June 15, 1943. C. J. CHAPLIN 2,321,574

METHOD OF PULP MOLDING

Filed April 19, 1937

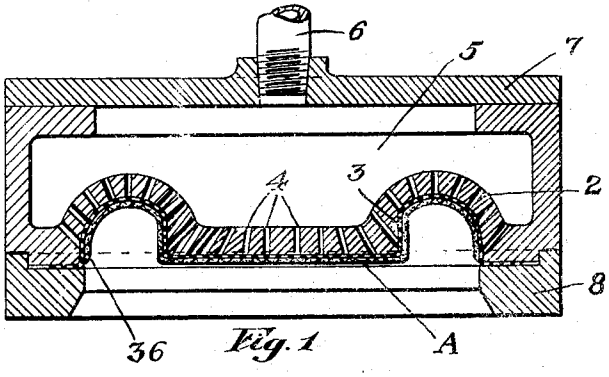


Fig. 1

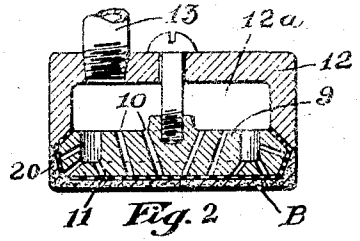


Fig. 2

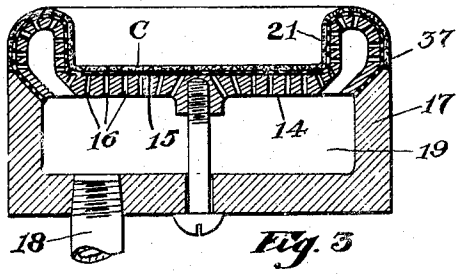


Fig. 3

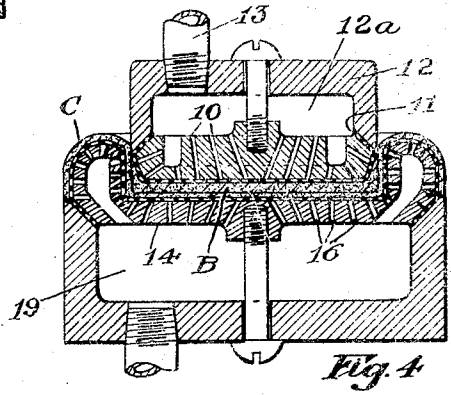


Fig. 4

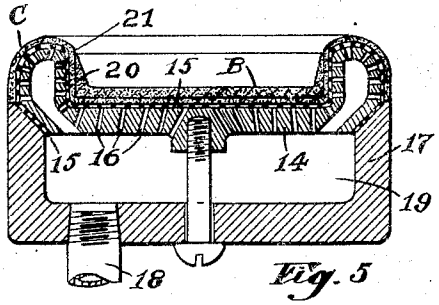


Fig. 5

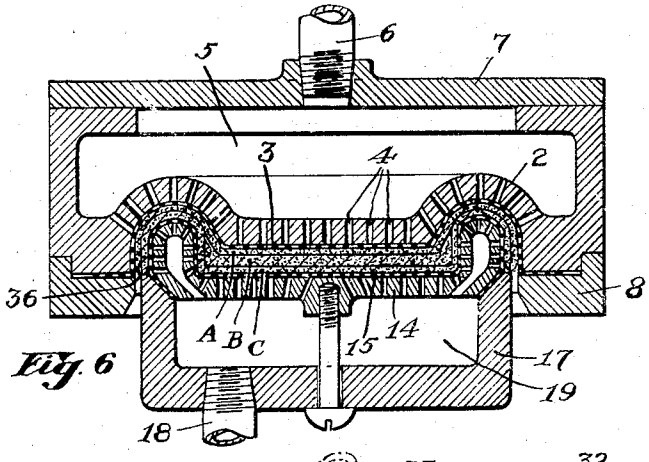


Fig. 6

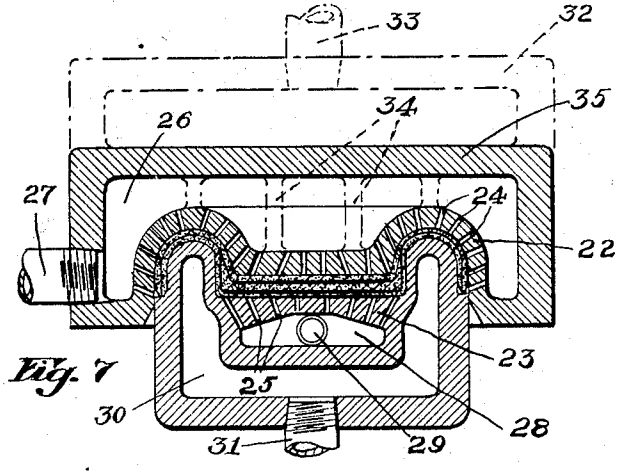


Fig. 7

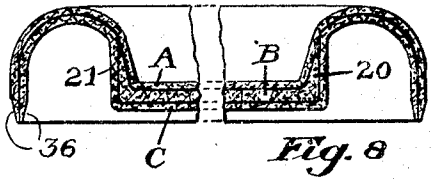


Fig. 8

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METHOD OF PULP MOLDING

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6 Claims. (Cl. 92—56)

In certain pulp articles it is desirable and sometimes necessary that certain sections or portions be made heavier or stronger than other portions. Moreover, certain pulp articles must necessarily have, not only a strong structure, but one which is hard and dense in order that the article may most fully serve the purpose for which it is intended.

The production of certain articles can frequently be most economically produced by molding them to the approximately desired shape from a liquid pulp mixture. Such articles after being molded are subsequently dried and in some cases are finished by being compressed between smooth and heated dies.

With ordinary pulp molding methods, where the pulp fibres are deposited on a foraminous die, by suction, the fibres collect rapidly and compactly until a certain thickness of deposit is attained over the die, after which the deposit is relatively slow, or ceases altogether. During the latter part of this deposit the fibres are not compacted as firmly together and any extra-thick molded pulp article or sheet does not have the density, hardness and strength throughout as is sometimes necessary for particular conditions and results.

In the manufacture of certain molded pulp articles such as pie-plates and the like, this rather loose and uncompacted formation of fibres is frequently desirable. Many of these articles are either made of absorbent fibrous materials, where the moisture and grease of food products must be absorbed by the plate to which they have been transferred, or in cases of articles like butter dishes or table plates designed to hold and retain food products, an extra thickness of fibre deposit in such molded pulp articles, as ordinarily produced, increases their ability to retain food products. When this same thickness or weight of fibrous deposit is compressed subsequent to molding, the structure of the interlocking fibres on the deposit is altered and the sheet is made more flexible.

For the production of hard, dense sheets of reasonable thickness and depth, it is necessary to employ different methods than those usually employed, which give a loosely compacted sheet, or to simply repress a loosely compacted sheet after it has been formed to make it more smooth, or to give it a finish. Moreover, ordinary moulding methods deposit a layer of pulp of generally uniform thickness over the surface of the die, resulting in the production of a finished article of reasonably uniform thickness, while on certain articles it may be necessary that portions be made heavier, thicker and stronger than other portions. Other articles may require that the fibre thickness in certain sections be limited in depth or size for some necessary or specific purpose.

This invention proposes means for producing such an article, and discloses one having certain portions of its structure thicker and stronger than other portions with the entire structure so made as to be dense, firm and strong throughout.

Reference is made to the following figures, each of which is a sectional elevation taken on a plane approximately through the center of the structure:

Fig. 1 is a forming or molding die for one portion of the article.

Fig. 2 is a forming or molding die for another portion of the article, and more particularly a portion which requires reinforcement.

Fig. 3 is a third molding die for another portion of the article.

Fig. 4 shows the portions molded or formed by the dies of Figs. 2 and 3 being consolidated with each other.

Fig. 5 shows the portion formed by the die of Fig. 2 consolidated with, and left on the portion formed by die of Fig. 3.

Fig. 6 shows the portion formed or molded by the die of Fig. 1 being consolidated with the already assembled portions formed or molded by the dies of Figs. 2 and 3.

Fig. 7 shows the consolidated sections being held densely compacted together while the moisture remaining therein is being removed by heat from the dies.

Fig. 8 shows a somewhat enlarged view of the completed article.

It has already been stated, that in order to mold or form a dense, compact sheet or structure, there is a definite limit to the thickness of sheet or of structure which can be so formed. This is particularly true where fibrous materials have been prepared or processed to increase their strength and their ability to form and felt into a dense, strong sheet. For these reasons it is necessary, where a molded pulp structure or article is desired having a strong, dense wall, both thicker and stronger than the ordnary molding methods will produce, to provide special means for securing the desired result. I have accordingly provided for the forming or molding of certain portions or parts of the completed article on separate foraminous dies and subsequently consolidating these separately formed portions together, under con-

ditions which render the finished article homogeneous and uniformly dense throughout.

As illustrative of the type of article to which these methods are particularly applicable, I have selected a milk bottle cap having a closure portion integral with a rim portion, which rim portion covers and protects the upper part of the exterior bead of an ordinary milk bottle.

The ordinary milk bottle closure is in the form of a heavy board disc which is forced down inside the recess at the top of the bottle, sealing the milk therein. This closing or sealing disc must be dense, firm and strong so that it will remain firmly in place in the bottle recess and be capable of being compressed into this recess with considerable force.

The particular bottle closure just referred to, while serving to retain the milk in the bottle, allows dirt and other contaminating and injurious matter to accumulate on this closure disc and in the recess at the top of the bottle bead over which it is necessary to pour the milk when removing it from the bottle.

The article of my invention illustrated more particularly in Fig. 8, provides for a strong closure disc like portion and an over-covering portion lighter in weight, fitting over and snugly around the top portion of the bead of the milk bottle, protecting the recess and this bead from becoming contaminated in any way and spreading this contamination to the milk, itself.

The strong central section which forms the disc portion of the article of my invention, is compressed into the bottle mouth recess forming a tight seal. When it is desired to use the milk or other bottle contents, the entire cap may be readily removed by hand. It also may be re-used as a cover-cap for the bottle, being easily replaced by hand as it has already been fitted to the bottle mouth recess when originally installed in place. This enables such an article to have a dual use, first, to effect the original closure of the milk bottle, insuring that the sealing recess and the top of the bottle bead are adequately protected against contamination while the milk is being stored and delivered, and second, that this cap can be re-used as may be necessary as a closure-cap for the bottle, until its contents has been completely used.

In forming the article of my invention, I first form section A on a foraminous die **2** (see Fig. 1). This die **2** is covered with a molding screen **3**, and through the die **2**, itself, are perforations **4**, permitting the liquid of the pulp mixture from which the article is formed, to be drawn into chamber **5**, by means of suction applied to pipe **6**. The chamber on the rear of die **2** is formed by means of a cover plate or other suitable means indicated at **7**. The molding screen **3** is held on die **2**, by means of a retaining ring **8**.

For molding or forming section B of my article I provide a forming die **9** (see Fig. 2) having perforations **10**, therein, said die being covered with a forming screen **11** clamped in place by a clamping member **12**. A chamber **12**—*a* is formed between the rear surface of die **9**, and the clamping member **12**, to which chamber there is connected pipe **13**. When suction is applied to pipe **13** a deposit B of fibrous material is formed on screen **11**.

For forming or molding a third portion C of my article, I provide a forming or molding die **14**, (see Fig. 3) having perforations **16**, therein, and covered with a forming screen **15** clamped in place by member **17**. This member **17** forms a chamber **19**, back of die **14**, to which chamber is connected pipe **18**. When suction is applied to pipe **18** exhausting the air and water from chamber **19**, a pulp fibre deposit C is formed on the screen **15**.

Each of the fibre deposits A, B and C are limited in thickness to a deposit which is firm and dense and well compacted and felted on the forming wire screen on which it is deposited. I do not permit or allow these deposits to build up to a thickness where the outermost fibres are loosely deposited or improperly felted, due to the loss in suction which must necessarily occur on the outer parts of a thick deposit.

For instance, using a certain grade or kind of fibres I may find that the limit of deposit thickness may be one-eighth of an inch, this deposit being made with a suction behind the die of sixteen inches vacuum, measured by a mercury column. With such a deposit there is, of course, full sixteen inches vacuum or suction at that portion or part of the deposit immediately adjacent to the screen, while there is zero or practically zero suction or vacuum at that portion of the article farthest from the screen. Assuming that the increase in vacuum is uniformly progressive, as the screen is approached and dividing the article into four parts, in direction of thickness we can assume that the section next to the screen may be held and compacted under a vacuum of from twelve to sixteen inches. The next section would be compacted under a vacuum of eight to twelve inches, and the third section, compacted under a vacuum of from four to eight inches. The last or outermost section under a vacuum of from zero to four inches.

Practically, the progression of loss of suction or vacuum occurs more rapidly as the distance from the forming wire increases. Hence, we know that with a deposit being formed only one-thirty-second inch thick, instead of one-eighth inch thick, that there will be available at least four times the suction or vacuum for compacting and interfelting the fibres than there would be available on a one-thirty-second inch thickness located at the outside of a sheet one-eighth inch thick.

It will be readily understood that the vacuum or suction behind a molding die and a screen results in a corresponding pressure being applied on the outside of the molding screen, either to the liquid passing thru or the fibres being retained by the screen, or to the complete fibre deposit on the screen and after it has been removed from the liquid mixture. The fibrous layer is then subjected to air pressure on the surface of the formed sheet which takes the place of the liquid pressure while the article was being molded. Assume a fair average suction on a one-thirty-second of an inch deposit already considered being fourteen inches mercury, this is roughly equivalent to seven pounds atmospheric pressure. This means that there is available when forming an article, only one-thirty-second of an inch thick, a pressure of seven pounds to each square inch of article's surface area serving to compact the fibres of this layer together during formation, rendering them dense and firm. Attempting to deposit a thicker layer rapidly reduces this available pressure, and can only result in a more loosely and unevenly compacted fibre structure.

For the above reasons, I, therefore, employ a plurality of forming and molding dies depositing on each die a layer of pulp of only such

thickness as will cause it to be thoroughly and completely compacted by the very act of formation. It has already been pointed out that the subsequent compacting of a thick, loosely formed or molded sheet disrupts the fibre structure of formation and does not give the required result.

If no extra reinforced or strengthened section of any particular article is required, I mould or form complementary sheets, in the form of thin, compact layers and consolidate these firmly together to form a thick, dense sheet molded and shaped in the form of the finished article desired. However, for the particular article illustrated, it is necessary that the central portion be reinforced as compared to the rim portions. To accomplish this I form section C on die **14**, and section B on die **9**. These dense, compact sections are then consolidated with each other, as illustrated in Fig. 4, the die **9** then being removed, leaving the dense layer B consolidated with the dense layer C already formed and still being retained on die **14**.

It will be noted that this layer C not only covers the flat, central portion of my article indicated generally at B, but also has tapering sections **20** adapted to fit inside the substantially vertical walls **21** of the article formed on die **14**. This serves to reinforce this wall and particularly those portions adjacent to the flat, central portion already mentioned.

After the layers B and C have been consolidated with each other, as is indicated in Fig. 5, the deposit A which was formed on die **2**, is then consolidated with deposits B and C as indicated in Fig. 6. It will thus be seen that the deposits A and C completely surround and overlie deposit B, which deposit, in effect, forms a reinforcing and strengthening member to that portion of the article where strength and stiffness is required.

It has already been pointed out that a method has been provided for producing a molded pulp article made up of sections densified and compacted by the very molding method employed. These sections, however, contain a certain amount of water, or other liquid, which must be removed before a uniform and homogeneous article structure is possible. This water removal is most readily accomplished by the application of heat.

For the particular article under consideration, in fact, for any unitary product, it is necessary that the densified compact sections be held compacted in themselves and to each other during the time that the water contained in them is being removed. To accomplish this I provide two co-acting and complementary dies **22** and **23**, as shown in Fig. 7.

For the removal of the moisture in the form of water vapor or steam I provide perforations in each of these dies, in the form of small openings **24** in die **22**, and **25** in die **23**. A chamber **26** is provided in die **22** behind these openings, or on the opposite side of the opening, that is in contact with the article, and to this chamber is connected pipe **27**. Suction or vacuum may be applied, if necessary, thru pipe **27** in chamber **26**, to assist in removing the vapor of evaporation.

Die **23** is also provided with a chamber behind the holes **25**, this chamber being designated at **28**, and having a connecting pipe or tube **29**. This die **23** is also provided with a heating chamber **30** to which steam or other heating vapor or liquid may be supplied through pipe **31**.

It will be noted that heat is applied to the article by means of die **23**, which heat will turn the water contained in the article into water vapor or steam, which will escape thru the holes **24** and **25** into the respective chambers **26** and **28**, from which they may be removed by pipes **27** and **29**.

It will further be noted that perforations or escape passages for water vapor is provided on both sides of the central portion of the article, which portion is thicker than the other portions. This is done in order that the water in the article may be removed uniformly throughout, and as the edge or rim portions contain less water than the central portion, additional means for the escape and removal is provided for the water vapor of the central portion, in order that this may be removed faster than that in the rim portion, so that the complete article and all sections thereof, will be dried out at approximately the same time, no portion being overdried and no portion being left wet or soggy.

If necessary or desirable, heat may also be applied to die **22**, by means of a heating chamber shown by the dotted lines at **32**, supplied with a heating medium thru pipe **33**. In this case, heat conducting ribs or posts **34** may be added to connect the outer wall **35** of die **22** with the inner wall, which is in contact with the article being dried.

A further feature incorporated in my method for producing the particular article being considered, is the control and limitation of the thickness of the edge of the rim portion by the particular die construction and method of formation employed. The particular article illustrated for use on the top of an ordinary milk bottle has a rim portion extending outwardly over a portion of the bottle bead. While this rim portion must be sturdy enough to properly cover the bottle bead, it is desirable that it not be as thick as the other portions, particularly, at its outermost edge.

The reason why it is desirable that the article be as thin as practicable at the outer edge is to avoid the possibility of the edge of the cap being caught or injured while the bottle is being handled. It is obvious, that if the cap which stands outwardly at the edge for a considerable distance, the possibility of this portion of cap catching on some object during handling is increased. However, I have provided a cap having a relatively thin edge, fitting tightly and snugly against the bottle bead, this thin edge offering the minimum of possibility of injury during handling.

Referring to Fig. 1 it will be noted that the pulp deposit on the wire screen **3** tapers off at **36** due to the limitation of drainage area behind the wire screen **3** at this point, and where it is held by the clamp ring **8**. Also, referring to Fig. 3 it will be noted that the edge thickness of the article at **37** is very definitely limitated by the diameter of the clamp member **17**. This edge thickness is also finally limited and controlled by the shape and space allowed between the dies **22** and **23** as shown in Fig. 7. I have controlled the deposit thickness at the extreme edge of my article and held this thin edge in compressed condition while the water is being removed and the article is being finished. The final result is illustrated at **3** in Fig. 8, where it will be noted that the edge thickness of the article is reduced at point **36** somewhat below the thickness of the rim at any other point.

While I have discussed the method of my in-

vention as particularly applied to the manufacture of milk bottle caps, it is obvious that this method may be utilized to great advantage in the manufacture of any article where a dense, compact and rigid structure is necessary. It is particularly applicable in the economical production of certain articles by the simple molding processes herein disclosed, such articles having heretofore been necessarily produced by the cutting of previously made sheets, and the assembling of these sheets together while dry by means of adhesives, pressing, rolling or winding these cut sheets in place to produce the article. These methods are not only expensive in production due to the fact that the original sheets have to be made, dried, and then cut and made over into the article, with the addition of adhesive materials but further there is excessive waste of sheeted material in cutting and forming of shaped articles.

As examples of other articles which may be economically produced by the methods herein disclosed are tubes, cones, cups and similar objects where strength and rigidity are necessary at low cost.

It will thus be seen, that I have provided a new method of producing useful articles. This method includes primary molding or forming of sections of the article, each having special characteristics, the consolidating of these sections together to form an article the different parts or areas of which are especially adapted for the particular use to which they will be put, and of removing the water remaining in or between the several sections while retaining them in firm, compacted condition and producing a uniform structure. I also provide means for removal of water or water vapor more rapidly in some thick portions of an article of non-uniform thickness than in other thin portions, effecting uniform drying of the completed article in densified or compact condition.

The article produced by my method has new and novel characteristics, and what I claim for both article and its method of production is:

1. The method of producing a molded, fibrous pulp article which comprises molding a dense relatively thin and highly compacted contoured section of pulp on a contoured, pulp forming die, similarly and separately forming a second pulp section of lesser area than said first section, similarly and separately forming a third section of pulp of an area substantially co-extensive with said first mentioned section, assembling these contoured sections of pulp in compacted condition individually and with each other, positioning said first and third mentioned sections to form the outer surfaces of the finished article, and removing fluids contained therein.

2. The method of producing a fibrous article which comprises forming on a die, a dense, relatively thin, highly compacted, contoured sheet having connected wall portions extending at an angle to each other, forming a second thin and compacted sheet contoured to overlie and fit a portion only, including the angularly disposed walls of said first sheet, assembling these compacted sheets in mating relation to each other, and retaining said sheets in compacted condition until the water or other liquid contained therein has been removed.

3. The method of producing a fibrous pulp article which comprises molding on a foraminous die, to its approximate final shape, a contoured, thin, relatively dense, compact sheet, forming on a second contoured die a thin, compact sheet of lesser area, and contoured to overlie and fit a portion only of the dense sheet formed on the first mentioned die, compacting the sheets with each other, and holding said sheets in compact condition until the water or other liquid contained therein has been removed.

4. The method of producing a fibrous pulp article which comprises molding on a foraminous die, to its approximate final shape, a contoured, dense, compact sheet, forming on a second contoured die a compact sheet of lesser area and contoured to overlie and fit a portion only of the surface of the article formed on the first mentioned die, molding on a third foraminous die a dense, compact sheet of an area substantially coextensive with that of the article formed on the first mentioned die, assembling the sheet formed on the second mentioned die with the sheet formed on the first mentioned die, assembling the sheet formed on the third mentioned die in overlying relation with the sheet formed on the second mentioned die and already assembled to overlie a portion only of the sheet on the first mentioned die, said sheet formed on the third mentioned die overlying both of the other sheets, and holding all three sheets in compacted condition in themselves and with each other, until the water or other liquid contained therein has been removed.

5. The method of producing a fibrous pulp article which comprises molding on a foraminous die to its approximate final shape, a contoured, thin relatively dense, compact sheet of pulp, forming on a second contoured die a thin compact sheet of lesser area, and contoured to overlie and fit within a portion only of the first mentioned dense sheet, compacting the sheets with each other under pressure, removing fluids contained therein by the application of heat and suction, and holding said sheets in compact condition until said fluids have been removed.

6. The method of producing a fibrous pulp article which comprises molding on a foraminous die, to its approximate final shape, a contoured, dense, compact sheet of pulp, forming on a second contoured die, a compact sheet of lesser area, contoured to overlie and fit a portion only of the surface of the article formed on the first mentioned die, molding on a third foraminous die a dense compact sheet, assembling the sheet formed on the second mentioned die with the sheet formed on the first mentioned die, assembling the sheet formed on the third mentioned die in overlying relation to the sheet formed on the second mentioned die, and already assembled to overlie a portion only of the sheet on the first mentioned die, said sheet formed on the third mentioned die overlying both of the other sheets, applying pressure to said assemblage to compact the sheets together, removing fluids contained in the assemblage by the application of heat and suction, and maintaining all three sheets in compacted condition in themselves and with each other until such fluids have been removed.

CHARLES J. CHAPLIN.