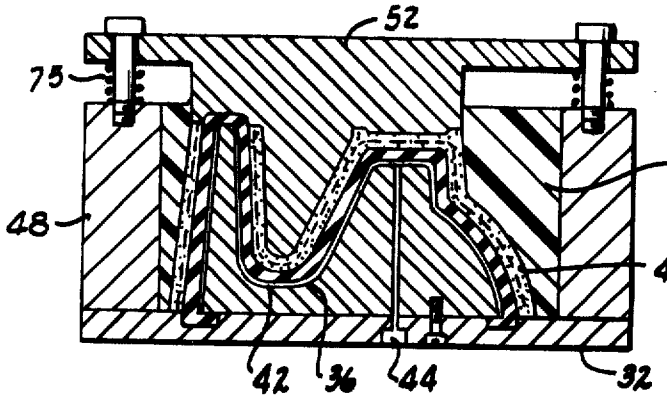


FIG_4

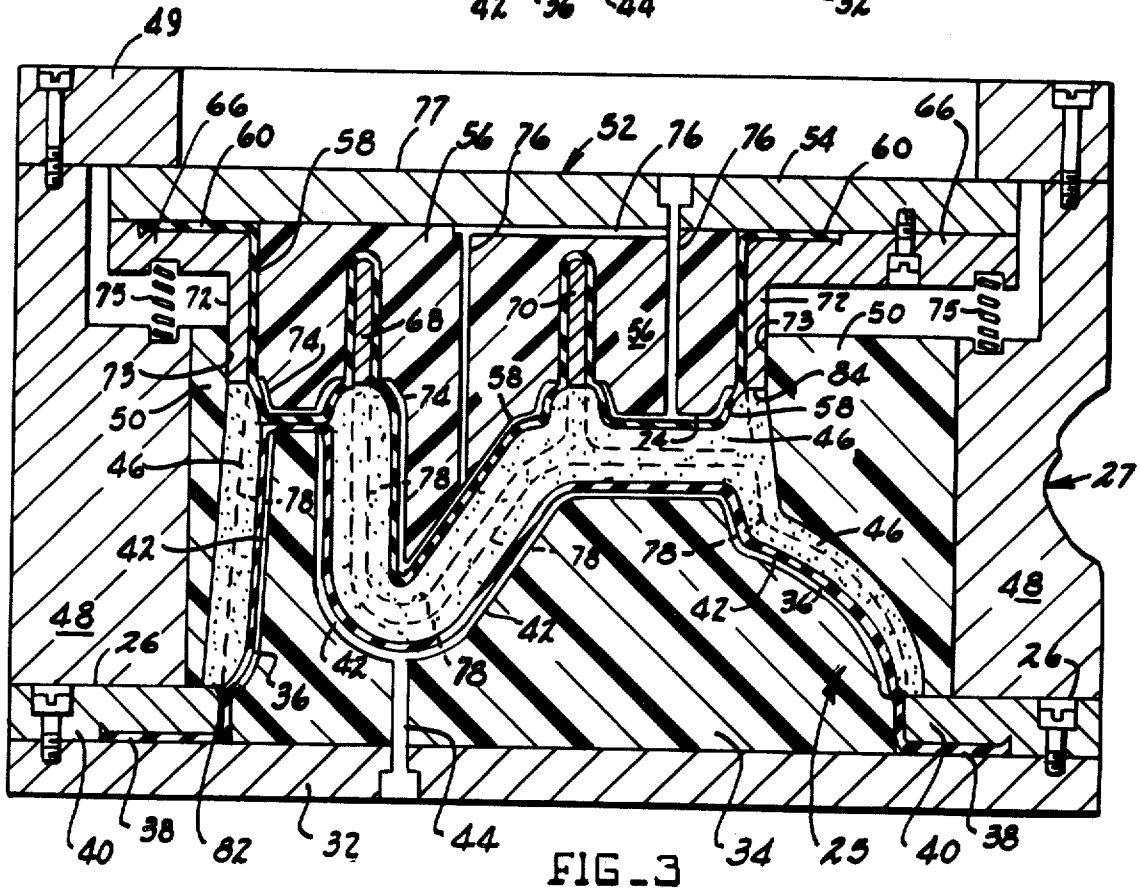


FIG_3

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POWDER COMPACTING PRESS

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U.S. Cl. 425—389 2 Claims

ABSTRACT OF THE DISCLOSURE

An isostatic powder press for compressing ceramic powders together to form a toilet bowl section, said press including one or more deformable membranes subjectable to fluid pressure to uniformly compress the powders to a substantially constant density throughout.

DRAWINGS

FIG. 1 is an exploded sectional view of a toilet bowl having one of its major parts formed by a press of this invention.

FIG. 2 is a sectional view of a mechanism for loading powder into the invention press.

FIG. 3 is a cross sectional view of a press of the present invention adapted to form one of the toilet bowl sections shown in FIG. 1.

FIG. 4 is a sectional view of a press constituting another embodiment of the invention.

Drawings in greater detail—FIG. 1

FIG. 1 is an exploded view showing a toilet bowl **8** formed of six separate but connectable sections numbered **10** through **15**. Each section may be formed from ceramic powders or pellets, as for example mixtures of ball clay, china clay and alumina. The powders for each section are loaded into a press and compacted to form a green uncured port of the desired shape. Thereafter the joinable edges of the various parts are moistened, and the parts assembled together in a conventional stick-up operation. The assembly is then dried, glazed and fired, as under conventional practice.

As shown in FIG. 1, the element identified by numeral **13** appears to be formed as part of bowl section **10**. Actually element **13** (known as panplate) is formed separately from bowl section **10**, and is later stuck onto section **10** by causing its lateral edges to seat against shoulders **22** pre-formed in the bowl section. The panplate is suitably curved, and the shoulders **22** are so configured that the joining edge or crack **23** is obliterated or eliminated in the finished article.

Bowl section **10** is the major section or part of the toilet bowl and is the most difficult to form under conventional practice. Under the present invention the green and uncured bowl section **10** can be press-formed from powders by means of the press shown in FIG. 3 or 4. Powder may be initially loaded into the press by the mechanism shown in FIG. 2.

FIG. 3

As shown in FIG. 3, the press comprises two separate die mechanisms **25** and **27**. Mechanism **25** forms the upper interior surfaces of the bowl section, and mechanism **27** forms the lower undersurfaces of the bowl section. Each die mechanism includes a supporting steel plate or shell, a rigid core, and a deformable elastomeric membrane. Relative vertical movement of the two die mechanisms allows them to separate at parting line **26** for removal of the formed article and insertion of the next powder charge. Such vertical movement can be accomplished by manual or mechanical means (not shown).

Actual formation of the part is accomplished by introduction of pressure fluid into channels located behind the respective elastomeric membranes; the membranes act as transmitters of the fluid pressure to the powder charge.

Die mechanism **25** comprises a flat steel plate **32** having a rigid core member **34** secured to its upper face. Overlying core **34** is a deformable elastomeric bag or membrane **36** having its peripheral edge area **38** lying flat against steel plate **32**. An annular steel plate **40** is suitably bolted to plate **30** to clamp the peripheral edge of the membrane **36** in place.

At selected points on its upper surface the core **34** is provided with channels or grooves **42**, said grooves communicating with one or more passages **44** leading through the steel plate **32**. Introduction of pressure fluid to passage **44** from a pressure source (not shown) causes the membrane **36** to be deformed away from the back-up surface of core **34**, thus compressing the powders previously admitted to the powder space **46**.

Die mechanism **27** comprises a steel shell **48** which encircles and fixedly contains a rigid die cavity member **50**. This die mechanism further comprises a plunger assembly **52** which includes a steel plate **54** and a rigid core member **56** adhered to plate **54** by any suitable means (not shown). Overlying the exposed surface of core **56** is a second deformable elastomeric membrane **58** having its peripheral edge **60** clamped in place by means of an annular plate **66**. Plate **66** is provided with an endless peripheral skirt or rib **72**, as well as internal ribs **68** and **70**, said ribs serving to anchor and confine the adjacent sections of the elastomeric membrane **58** so that said sections are incapable of movement relative to the plunger assembly **52**. The plunger assembly (members **54**, **56**, **58** and **66**) is capable of vertical slidable movement through an opening **73** formed in member **50**. Normally the plunger assembly is maintained in the illustrated elevated position by compression springs **75**; however when it is necessary to eject a formed part the plunger assembly is moved down by application of a downward force on plunger surface **77**. Annular retaining ring **49**, which is bolted to steel shell **48**, restrains plunger assembly **52** in the elevated position.

As shown in FIG. 3, the lower face of core **56** is provided with one or more channels **74** which connect with passages **76** leading through plate **54**. With the parts in their FIG. 3 positions pressure fluids can be simultaneously introduced into passages **76** and **44**, thus causing the channels **74** and **42** to fill with fluid and produce movements of the membranes **58** and **36** away from the respective core **56** and **34** surfaces. The simultaneous movements of the two membranes **58** and **36** causes the mass of powder in cavity **46** to be compressed to the general configuration and thickness denoted by dotted line **78**. In general, the movement of each membrane **36** or **58** is in a direction normal to the backup surface of the respective core. The membranes thus have different portions thereof moving in different directions as determined by the contour of the core sections, so that the membranes function somewhat in the manner of complex motion dies, but without the mechanical complications or difficulties. The use of multiple membranes as shown in FIG. 3 is therefore advantageous for pressing powders into complex shapes which may have hidden crevices or undercuts therein. Since the membranes move at right angles to the adjacent core surfaces they have direct compressive action on the powder granules without any substantial traverse sliding contact between the adjacent powder particles or between the powder particles and the membrane surfaces. The general configuration of the article is therefore well preserved, and there is little tendency for the wall sections to be excessively

thinned out in any particular area. Compaction using multiple deformable membranes provides minimum average particle movement for a given degree of compaction and therefore provides uniform density in the final product, thus contributing to maximum strength without requirement for excessive wall thickness.

Ejection of the compacted article from the die cavity is accomplished after the die mechanisms **25** and **27** have been separated from one another at parting line **26**. Mechanism **27** can be drawn up from mechanism **25** and/or mechanism **25** can be drawn down from mechanism **27** by suitable means, not shown. With the two die mechanisms thus separated from one another a downward force can be applied to plunger surface **77** to move the plunger downward through opening **73**, thereby ejecting the compacted article **78** from the press cavity.

It will be noted from FIG. 3 that the end edges **82** and **84** of the toilet bowl section are formed by machined surfaces on members **40**, **68**, **70** and **72**. These edges **82** and **84** are the upper and lower edges of the FIG. 1 bowl section **10** which are to be joined to the bowl sections **12** and **14**, respectively; they should therefore be fairly flat, without ridges or depressions, if they are to correctly mate. By forming edges **82** and **84** on machined surfaces the edges are not likely to be wavy, hilly, etc. due to any variations in fluid supply pressure, elastomer durometer, elastomer thickness, etc.

It is of some importance that the planar outline of the compacted article be maintained within fairly close dimensional tolerances, especially the peripheral outline of the article immediately adjacent the bowl section lower edge **84**. Thus is because the surface area of sections **10** and **14** must be continued uninterrupted to eliminate objectionable cracks or joints in the finished article. The FIG. 3 compacting apparatus is designed so that wall surface areas at and adjacent to edge **84** are formed by rigid cavity surfaces which are dimensionally stable and which are the same irrespective of any minor variations in deformation of member **74** during the application of fluid pressure through passages **76** and **44**.

FIG. 2—powder loading

FIG. 2 schematically illustrates one mechanism for loading powder onto membrane **36**. The loading operation is performed with the upper die section removed from the lower die section **25**, so that the upper face of membrane **36** is exposed to receive powder thereon. The powder is initially delivered from a hopper **90** which seats on a powder box **92**. Box **92** has a lower surface **94** configured to the same shape as the face of membrane **58** when said membrane is in its normal unstressed state as shown in FIG. 3. Box **92** is preferably provided with one or more passages **96** which communicate between a manifold space **98** and respective porous metal filters **100** disposed at selected points on surface **94**.

Application of a vacuum to manifold **98**, coupled with the sudden application of a substantial volume of gas from gaseous pressure pump **99** to space **102**, causes the powder in hopper **90** to be fluidized, and to discharge rapidly into the space **104** to produce a lightly compacted powder layer on the surface of membrane **36**. After removal of box **92** from die mechanism **25** it is intended that the lightly compacted powder layer adhere to the elastomeric membrane **36** rather than to box surface **94**. If necessary the powder layer can be prevented from adhereing to the box surface **94** by previous application of powdered mold release agents to surface **94**; also a positive gas pressure can be produced in manifold **98**, to act through passages **96** to thus eject the powder preform away from surface **94**.

FIG. 4 press

FIG. 4 shows a press generally similar to the FIG. 3 press except that the upper deformable membrane **58** has been omitted. Instead the lower face of plunger **52** acts as a fixed die surface.

The principal feature of the present invention is the construction of the die mechanisms shown in FIGS. 3 and 4, whereby the single or multiple deformable members **36** and **58** are utilized to heavily compact the powder material in a manner to produce a green ware article having closely toleranced dimensions and uniform density.

We claim:

1. An isostatic powder press for compressing a toilet bowl section which is to be later joined with other bowl sections at its upper and lower peripheral end edges: said press comprising first and second die mechanisms advanceable toward each other to define a powder cavity, and retractable from each other to permit discharge of the formed toilet bowl section; said first die mechanism comprising a rigid cavity member contoured to form the external undersurface of the bowl section, a first central rigid core section, and a first deformable membrane shaped to form the interior undersurfaces of the bowl section; said first membrane lying against said first rigid core section and having its peripheral edge sealed thereto; said first core section having fluid passages therein for admitting pressure fluid to the dead space between the membrane and the core section; said second die mechanism comprising a second convex core section locatable within the space circumscribed by the first die mechanism, and a second deformable membrane shaped to form the interior upper surfaces of the bowl section; said second membrane lying against the second core section and having its peripheral edge sealed thereto, and said second core section having fluid passages therein for admitting pressure fluid to the dead space between the second membrane and second core section, whereby when both dead spaces are pressurized the membranes are deformed toward one another to compress the powder.

2. The powder press of claim **1** wherein the first die mechanism comprises two relatively movable parts, one of said parts being the aforementioned rigid cavity member, and the other part being a plunger element slidably received in a central opening of the rigid cavity member for ejection of a pressed powder bowl section from the cavity; said plunger element including the aforementioned first rigid core section and the aforementioned first deformable membrane.

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164—170; 425—109, 444, 199