June 19, 1934. A. KEIDING 1,963,134

MOLDED PAPER ARTICLE AND THE ART OF MANUFACTURE THEREOF

Filed Oct. 27, 1930 2 Sheets-Sheet 1

FIG. 1.

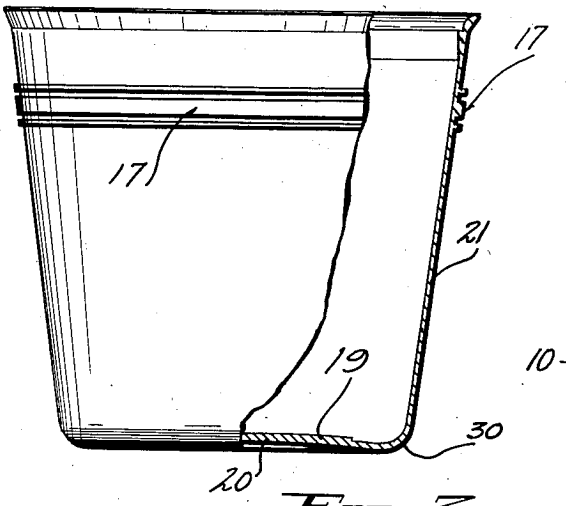

FIG. 2.

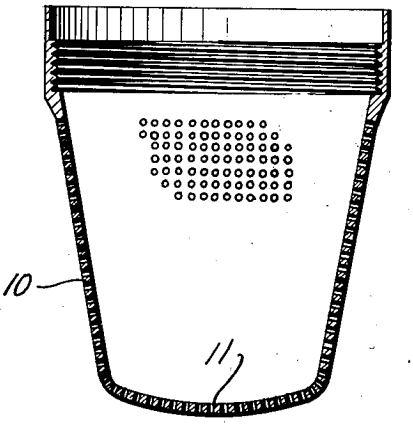

FIG. 3.

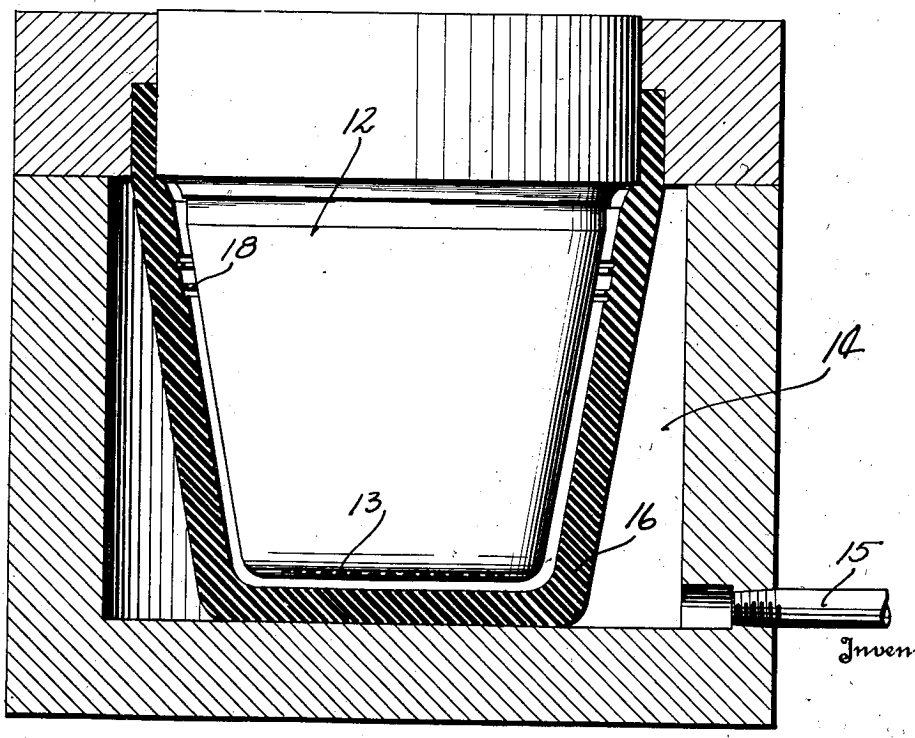

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FIG. 4.

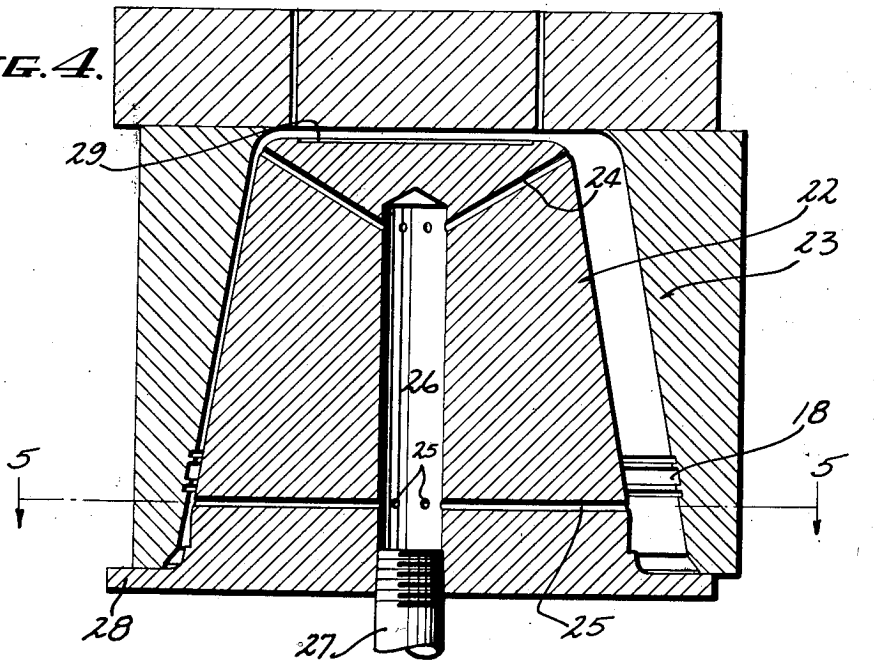
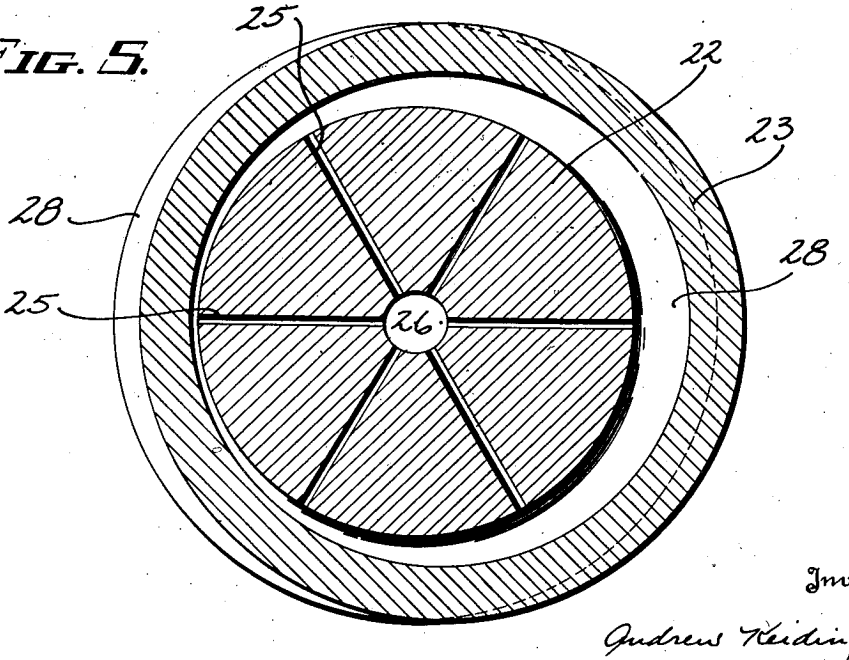


FIG. 5.



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Patented June 19, 1934 1,963,134

UNITED STATES PATENT OFFICE

1,963,134

MOLDED PAPER ARTICLE AND THE ART OF MANUFACTURE THEREOF

Andrew Keiding, Whitefish Bay, Wis., assignor to American Lace Paper Company, Milwaukee, Wis.

Application October 27, 1930, Serial No. 491,433

13 Claims. (Cl. 92—54)

This invention relates to improvements in molded paper articles and the art of manufacture thereof.

The primary purpose of the invention is the production of a novel and desirable texture and finish wherein all surfaces of the article will preferably be left substantially smooth and free of pressure ridges, mold marks and lumps, but provided with a novel and attractive parchment-like shading in the smooth wall of the finished product making it far preferable from a commercial standpoint to the textureless wall of the ordinary paper article.

The mottled or parchment-like surface referred to is produced on the surface which is free of the mold and may appear either on the inner or the outer walls of the receptacle or other article depending on whether the pulp is deposited on the inner or outer surfaces of the foraminous mold commonly used in this art. In other words, the present invention relates particularly to treatment given the article after its original molding by the deposit of pulp. The preferred treatment will also leave smooth the wall of the article which originated next the mold, all marks of the foraminous mold or screen being eliminated.

A further important object of this invention has to do with the substance or body of the wall of the article. It is my purpose to provide means for making the wall of the article compact and strong in such fashion that the strength of its fibers will be unimpaired and the article will have unusual strength mechanically, unusual resistance to disintegration by hot liquids, and unusually low thermal conductivity as compared with other articles made of pulp. The desirable results in this regard make this invention particularly significant in the manufacture of paper cups and pails for hot beverages, but the invention is by no means limited to these specific articles. In attaining these results the principal considerations involved are—first, the use of pressure in the presence of a retained and relatively high percentage of water; secondly, the degree of the pressure and the manner in which it is applied; and, thirdly, the contraction of the article rather than the expansion thereof under pressure.

It is another object of the invention to produce an article having a properly reinforced bottom and corner margin. This is particularly important in cups and other containers in which the corner ordinarily represents a line of weakness attributable to the methods of manufacture heretofore practiced. It is my purpose to provide a container wherein the lower corner margin will be at least as strong and at least as dense as any other part of the container.

It is also my purpose to provide improved means of applying surface embossing in the form of designs and the like either to the interior or the exterior of an article embodying or made in accordance with the present invention.

In the drawings:

Figure 1 is a side elevation of a container embodying this invention, with a portion of its wall broken away to expose a transverse vertical section.

Figure 2 shows, on a reduced scale, a mold used to produce the cup shown in Figure 1.

Figure 3 is a full sized view, in cross section, of one forming device capable of use in accordance with this invention.

Figure 4 is a similar view showing a wholly different forming device capable of use in accordance with this invention.

Figure 5 is a view of the second forming device in a horizontal section in the plane indicated at 5—5 in Figure 4.

Like parts are identified by the same reference characters throughout the several views.

As exemplifying the articles that may be made in accordance with this invention, I have illustrated a container or cup which is preferably molded from pulp on a foraminous body such as that shown at 10 in Figure 2. It will be understood that the structure of this body is as open as it can be made, the holes in its walls having been merely indicated. In actual practice this body will ordinarily be covered with some kind of a fine mesh screen of fabric or wire gauze, although this is not necessary where the pulp fibers are long. My particular purpose in the inclusion of a drawing of the foraminous member 10 relates to the disclosure of its convex bottom 11. The bottom of the completed container is not convex but is somewhat concave. However, it has an extra thickness, as compared with the sides of the container, which is derived from the surplus stock deposited over the greater area of the bottom which results from the convex form of the bottom of body 10.

The container will preferably be moulded by subjecting the interior of the foraminous member 10 to a vacuum at a time when said member is submerged in a vat containing a liquid in which paper or other fibrous pulp is floating.

The pulp referred to herein is preferably a paper pulp made either directly from wood fiber or from previously manufactured paper stock. It is a fact, however, that for many purposes of this

invention other vegetable pulp and even such pulped animal matter as hair is the full equivalent of that which is indicated as preferred.

After the water or other liquid has been drawn through the foraminous member 10 for a certain period of time, a deposit of pulp will be produced upon its exterior surface, as is well known in the art. The exterior surface of this deposit will be highly irregular and lumpy and the interior surface will take the form of the mold 10 and will show the pattern of the openings in the mold.

After the deposit is complete and self sustaining, the container is blown, while still very wet, from the mold, this practice also being old and well known in the art.

No pressure is applied to the article until it has dried sufficiently so that only about fifty per cent (50%) of its weight is removable water. In other words, the article at this stage of manufacture weighs approximately twice as much as it does when complete for the market. It is then subjected to a forming operation, preferably through the use of either of the pieces of apparatus herein disclosed.

I have found that the percentage of water is rather critical but it varies according to the pressure, the type of pulp used and possibly other factors. My present manufacturing results indicate that fifty per cent (50%) of water by weight is a very desirable proportion approaching fairly closely to the upper limit. The lower limit has not been determined but for most materials and pressures it is probable that the percentage of water should not be less than thirty per cent (30%) to get the preferred results described herein. If too much water is used it is impossible to make the cup accurately as to size. Accurate size is regarded as an important commercial requisite. If too little water is used, or if too much of the water is allowed to escape during application of pressure, the pressure will break the fibers and also they will not be desirably felted or interlocked due, as I believe, to excessive friction which might have been minimized between fibers in the pulp by continued presence of a sufficient proportion of water.

While I refer to the use of water in accordance with standard practice, it will be understood that from the standpoint of this invention it is broadly immaterial what liquid is used provided it leaves no residue which would be deleterious in the use of the article or container.

When the apparatus shown in Figure 3 is used, the article is placed upon the die 12 which will be noted to have a flat bottom 13. Hydraulic pressure is then established by forcing water or some other liquid into chamber 14 through pipe 15 to cause the heavy rubber diaphragm 16 to contract into the article confined between the diaphragm and the die 12. It is particularly to be noted that the pressure is not employed to squeeze water from the pulp and no means is provided for the escape of water during the forming operation. On the contrary, the presence of water in the indicated proportions has been found to be very desirable in ensuring an adequate and proper arrangement of the pulp fibers under the heavy pressure employed, which should preferably amount to several hunderd pounds per square inch.

The diaphragm used is exceptionally heavy and form sustaining. When the pressure is relieved it will resume its original position. It is possible, therefore, to incorporate in the diaphragm or the die a molded or engraved design to be reproduced on the corresponding surface of the cup wall as exemplified in Figure 1. For simplicity of illustration, this design has been illustrated as comprising a series of ribs and grooves, collectively designated by reference character 17 and formed by the complementary ribs and grooves collectively designated by reference character 18 in Figure 3.

Following the pressure operation by which the container is formed to the shape of the die 12, the container is removed and its drying is completed by any suitable dehydrating apparatus. The excess material resulting from the use of the convex bottom 11 in the mold 10 has been pressed flat to comprise a reinforced bottom 19 in the completed container or cup. Upon this bottom a trade-mark or embossed design may be made at 20 either on the inside or outer surface, resulting in a slight variation in thickness which, however, has no bearing upon this invention. It is in the final drying operation that the bottom of the cup tends to assume the upwardly curving form shown in Figure 1.

Due to the particular condition of the article with particular reference to its moisture content at the time of the forming operation above described, the mold marks will be practically eliminated from the interior of the cup and the lumps or irregularities resulting from the uneven adhesion of the pulp to the mold 10 will be flattened out so that the wall 21 of the finished article will have substantially uniform thickness and density. Its original irregularities, however, will be visible on the exterior of the wall in the form of a pleasing appearance of texture or shading which makes the cup very attractive.

A modified apparatus for producing a similar article is shown in Figure 5 wherein two metallic die members 22 and 23 are arranged for manipulation in a relative orbital movement. The die member 22 is preferably stationary and provided with upper and lower radial ducts 24 and 25 leading to an axial bore 26 which is connected with a vacuum line 27. The purpose of this arrangement is not to extract moisture and it has virtually no effect on the moisture content of the pulp. Its function is simply to hold the soft pulp in intimate contact with the die 22 during the forming operation

An annular flange 28 supports annular die member 23 which may either be manipulated by hand or by any suitable machinery to move upon flange 28 in a circular path about the axis of die member 22 while in pressure engagement with the article thereon at successive peripheral points which shift circumferentially as the position of the outer die member 23 changes. It will be understood that the outer die member does not necessarily rotate upon its own axis but preferably has merely the orbital movement described above. This results in a slightly rubbing engagement of the die member 23 with the wall of the article which seems to facilitate the rearrangement of the fibers whereby they are easily felted with low pressure if adequate water is present.

The relative sizes of the inner and outer dies are important as affecting the degree of rubbing friction and the angle of bight between the dies. In practice the total clearance should be made as small as is reasonably practicable although, obviously, some orbital movement and rubbing pressure is necessary to facilitate rearrangement of the fibers and thus avoid the use of the heavy pressures required when the pressure is radial only. I have successfully used a clearance of one-

fourth inch between the dies for making a cup averaging three and one-eighth inches in diamter. I have found that any considerable increase in clearance results in rubbing up the surface of the pulp into rolls of fiber which become larger as the clearance is increased, and finally results in the complete disintegration of the article. A set of dies having the exact proportions shown in Figure 4 has been successfully used to make by hand cups in accordance with this invention. But apparently an increase of pressure to produce quickly the desired compactness in the wall of the article must be accompanied by a decrease in the extent of rubbing friction.

The outer die is completed by a cover plate 31 which is preferably stationary to avoid the excessive rubbing friction on the bottom of the receptacle which would be occasioned by its movement.

It will be noted that the outer die member has the same configuration 18 which is found in the rubber diaphragm of the forming device shown in Figure 3. The inner die member is likewise embossed at 29 and complementary embossing may be provided at 29' on the cover plate 31 to produce a trade-mark or central design such as is shown at 20 in Figure 1.

Each of the disclosed pieces of apparatus, when used in accordance with the method herein described, will produce practically all of the desirable features required for a cup or container embodying this invention. The mechanical apparatus requires materially less power than the hydraulic apparatus for effecting the desired results.

Regardless of which piece of apparatus is used, the process described involves the retention of a very high percentage of water, and the pressure applied to the article for the purpose of felting its fibers and smoothing its surface is not used for the purpose of extracting water. The presence of water minimizes friction between the fibers or perhaps, because of the incompressibility of the water, the fibers are relieved of pressure within the limits necessary to permit of their rearrangement without breakage. In any event, the observed fact is that breakage of fibers does not occur when the water is retained, and the resulting article has a much stronger and more impervious wall than it is possible to produce when the pulp is relatively dry or is permitted to become dry under pressure.

In each case the mold marks are substantially eliminated and there are no pressure ridges such as appear in some containers between areas of high pressure. In each case the desired appearance of ornamental shading or texture is produced in a comparatively smooth surface on the exterior wall of the container. In each case the container will have a wall of substantially uniformly high density, high thermal insulating value, high tensile strength, and high resistance to distortion and to the destructive action of hot liquids. A container made in accordance with this invention may be filled with water or any beverage liquid at the boiling point which may be allowed to cool therein while the container is held in the hand without undue discomfort to the person and without disintegration of the container or leakage of its contents.

In each case also the corner 30 between the bottom and the side wall of the cup will be thickened and reinforced as the result of an application of pressure thereto at least equal to that at other points of the cup. In my improved cup there is no line of weakness at this corner and the density is equal to or greater than the density existing throughout the wall of the cup.

In each case also the article may be adapted for special purposes as by provision of a channel at 32 for frictional retention of a cover for the receptacle illustrated.

I claim:

1. The process of manufacturing articles from pulp, which comprises the deposit of water borne pulp fiber upon an internal mold in the approximate form of the desired article, and the subsequent external application of pressure and a slight degree of rotative friction to the pulp fibers while it retains a substantial volume of water.

2. A process of manufacturing paper articles which consists in holding wet pulp to a predetermined shape and size and simultaneously subjecting it externally to pressure and a slight degree of rotative friction tending to compact its mass.

3. A process of manufacturing paper articles which consists in holding wet pulp to a predetermined shape and size and simultaneously subjecting it to pressure progressively shifting as to its point of application tending to compact its mass in the presence of water sufficient to reduce friction between the pulp fibers and permit their rearrangement under pressure without substantial breakage.

4. A process of manufacturing paper articles which consists in hydraulically depositing pulp upon a mold, removing the formed pulp from the mold, holding the formed pulp securely against change of shape or size and simultaneously smoothing its inner and outer walls in the presence of a substantial amount of liquid approximately equal in weight to the finished article under pressure sufficient to eliminate mold marks and to flatten uniformly substantially all pulp deposits.

5. A process of manufacturing paper articles which comprises the step of subjecting a previously formed molded wet pulp article to suction upon a generally smooth die pending the application of pressure thereto.

6. A process of manufacturing paper articles which comprises the introduction of a previously formed wet pulp article into a confined space, restraining the escape of liquid from said space and subjecting to substantial pressures the pulp and contained liquid so confined.

7. A process of manufacturing paper articles, which comprises the introduction into a confined space between smooth surfaced forming members, of a previously formed wet pulp article containing sufficient water to facilitate rearrangement of its pulp fibers, restraining the escape of liquid from said space, and moving said forming members axially and circumferentially with respect to each other to subject the inner and outer surfaces of said article simultaneously to smoothing pressure, whereby to rearrange the fibers of said article in the formation of smooth inner and outer surfaces therefor.

8. A process of manufacturing paper articles, which comprises the introduction into a confined space between smooth surfaced forming members, of a previously formed wet pulp article containing sufficient water to facilitate rearrangement of its pulp fibers, restraining the escape of liquid from said space, and moving said forming members axially and circumferentially with respect to each other to subject the inner and outer surfaces of said article simultaneously to smoothing pressure, whereby to rearrange the fibers of said article in the forma-

tion of smooth inner and outer surfaces therefor, and holding the article to the inner forming member by suction during the smoothing operation.

9. A process of manufacturing paper articles which comprises the step of subjecting pulp to circumferentially shifting pressure between relatively movable smooth walled formers, whereby simultaneously to smooth the interior and exterior surfaces thereof.

10. A process of manufacturing paper articles, which consists in hydraulically depositing pulp upon a mold, removing the formed pulp from the mold, holding the formed pulp securely against change of shape or size, and simultaneously smoothing its inner and outer walls under pressure and shifting the application of such pressure circumferentially about the article.

11. The process of manufacturing paper articles from fibrous pulp which includes the step of subjecting the wet pre-molded articles to pressure in the continued presence of the original water present in the pre-molded article, a high percentage of water being retained during the pressing operation to reduce the friction between fibres of the pulp and facilitate their compact rearrangement in felted relation without substantial breakage.

12. The process of manufacturing articles from pulp which includes the depositing of the wet pulp fibres on the bottom and sides of a mold in the form of the desired article and the subsequent application of pressure to the wet fibres in the presence of about 30% to 50% by weight of the water present in the molded article, a high percentage of water being retained during the pressing operation to reduce friction between the fibres of the pulp and facilitate their compact rearrangement in felted arrangement without substantial breakage.

13. The process of manufacturing articles from pulp which consists in depositing the wet pulp upon a mold in the general form of the desired article, and subsequently compacting the article in the presence of water approximately equaling the finished cup in weight, a high percentage of water being retained during the pressing operation.

ANDREW KEIDING.