Feb. 21, 1967 R. T. BERNIER ETAL 3,305,434

METHOD AND APPARATUS FOR FORMING RIGID PAPER PRODUCTS FROM WET PAPERBOARD STOCK

Filed Feb. 15, 1966 4 Sheets-Sheet 1

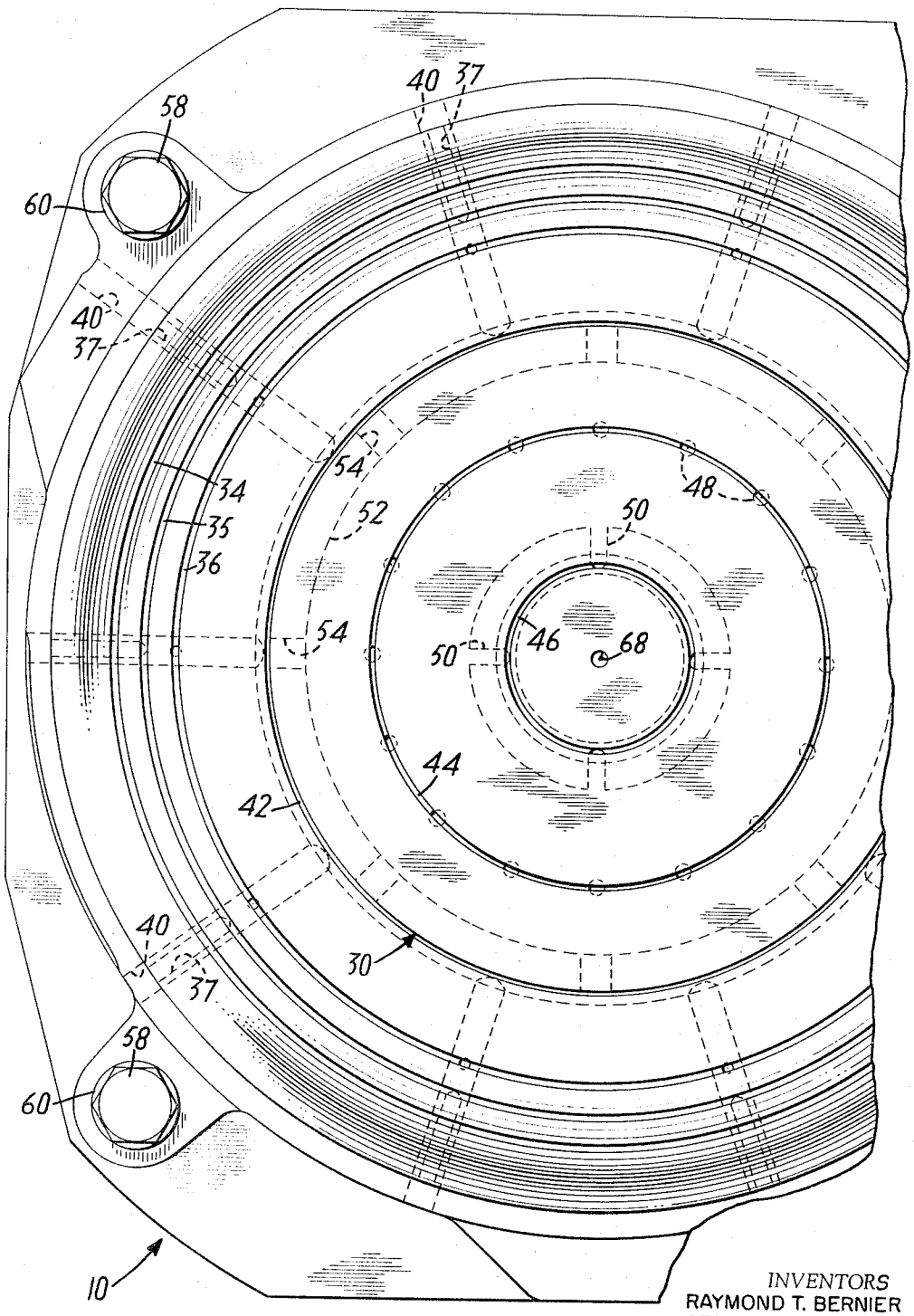


FIG. 1

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Filed Feb. 15, 1966 4 Sheets-Sheet 2

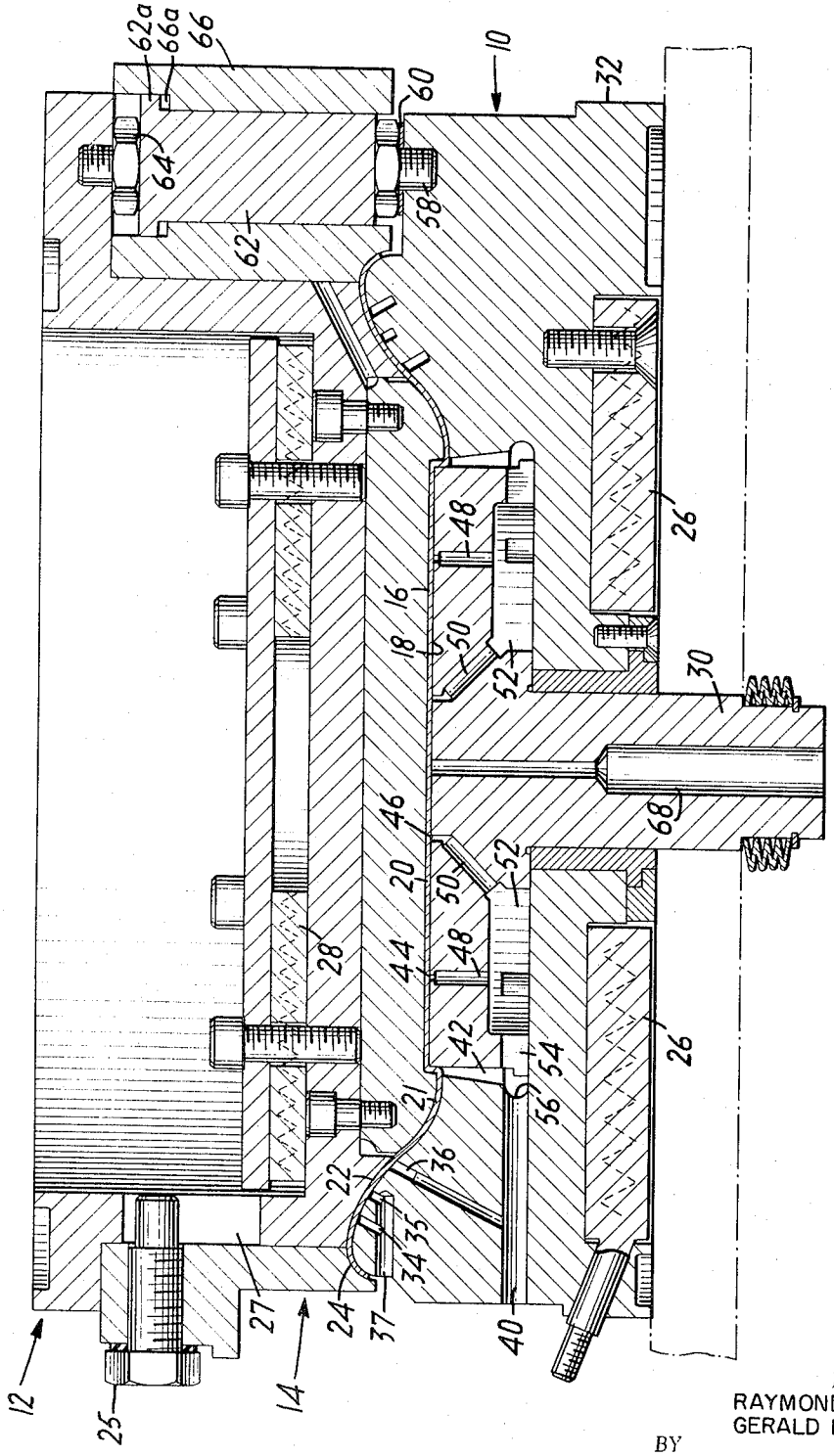


FIG. 2

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Filed Feb. 15, 1966 4 Sheets-Sheet 3

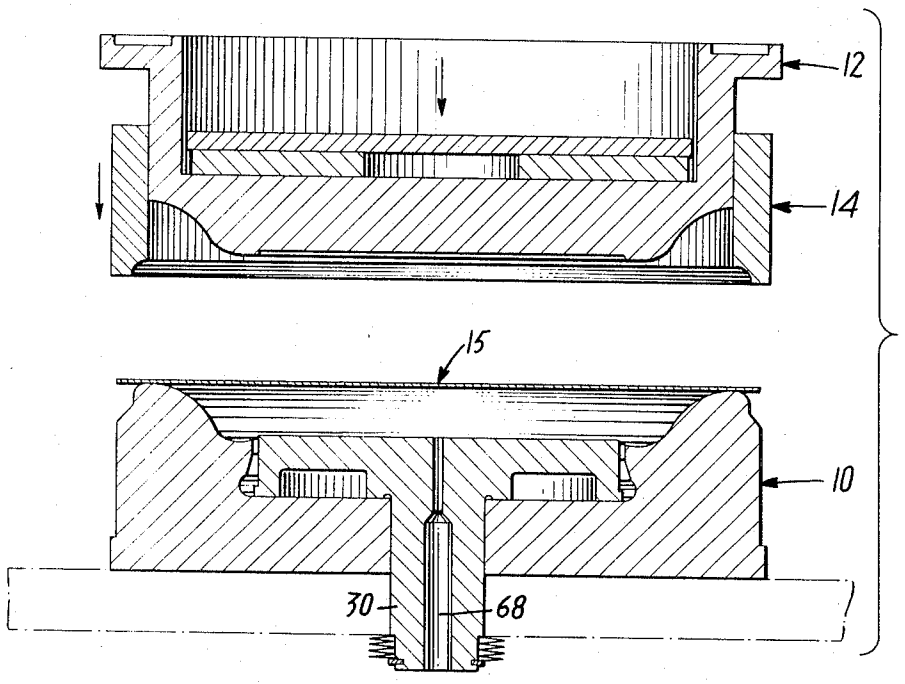


FIG. 3A

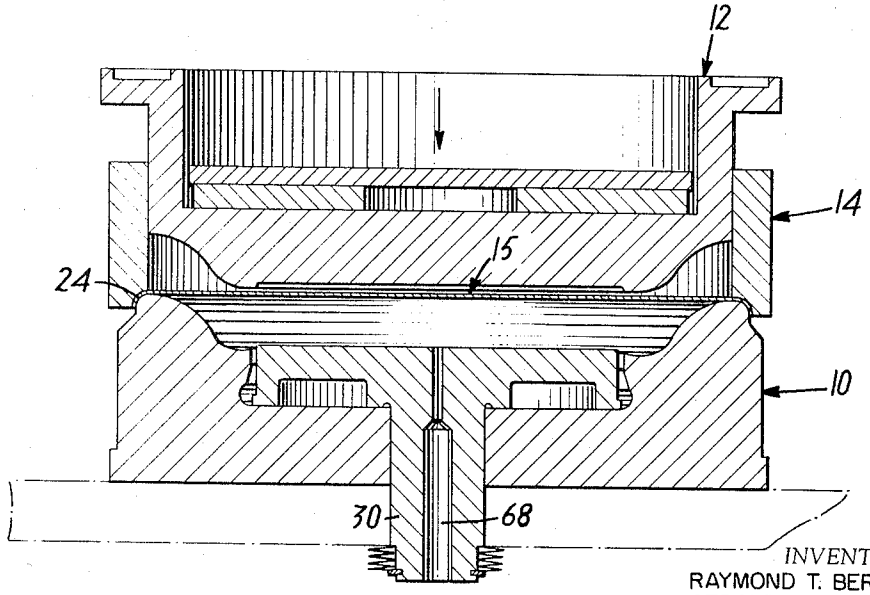


FIG. 3B

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Filed Feb. 15, 1966 4 Sheets-Sheet 4

FIG. 3C

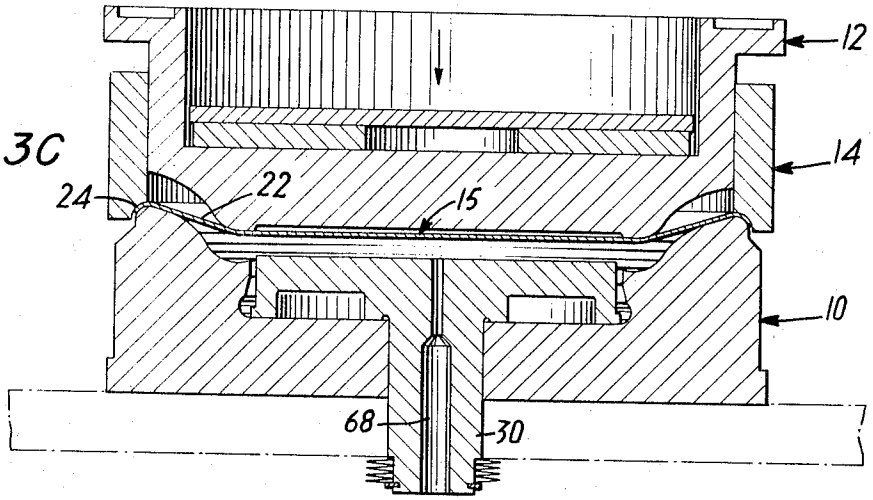
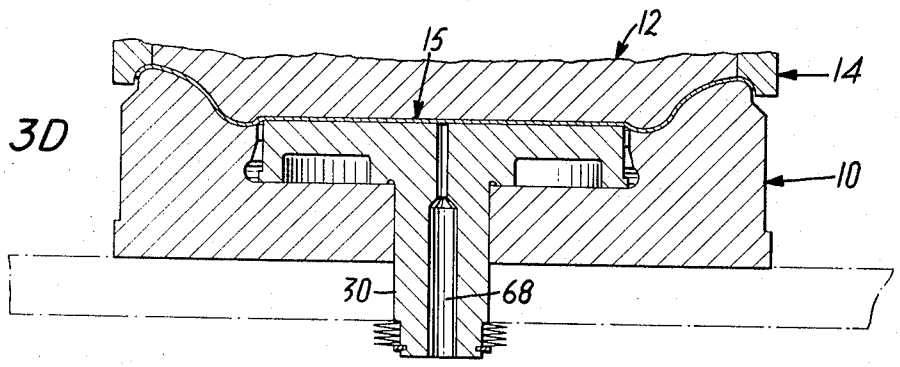


FIG. 3D



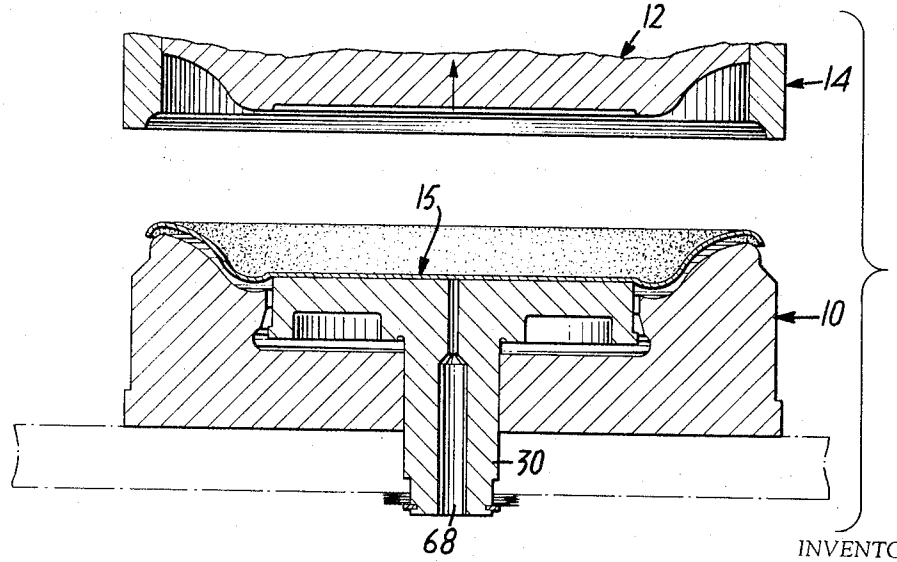


FIG. 3E

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United States Patent Office 3,305,434 Patented Feb. 21, 1967

3,305,434

METHOD AND APPARATUS FOR FORMING RIGID PAPER PRODUCTS FROM WET PAPERBOARD STOCK

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Filed Feb. 15, 1966, Ser. No. 532,822
7 Claims. (Cl. 162—117)

This application is a continuation-in-part of co-pending application, now abandoned, Serial No. 258,820, filed February 15, 1963, and entitled, "Improvements in Method and Apparatus for Forming Rigid Paper Products."

This invention relates to a novel method and apparatus for forming paper products from a pressed paperboard stock or the like, having a high moisture content, thereby to produce improved paper products of relatively high rigidity and caliper, low density and improved surface characteristics compared to paper products made by known methods.

The present methods of manufacturing paper products, such as paper plates, dishes, packages and the like, can be divided into two broad categories. The first category is generally termed the "molded pulp" process and uses pulp slurry as a raw material. In this process, a suction head in the general shape of the desired product is immersed in the pulp slurry, and after a sufficient thickness of fiber is built up on the suction head, the suction head and fibrous mass are carried to a forming die where the fibrous material is compacted and dried to form a plate or similar vessel. The resultant article, while having a fairly high stiffness and little tendency to flatten, has a very rough surface of considerable porosity rendering it highly absorbent when used as a receptacle for certain foods and moist goods. Additionally, it is extremely difficult to apply a decorative design or a water-resistant material to the rough surface of the article.

In the second group of methods for producing paper products, known as the "pressed paperboard" process, a precut paper or cardboard web is inserted between a pair of forming dies which stamp it into the desired shape. Inasmuch as the paper web is a flat sheet, it has heretofore been necessary to make provision in the stamping process for the change of area resulting from forming curved surfaces in a paper product, since the paper web tends to wrinkle along the curved portions during forming. One solution has been to form corrugations or flutes in those portions of the product which are reduced in area during forming with respect to the plane area prior to forming. Alternatively, these portions have been formed with overlapping surfaces or folds, producing large wrinkles which, in many cases, make the product commercially unsatisfactory.

A desirable characteristic of the pressed paperboard process is that the paperboard web may be coated with a moisture-resistant surface and printed with decorative designs before stamping by roller coating and ordinary methods of printing, such as offset or other planographic methods. Thus, products made by the paperboard process are commercially superior, inasmuch as they are more attractive and considerably less absorbent than paper products formed by the molded pulp process. Further, the use of a pre-treated or pre-printed paper web results in a smoother surface as compared to the rough surface of products made by the molded pulp process. On the other hand, a significant disadvantage of the pressed paperboard process is that heretofore it has not been possible or practical to obtain a very high degree of stiffness in the resultant product. For example, conventional paper

plates made by this process cannot be safely held other than by supporting them beneath a fairly large area of the food-carrying surface. If held at the edge, there is danger that the plate will collapse and spill the contents. Another disadvantage of plates formed by presently known pressed paperboard processes is that the upwardly sloped outer regions thereof tend to flatten and collapse, particularly upon absorbing moisture.

There is provided, in accordance with the invention, an improved process for making paper products of much greater rigidity, higher caliper, lower density and improved surface characteristics than products formed by presently known methods. More particularly, in accordance with the invention, the paper or cardboard stock of high bulk (low density), low stiffness and high moisture content, for example, from about 15% to about 35% by weight, based on the weight of finished stock, is formed between a pair of forming dies in a manner involving significant reorientation of the fibers of the stock in certain regions. The forming is accomplished in the presence of heat and a separation between the dies is maintained so that the removal of vapors evolved from the stock, which might otherwise produce undesirable blisters in the product, is greatly facilitated. The web, if desired, can be printed with a decorative design and coated with a moisture-resistant material. The web is then preferably precut to form a blank of the approximate overall size and shape of the finished product before it is introduced between the forming dies. In the dies, the blank is first gripped along a line or band approximately defining the perimeter of the paper product being formed so as to hold it securely during forming to provide reorientation of the fibers of the stock during the forming operation. Next, the forming dies are brought together leaving sufficient clearance therebetween to avoid excessive compression of the stock which might otherwise result (1) in entrapping steam or evolved vapor therein, and (2) in decreased rigidity of the formed product by reducing its thickness. The paper stock is subjected to relatively high temperatures during the forming operation to remove the excess moisture, which incidentally must be withdrawn from between the forming dies to prevent blistering, and after the formed paper product is adequately dried in the dies, it is removed for completion of drying or for packing.

The forming apparatus of the invention includes a pair of relatively movable cooperating forming dies of the desired shape, an outer annular gripping means surrounding the forming dies to grip or hold the perimeter of the paper blank securely about the region to be formed during formation of the article, and a network of steam venting passages communicating with the paper stock between the forming dies. In the particular embodiment of the apparatus shown and described, the lower forming die comprises relatively movable parts to facilitate removing the product from the forming apparatus upon completion of the forming operation. To prevent the excessive compression of the paper stock, positive stop means is also provided to limit the relative movement of the forming dies toward each other during the forming operation.

Inasmuch as the perimeter of the web is gripped during forming of the product, the process of the present invention involves a degree of stretching, in the range of up to 2½ or 3%, the paper web radially. However, because there is radially inward translation of the gripped portion, the process also involves compressing or shrinking the web in a direction generally perpendicular to the radial. In being stretched radially and compressed circumferentially, the paper blank exhibits the characteristics of ductility, although heretofore paperboard has been thought of as a non-ductile material, particularly inas-

much as attempts to form it in a manner involving substantial deformation of fiber structure have resulted in tearing or other harmful deterioration of the fiber structure. However, it is believed that the high moisture content of the paperboard stock used in the process of the present invention allows a high degree of fiber mobility and makes possible controlled fiber slippage. Thus, during the forming of a paper product in the process of this invention the individual fibers undergo transformation, some radially with respect to the center of the die members, and others transverse to the radial. When the moisture is removed by heating during forming, the reoriented fibers become locked in place, inasmuch as they are no longer "lubricated," so to speak by the moisture. Since the deformation is permanent upon drying, there is no tendency for the plate to flatten.

In forming paperboard stock of high moisture content in the presence of heat, there is a tendency for the surfaces to blister and break down if provision is not made for effectively and rapidly removing vapors evolved in the stock. By using paperboard stock of low density, maintaining appreciable clearance between the dies during forming and providing for the rapid and effective removal of the evolved vapors from between the forming dies during the forming operation, it has been possible virtually to eliminate these surface defects. In processes of forming paperboard stock where the closure of the die members has been resisted only by the paperboard stock itself, a densely compacted fibrous structure is produced. In the present invention, by using paperboard stock of relatively high caliper and low density and by maintaining a high clearance between the die members during the forming operation, for example, very slightly less than the thickness of the moistened paperboard stock (but in no case less than a clearance which would impede the removal of the moisture at a rate necessary to avoid blistering or prevent the necessary reorientation of the fibers of the paper stock), the caliper of the resultant product is relatively high and the density is low compared to conventional paper products of similar types. Further, there is a significant reduction in the amount of pulp required for products made by the process of the invention having comparable stiffness to those made by ordinary methods, and accordingly, a lower cost of production.

For a better understanding of the detailed description of an exemplary process of an embodiment of the apparatus, in accordance with the invention, set forth hereinafter, reference may be made to the appended drawings, in which:

FIGURE 1 is a partial plan view of an exemplary embodiment of the forming apparatus, showing the lower die member only;

FIGURE 2 is a view in cross-section taken at the center of a complete forming apparatus, the lower die member of which conforms to that illustrated in FIGURE 1; and

FIGURES 3A through 3E are cross-sectional views which illustrate the operation of the apparatus shown in FIGURES 1 and 2, as well as certain of the steps of the forming process.

In the process of making paper plates according to the present invention, paperboard stock, such as multi-layer paperboard stock fed from a cylinder type papermaking machine or from a Fourdrinier type paper machine and having the characteristics of high bulk (low density), high moisture content and low stiffness which are necessary to allow the fiber reorientation during forming, is presented to a forming apparatus of the type shown in FIGURES 1 and 2 of the drawings. By high thickness is meant heavy duty paperboard stock greater than .016 inch in thickness up to .040 or .050 inch, and in the manufacture of paper plates a range of from about .029 to .033 inch is preferred. The critical range of high moisture content is from about 15% to about 35%, and

preferably between 17% and 25% by weight. The normal density range of heavy duty paperboard stock is from 8.8 to 9.6 lbs. of basis weight per point of caliper, where basis weight is taken at the high moisture as introduced to the die and is measured in terms of lbs. per 3000 sq. ft. (N.B. A "point" of caliper is .001 inch. Thus, 9.2 lbs./pt. density at .030 inch caliper=276 lbs./3000 sq. ft. By way of reference, paperboard stock normally used for ordinary paper plates has a density of 10.5 lbs./pt. or greater.)

The paperboard stock will ordinarily be manufactured in web form which is cut or stamped to produced blanks of the desired diameter before being presented between the forming dies. If desired, the web can be printed, plastic-coated or moisture-proofed. Normally, the moisture content of the stock would be reduced below the critical range if the stock is to be printed or plastic-coated before the forming operation, in which case it is necessary to increase the moisture content to within the critical range before forming. In this regard, it has been found that paperboard stock having a moisture content of approximately 25% can be printed and plastic-coated by rotogravure process with but a small loss of moisture, and that the stock so prepared can be used in carrying out the present process.

A paperboard blank **15** of high moisture content, as described above, is formed in the apparatus shown in FIGURES 1 and 2. This apparatus comprises three relatively movable components, namely, a lower forming die **10**, an upper forming die **12** and a drawing ring **14** which surrounds the upper forming die and cooperates with the lower forming die to hold the outer periphery of the blank while it is formed between the forming dies **10** and **12**. The particular forming dies shown in FIGURES 1 and 2 of the drawings have complementary forming surfaces **16** and **18** for shaping the blank **15** from the sheet-like form shown in FIGURE 3A to the dish-shaped form shown in FIGURE 2. This particular dish is characterized by a generally flat central region **20**, a downwardly depending shoulder portion **21** surrounding the central region **20**, and an outer upwardly sloped flange **22** which turns downwardly at the extreme outer periphery **24**.

In the embodiment of the apparatus shown in the drawings, the upper die **12** is movable relative to the lower die **10** from a raised position, which permits the formed product to be removed and another blank presented between the forming dies, to a forming position at which a predetermined clearance is maintained between the forming dies. The retaining ring **14** carries a plurality of inwardly projecting screws **25** which are accommodated within vertical slots **27** formed in the forming die **12**. Thus, although the retaining ring **14** is carried by the forming die **12** toward and away from the lower forming die **10**, a limited amount of independent movement is afforded to the retaining ring relative to the forming die **12** by the lost-motion connection therebetween. This permits the retaining ring to be actuated independently of the forming die **12** by air cylinders (not shown) carried by the forming die. These air cylinders control the retaining ring pressure accurately and uniformly as the forming die **12** closes, so that full force of the retaining ring can be immediately brought to bear against the blank to be formed. The retaining ring pressures vary considerably, depending upon the density, moisture content and other properties of the paperboard stock and upon the size and shape of the product, between about 10 lbs. and 40 lbs. per square inch of the projected area of the retaining ring. Generally, a reduced moisture content requires an increased ring pressure and involves a lesser degree of radial stretching of the blank. Those skilled in the art can readily determine the optimum retaining ring force for the characteristics of the paperboard stock used and the geometric form and size of the product made.

The lower and upper forming dies 10 and 12 are equipped with electrical heating elements 26 and 28, respectively, to heat the paperboard stock during the forming operation and vaporize the moisture.

In order to facilitate removal of the paper plate after the forming operation, the forming die 10 is made in two relatively movable components, a movable ejector head 30 and a stationary base 32 having a central recess to receive the ejector head therein. When the ejector head is recessed within the base of the forming head, the upper surface of the ejector head and the upper surface of the base surrounding the ejector head together define the forming surfaces of the forming die 10. After the forming operation and the raising of the upper forming die, the ejector head, as will be explained in more detail below, is raised to lift the formed plate with respect to the remainder of the forming die to facilitate the removal of the formed plate from the forming apparatus.

The steam or vapor evolved from the paperboard blank is vented to atmosphere through a venting system in the forming die 10 which includes the concentric grooves 34, 35, 36, in the upper surface of the outer part of the base 32 of the forming die, the annular space 42 separating the ejector head 30 and the surrounding part of the base 32, and the concentric grooves 44 and 46 in the top of the ejector head. The outer grooves 34 and 35 communicate with atmosphere through a plurality of outwardly extending passages 37 in the base 32 of the forming die. The groove 36 and the space 42 are vented by a plurality of outwardly extending passages 40 in the base 32. The grooves 44 and 46 in the upper surface of the ejector head are connected with a recessed portion 52 in the underside of the ejector head which, in turn, communicates with the space 42 and the vent passages 40.

It is apparent that the moisture removing grooves need not be circular or concentric, but that various patterns of grooves can be used. While it is usually adequate to vent the steam and vapors evolved from the paperboard stock directly to atmosphere, the network of vent passages may communicate with a pressure below atmospheric so that the moisture is withdrawn by suction.

In the particular apparatus shown in the drawings, provision is made for venting the vapor or steam evolved from the paperboard stock from the bottom of the stock and through the lower forming die 10. By removing the moisture from the bottom of the paperboard stock, the upper surface will be free of blemishes, perforations and other imperfections which might result from venting vapors through the upper forming die 12. Furthermore, if the upper surface of the paperboard stock has been printed or treated to make it moisture-proof, it will not be feasible to withdraw moisture from the upper surface of the paperboard stock during the forming operation. However, the surface imperfections are not readily detectable, provided that vapors are withdrawn immediately and not permitted to become entrapped between the forming dies, and in many instances, it may be possible to incorporate venting means in both of the forming dies.

The forming apparatus includes means to limit the compression of the paperboard stock by the forming dies 10 and 12. This stop device includes a plurality of stop screws 58 carried by the lower die 10, a plurality of stop screws 64 carried by the upper forming die 12 and aligned with the stop screws 58, and a plurality of floating pins 62 carried by the retaining ring 14 interposed between corresponding of the stop screws 58 and 64. More specifically, the stop screws 58 are threaded into the upper surfaces of bosses formed integrally with and projecting outwardly from the base 32 of the forming die 10. The heights of these stop screws 58 can be adjusted by placing washers or shims 60 of the desired thickness between the heads thereof and the upper surfaces of the boses. Corresponding stop screws 64 are threaded into the lower surfaces of projecting

portions of the upper forming die. The pins 62 are each supported within a sleeve 66 carried by the retaining ring by the engagement of the enlarged head 62*a* of the pin with a shoulder 66*a* of the sleeve.

As explained above, during the descent of the upper forming die 12, the retaining ring 14 first engages the outer periphery of the blank, and almost immediately the full force of the retaining ring is brought to bear against the blank through the pneumatic pressure acting thereon. Before the retaining ring comes to rest, the pins 62 engage the heads of the stop screws 58 and lift the pins slightly within their respective sleeves 66. Thereafter, the downward movement of the upper forming die stops upon engagement of the stop screws 64 carried by the upper forming die with the upper ends of the pins 62.

After completion of the forming of a plate and withdrawal of the upper die member 12 and the draw ring 14, the ejecting head 30 of the lower die member 10 is moved upwardly by any suitable means (not shown), in order to lift the paper plate from the lower forming die. If desired, removal of the paper plate from the ejecting head can be facilitated by an air blast directed through a passage 68 in the ejecting head 30.

The operation of the forming apparatus can best be explained in connection with the process of the present invention. In a typical example of the process, a cardboard or paperboard web having a low density of from 8.8 to 9.6 lbs./pt., a thickness of about .029 to .033 inch and a moisture content of about 22% to 25% by weight is precut to form a blank 15 of predetermined size and shape and inserted between the die members 10 and 12, as illustrated in FIGURE 3A. Alternatively, it may be fed between the forming die members in a web or oversized sheet and cut to a blank 15 of proper size by a knife edge (not shown) on the outer edge of the ring 14. When the blank has been fed between the forming dies, the draw ring 14 is lowered to grip the edge of the blank securely between the ring and the outer periphery of the lower forming die, as shown in FIGURE 3B. Thereafter, as illustrated in FIGURES 3C and 3D, the upper die member 12 is lowered to complete the shaping of the plate between the heated forming dies spaced apart by the stops described above to provide a clearance of about .001 to about .005 inch less than the thickness of the paperboard stock. As the steam vapors are evolved from the blank, they are vented to atmosphere through the above described network of venting passages in the lower die to avoid blistering and deterioration of the fiber structure. When the forming has been completed and the blank sufficiently dried to lock the fibers in place, the forming dies are separated, the ejector head lifted and the formed plate is removed from the forming apparatus. Due to the "spring back" of the paperboard stock after the forming operation, the thickness of the paper plate will probably be several mils thicker than clearance provided between the dies during the forming operation.

The range of density of the formed product normally varies from 7.6 to 10.2 lbs. per point of caliper. Density is greatest in this area where the fibers have been extensively rearranged in order to present a smooth, finished surface and also to lock the fibers more rigidly into their new orientation.

During the forming operation of the present invention, the paperboard blank undergoes a substantial amount of radial stretching, and further, the flange portion 22 of the paper plate is subjected to circumferential shrinking or compression. In other words, the process of the invention may be termed a ductile process, and utilizes a property of paperboard, ductility, not previously recognized. To indicate the nature of the ductile forming process, a typical paper blank might undergo an increase in area of approximately seven percent in being formed according to the present invention.

It is believed that the relatively high moisture content of the paperboard serves to lubricate the fibers and to enable them to become somewhat mobile and undergo deformation without tearing or similar destruction of the integrity of the paperboard web. Additionally, it is thought that this deformation causes substantial rearrangement of the fibers, both in a radial direction, and also because of some radial inward movement of the gripped portion of the blank, in a circumferential direction along the curving edge portion 22. This rearrangement considerably increases the rigidity of the resulting paper product. During the drying of the paper product the new fiber structure is stabilized, and the fibers become locked in their reoriented relationship after the removal of the excess moisture. Paper products made by the process of the invention exhibit as much as double or more the rigidity of paper products of similar weight and size formed by presently known pressed paperboard methods. Further, paper plates made according to the present invention do not tend to become limp and flatten out, even after wetting or soaking as do conventional paper plates.

Stiffness tests modified from Federal Specification UU–P–670A (QMC) for plates, paper, rectangular and round, using a 1 lb. concentrated load consisting of a steel bar 1.5" in diameter (rather than the 1 lb. of sand uniformly distributed) were performed on paper plates of conventional manufacture and results were compared to the results of tests made on plates made according to this invention. The plates made according to this invention averaged well over 100% stiffer than plates of the same basis weight paperboard made by regular manufacturing methods. For example, one set of tests averaged a .70" deflection for plates made according to the present invention compared to 1.656" for plates of regular manufacture. As a point of incidental interest, the 1 lb. steel weight was used to create a test more severe than that provided by the government specifications because the latter were apparently designed for present paperboard plates and deflections were very small in all cases. In the tests referred to above, the 1 lb. weight was concentrated in the bottom eating surface of the plate on the side most remote from the holding fixture. The tests were identical to the government specifications in all other respects.

Since the paperboard is not compressed or its density increased during the forming process beyond what is necessary to form the product to the desired shape, the moisture is more readily withdrawn from the paperboard stock by the network of venting passages. As a consequence, the completed product, although less dense, is of considerably higher caliper and rigidity than products made by presently known methods. Compression resulting in over 20% reduction in thickness of the "high bulk" paperboard stock should be avoided in that the appearance of the product may suffer and the forming time will be increased considerably.

It will be understood by those skilled in the art that the above-described embodiments of the apparatus and process are susceptible of considerable variation and modification without departing from the scope and spirit of the invention. Therefore, the invention will not be deemed limited except insofar as such limitations are expressly set forth in the appended claims.

We claim:

1. A method of forming a rigid paper product from paperboard stock having a high bulk and a low density in the range of from about 8.8 to about 9.6 pounds per 0.001 in. thickness per 3000 sq. ft. area, a high moisture content in the range of from about 15% to about 35% by weight, based on the weight of the finished paperboard stock, and a thickness in the range of from about 0.016 to 0.040 in., comprising the steps of gripping the paperboard stock around the periphery of a region to be formed, forming the said region between a pair of forming dies in the presence of heat, said forming dies increasing the area of the region formed and involving reorientation of the fibers of the paperboard stock, and withdrawing the vapors evolved from the paperboard stock from between the forming dies during the forming operation, the forming operation being carried out without reducing the thickness of the stock more than 0.005 inch so as to avoid compressing the paperboard stock to such an extent that the removal of moisture from the paperboard stock is impeded.

2. A method of forming a paper product from paperboard stock having a high bulk and a low density in the range of from about 8.8 to about 9.6 pounds per 0.001 in. thickness per 3000 square feet area, a thickness in the range of from 0.016 to 0.040 in. and a high moisture content in the range of from about 15% to about 35% by weight, based on the weight of the finished paperboard stock, comprising the steps of gripping a sheet of the paperboard stock around a region to be formed, thereafter deep drawing the said region to be formed by moving a pair of forming dies against opposite sides of the said region to be formed, the drawing involving reorientation of the fibers of the paperboard stock, stopping the movement of the dies when they are spaced closely apart a distance not less than 0.005 inch less than the thickness of the stock so as to prevent compression of the paperboard to an extent that would impede the removal of moisture from the paperboard stock during the deep-drawing operation, the deep-drawing substantially increasing the area of the said region and including drawing at least some of the fibers of the paperboard stock in a generally radial direction and compressing at least some of the fibers in a direction generally transverse to the radial, heating the paperboard stock during the deep-drawing operation to drive off moisture from the paperboard stock in the form of vapors, and withdrawing the vapors evolved from the paperboard stock from between the forming dies during the deep-drawing operation, the deep-drawing operation being continued until the formed paperboard stock has acquired self-sustaining rigidity.

3. A method of forming a paper product from paperboard stock having a high bulk and a low density in the range of from about 8.8 to about 9.6 pounds per 0.001 in. thickness per 3000 square feet area, a thickness in the range of from 0.016 to 0.040 in. and a high moisture content in the range of from about 15% to about 35% by weight, based on the weight of the finished paperboard stock, comprising the steps of introducing the paperboard stock between two forming dies, gripping the paperboard stock between a gripping ring and one of the forming dies in a narrow band around a region to be formed, thereafter bringing the dies together in the presence of heat to form the paperboard to the shape of the product, the forming operation substantially increasing the area of the said region formed over the original area thereof without compressing the paperboard stock more than 0.005 in., and removing vapor evolving from the paperboard stock from at least one surface of the paperboard stock during the forming operation.

4. A method of forming a paper product from a paperboard sheet having a high bulk and a low density in the range of from about 8.8 to about 9.6 pounds per 0.001 in. thickness per 3000 square feet area, a thickness in the range of from 0.016 to 0.040 in. and a high moisture content in the range of from about 15% to about 35% by weight, based on the weight of the finished paperboard stock, comprising the steps of gripping said sheet along a narrow band approximately defining the perimeter of the paper product being formed to hold the gripped portion thereof securely during further forming of said product, forming the product between a pair of relatively movable forming dies having substantially complementary forming surfaces, the forming involving reorientation of the fibers of the paperboard stock, while maintaining a clearance between the forming dies of a

magnitude not less than 0.005 inch less than the thickness of the paperboard sheet so as to prevent compression of the paperboard to an extent which would impede the removal of moisture from the paperboard, thereby drawing the paperboard sheet along radial lines and rearranging the fibers, heating said paperboard sheet during the forming step to evolve vapor from the moisture, removing the vapor from at least one surface of the paperboard sheet and from between the forming dies during the forming step, and continuing to heat said paperboard sheet and remove the vapor until the product is formed and set.

5. A method of forming a paper plate comprising the steps of introducing paperboard stock between two forming dies, said paperboard stock being of high bulk and having a low density in the range of from about 8.8 to about 9.6 lbs. per 0.001 in. thickness per 3000 sq. ft., a thickness in the range of from about 0.016 to about 0.040 inch and a high moisture content in the range of from about 15% to about 35% by weight, based on the weight of finished paperboard stock, gripping the paperboard stock between a gripping ring and one of the forming dies in a narrow band around a region to be formed, bringing the dies together in the presence of heat to form the paperboard to the shape of a plate, said forming operation substantially increasing the area of the formed paperboard without compressing the stock more than about .005 inch, and removing the evolved vapor from at least one surface of the formed paperboard.

6. A forming apparatus for forming a paper product from highly moistened paperboard comprising a pair of forming dies relatively movable from positions spaced far apart to positions spaced closely apart, means including a retaining ring for gripping the paperboard about the periphery of a region to be formed against one of the forming dies, stop means cooperating directly between the forming dies and acting independently of the paperboard stock to establish a predetermined minimum clearance between the forming dies during the forming operation, and means defining an array of vent passages in at least one of the forming dies for removing vapor evolved from the paperboad stock during the forming operation.

7. A forming apparatus as set forth in claim 6 wherein the stop means includes a floating stop element carried by the retaining ring and engaging at one end a part of the forming die with which the retaining ring cooperates to grip the paperboard to be formed while the retaining ring and the respective forming die are moving together, the opposite end of said stop element engaging the other forming die to establish a predetermined minimum clearance between the forming dies during the forming operation.

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