

[54] **PULP MOLDING SYSTEM EMPLOYING SUCTION BOX WHICH PREVENTS REWETTING OF THE MOLDED PRODUCTS**

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[22] Filed: **Feb. 11, 1971**

[21] Appl. No.: **114,514**

[52] U.S. Cl. **162/219, 162/220, 162/227, 162/228, 162/364, 162/374, 162/387, 162/388, 162/389, 162/390**

[51] Int. Cl. **D21f 1/52, D21j 7/00, D21h 1/02**

[58] Field of Search **162/218, 228, 219, 380, 162/264, 388, 389, 329, 315, 348, 367, DIG. 1, 383, 351, 116, 382, 363, 364, 374, 220, 227, 387, 390**

[56] **References Cited**

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[57]

ABSTRACT

A system for producing molded pulp products which includes a tank containing a pulp furnish, a suction box located above the tank which has an arcuate bottom wall located below the furnish level in the tank, and an endless, moving belt which carries multiple foraminous molds over the arcuate bottom wall of the suction box so that liquid can be drawn upwardly through the molds depositing a pulp layer thereon. The tank bottom wall is also arcuately shaped to provide a narrowing cross-sectional area for the pulp furnish which itself flows through the channel so provided. The suction box is compartmented to allow for varying suction zones. The suction box bottom wall has V-shaped grooves that communicate with flow-pipes to allow for suction withdrawn liquid to flow into the suction box and accumulate on the bottom wall opposite the furnish but remain out of direct fluid contact with the grooves to prevent rewetting of the deposited pulp on the molds. A separate liquid removal system removes such accumulated liquid.

36 Claims, 10 Drawing Figures

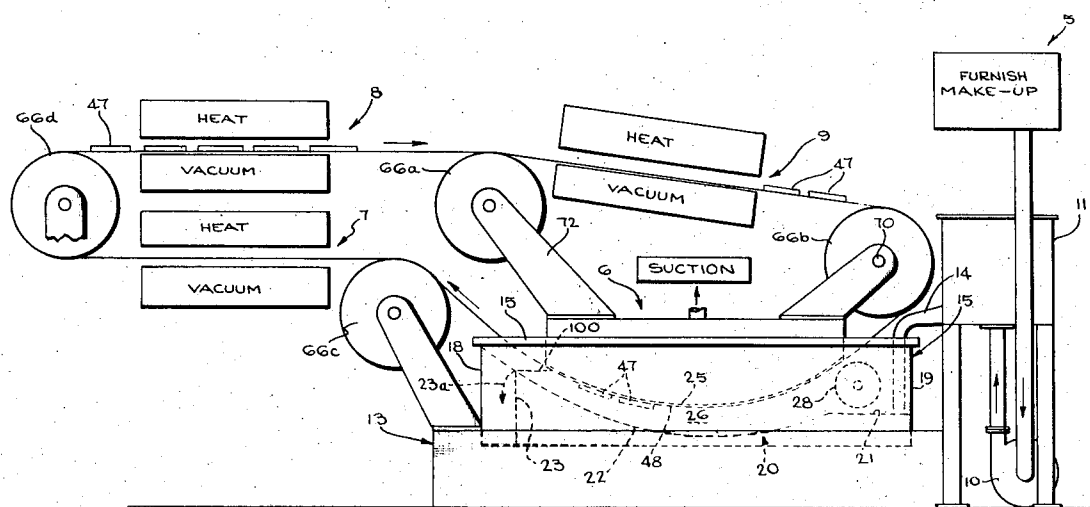
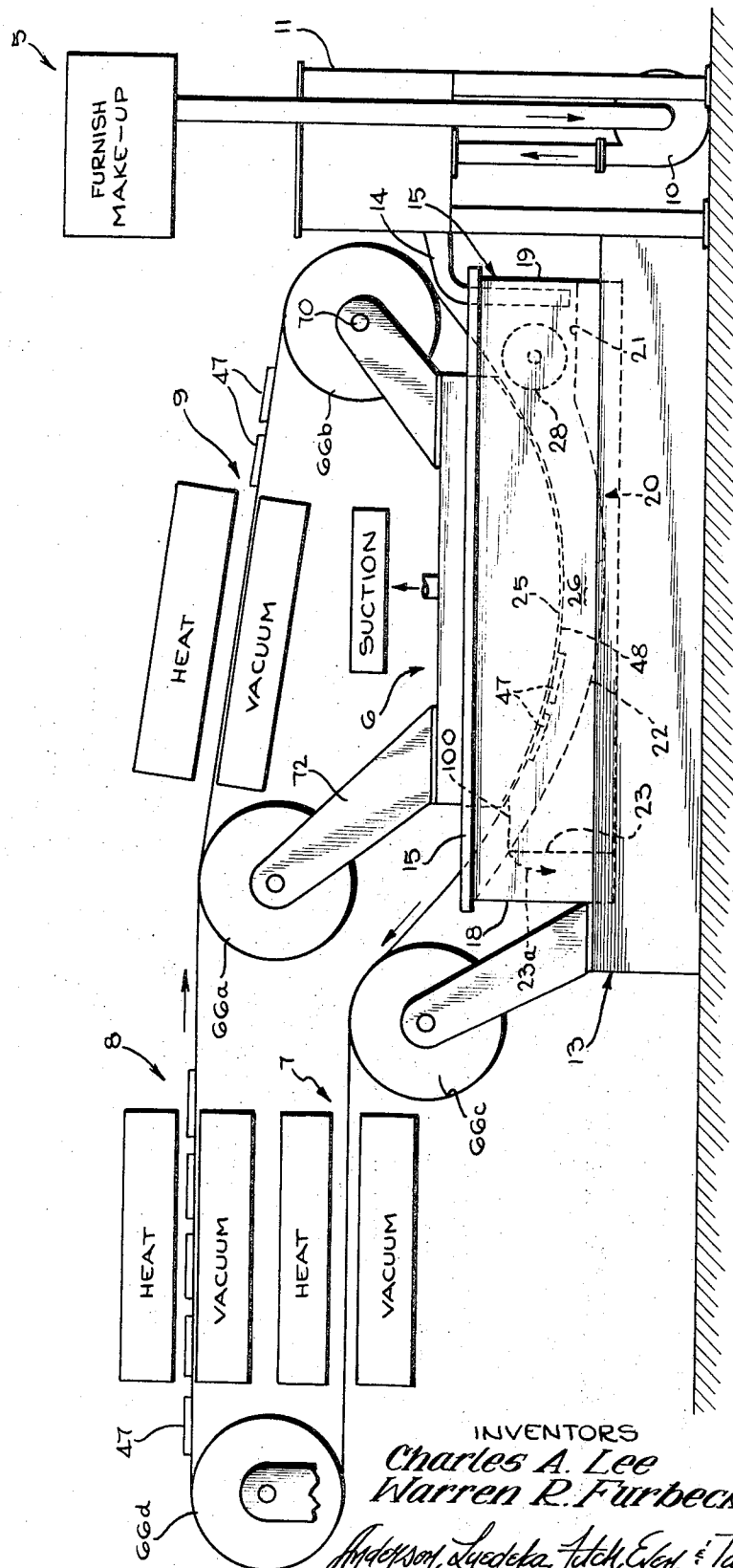


FIG. 1



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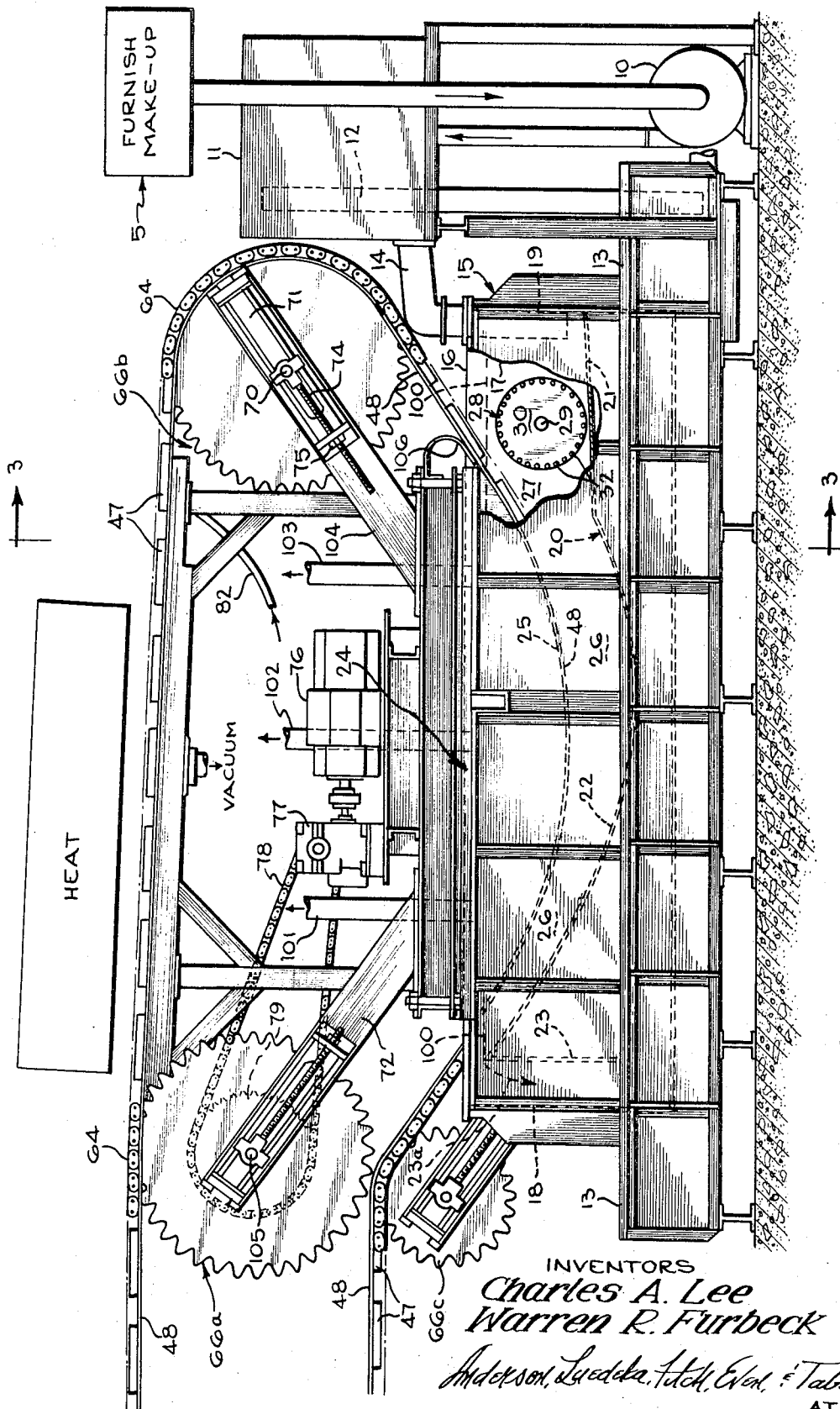


FIG. 2

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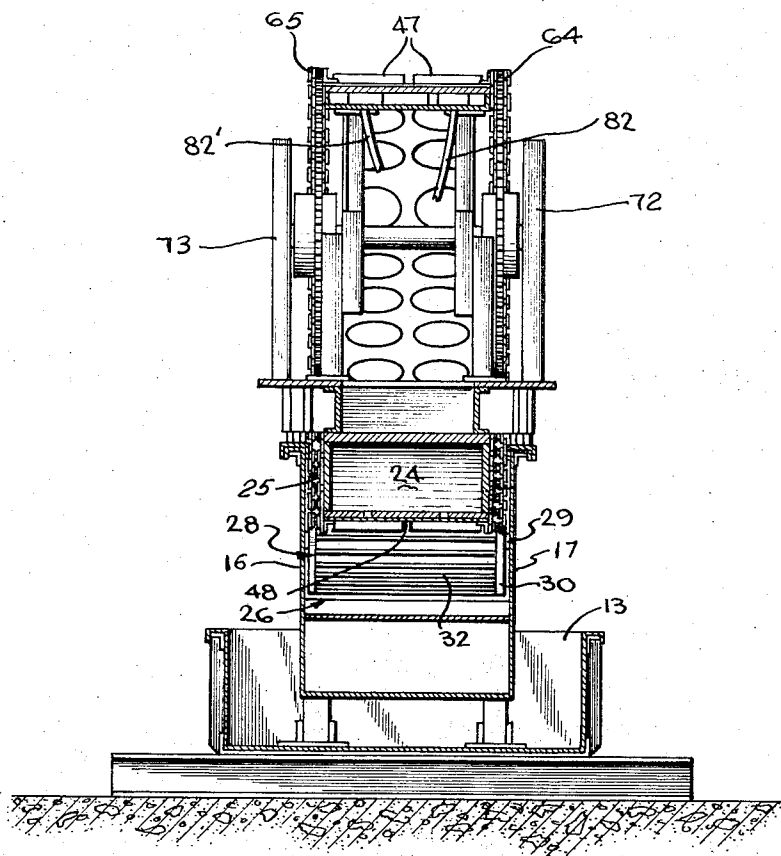


FIG. 3

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FIG. 4

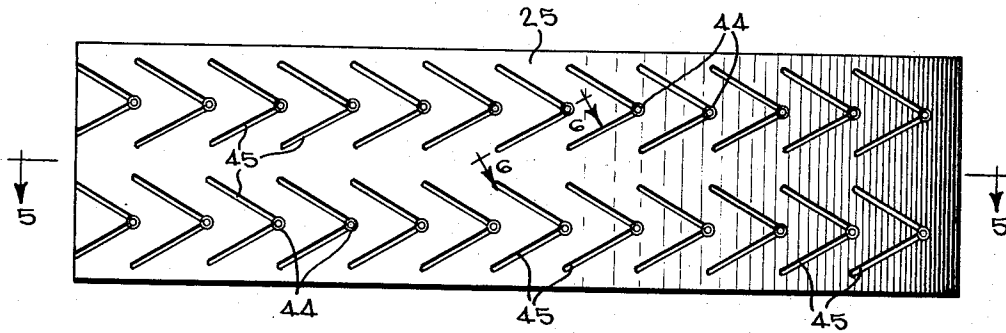


FIG. 5

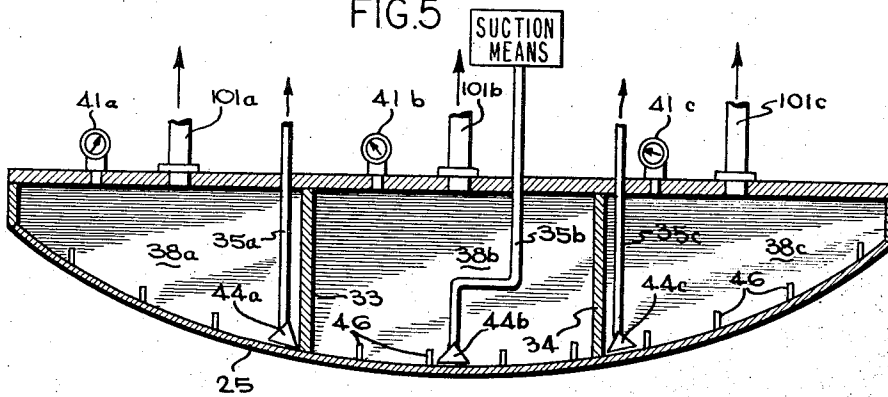
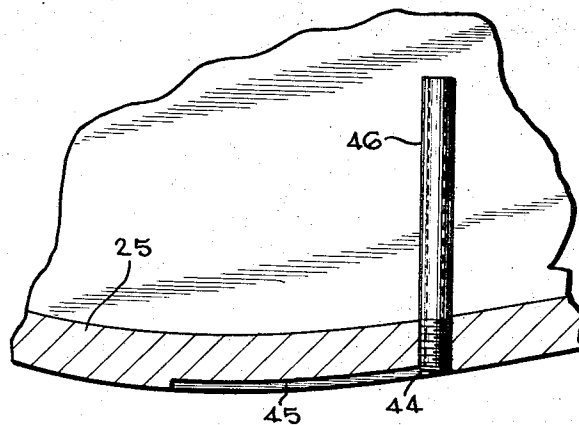


FIG. 6



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FIG. 7

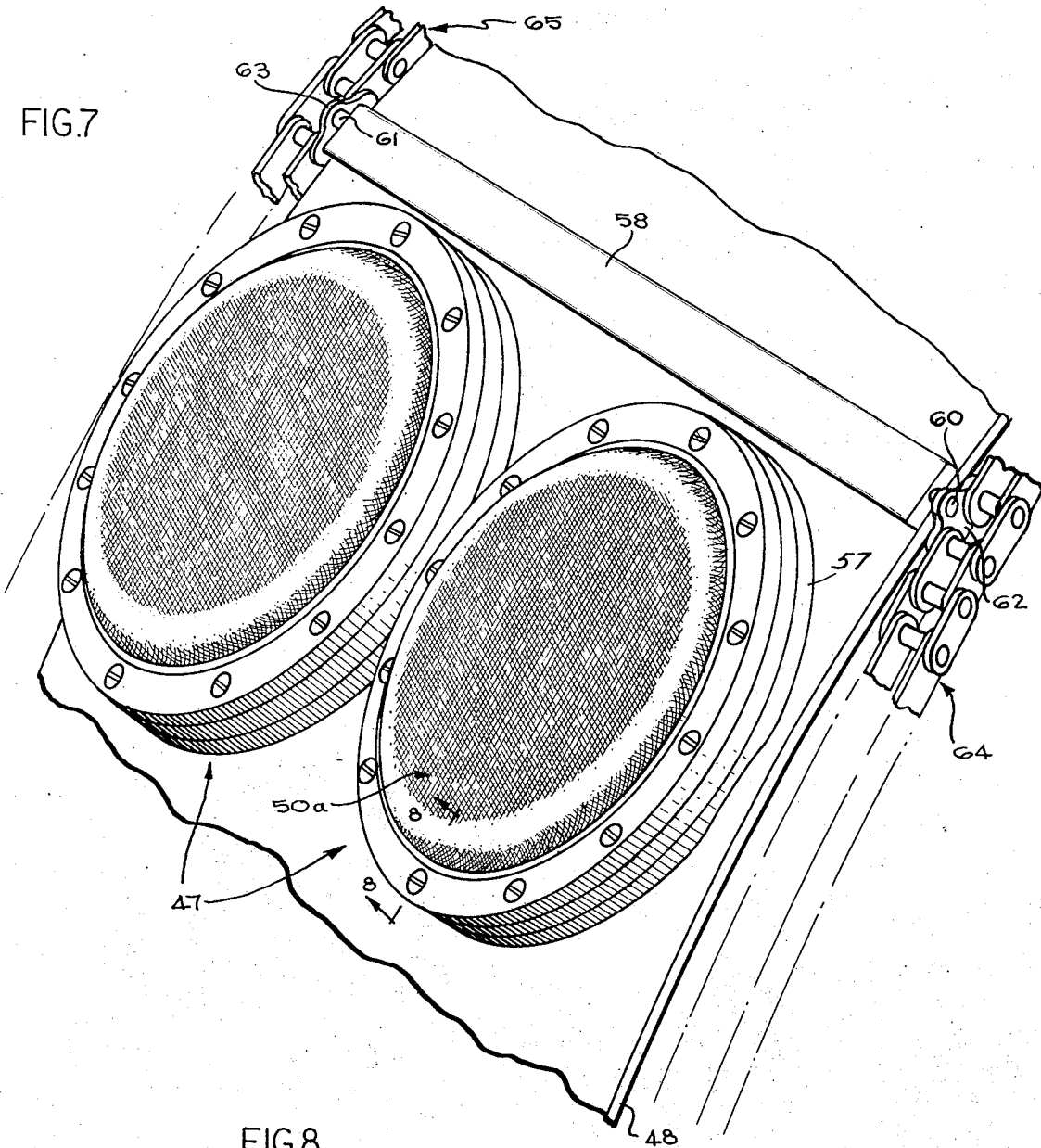
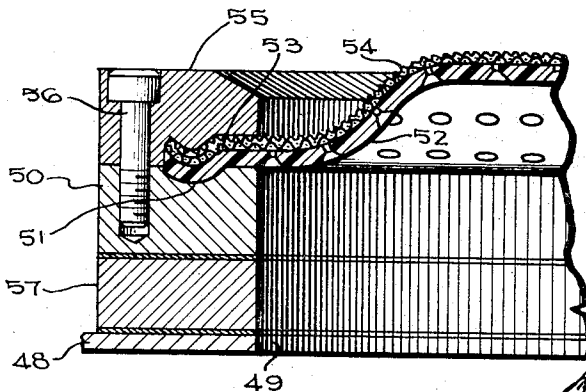


FIG. 8



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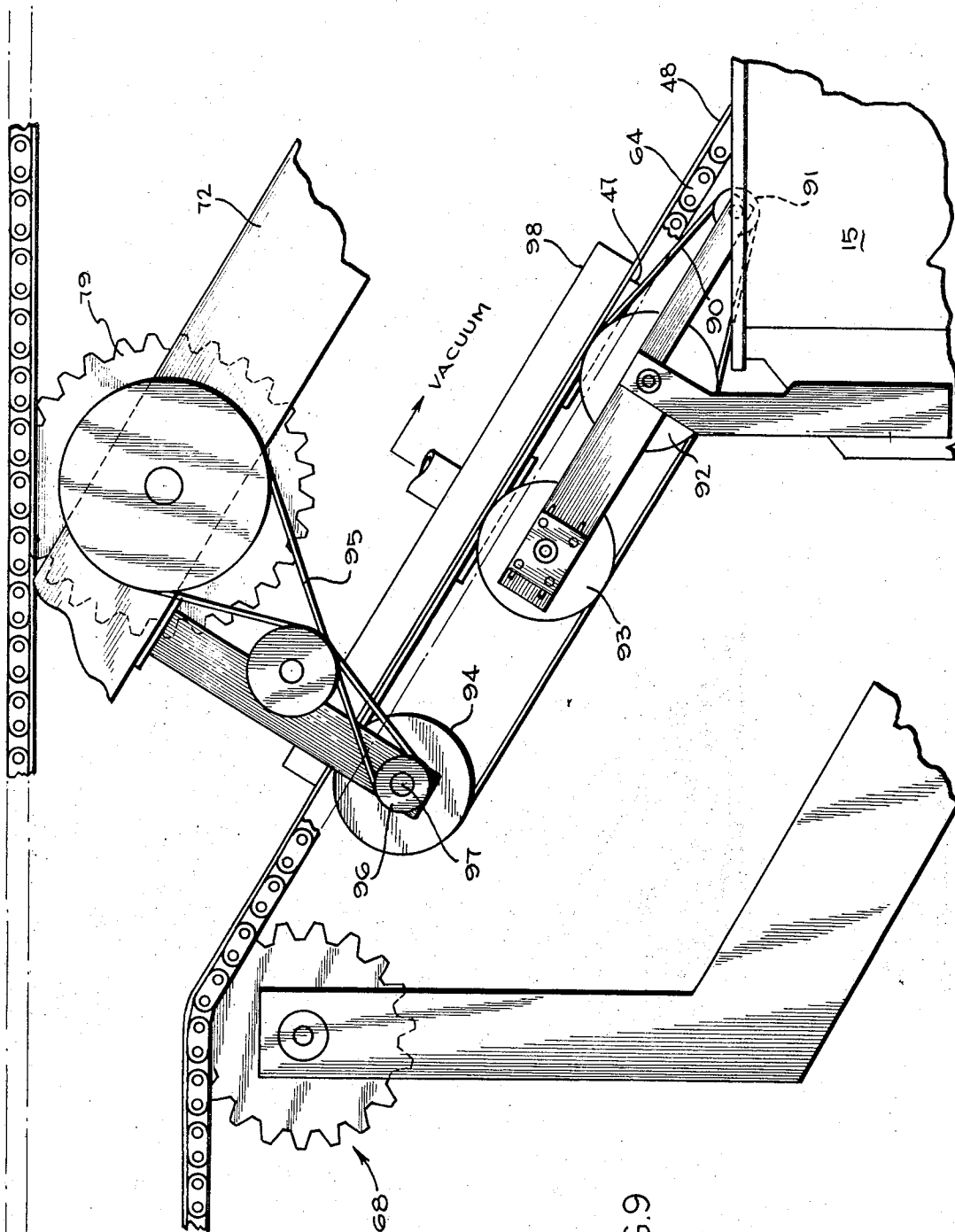


FIG. 9

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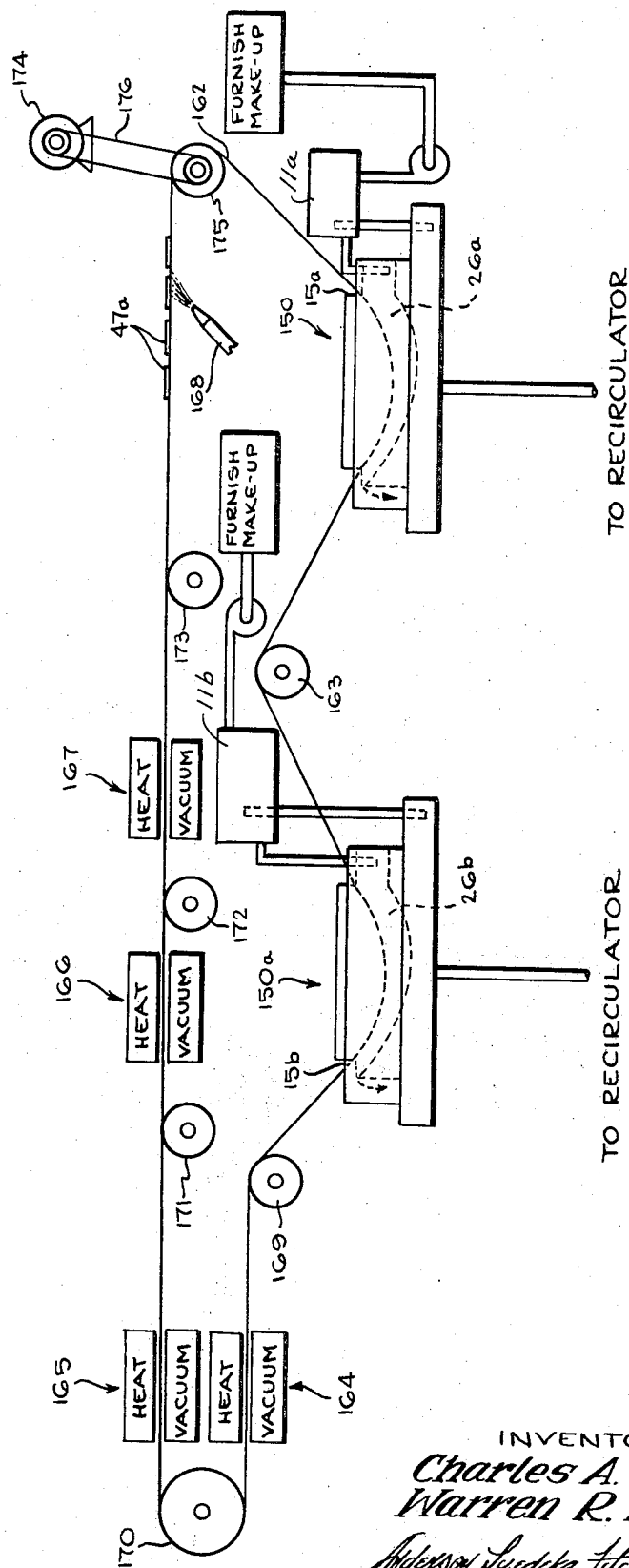


FIG. 10

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PULP MOLDING SYSTEM EMPLOYING SUCTION BOX WHICH PREVENTS REWETTING OF THE MOLDED PRODUCTS

This invention relates to molded pulp products and their methods of manufacture wherein foraminous molds are exposed to a pulp slurry, i.e., furnish, while suction is applied to one side of the mold to develop a mat of pulp fibers on that side of the mold which is exposed to the furnish.

Molded pulp products, e.g. paper plates, trays, egg cartons, and the like, have long been made by the process of matting pulp fibers in the form of a layer onto one side of a foraminous mold by the application of suction to one side of the mold while the other side is disposed in a furnish. The deposited mat generally conforms to the geometry of the mold and is usually dewatered and dried by pressing and by the application of heat to produce a self-sustaining molded product.

In manufacturing molded pulp products in the prior art, the molds were submerged in a furnish by various types of apparatus including devices where the molds were moved through the pool of furnish on rotating drums or spoke devices. Other prior art devices moved the molds into and through the furnish intermittently, as by cyclically dipping the molds into it.

The prior methods in general did not consistently produce uniform products. The products frequently exhibited nonuniform thickness and poor strength or other undesirable physical characteristics. Further, not infrequently, excessive pulp was required to obtain the desired product. The production rates possible with the prior art methods were low, thereby resulting in uneconomical operation. A further major deficiency of the prior art products involved the flocculation of fibers which caused aggregates of the fibers to be deposited in the product. The presence of these aggregates made it difficult to control the density of the product and resulted in random strengths throughout the product. These aggregates also created uneven surfaces on the product and destroyed the desired smoothness.

It is an object of the present invention to provide an improved molded pulp product and method for its manufacture. It is also an object to provide improved apparatus for the manufacture of molded pulp products. Other objects and advantages of the invention will become apparent from the detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a representation of apparatus for carrying out a method in accordance with this invention and depicting various novel features of the invention;

FIG. 2 is a side elevation, part cut-away, of a portion of the apparatus of FIG. 1;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a bottom view of the arcuate bottom wall of the suction box depicted in FIG. 2 and showing means for collecting the liquid pulled through the molds and channeling it into the suction box openings;

FIG. 5 is a sectional view taken along the longitudinal center plane of the suction box depicted in FIG. 4;

FIG. 6 is a fragmentary view, in section, of a portion of the arcuate bottom wall of the suction box and showing a groove and standpipe arrangement for channeling liquid into the suction box;

FIG. 7 is a fragmentary view of an endless belt of one type employed in the present invention and showing a plurality of molds secured thereon;

FIG. 8 is a fragmentary view, in section, taken along the line 8—8 of FIG. 7 and showing one means for securing a mold to the endless belt over an opening in the belt;

FIG. 9 is a fragmentary view of the apparatus of FIG. 2 and depicting one embodiment of apparatus useful in dewatering and otherwise treating the pulp layer on respective molds; and

FIG. 10 is a representation of apparatus for moving a plurality of molds on an endless belt through multiple units containing diverse furnishes to produce a multi-layered molded product.

Broadly stated, this method involves the steps of flowing a pulp furnish through a confined channel under conditions of controlled flow and moving one or more molds with the flowing furnish along one boundary of the channel in the same direction as the flow of furnish and at a rate of forward travel correlated to the rate of flow of the pulp furnish, while suction is applied to one side of the molds to draw liquid through the molds and accumulate pulp fibers on that side of the molds exposed to the furnish. Unexpectedly, the method of this invention has been found to provide a product which exhibits unusual strength and other improved characteristics per unit of fibrous content in the product.

Preferably, in the method, the furnish and molds are moved along an arcuate channel so as to enhance the economic aspects of the method through consistent production of uniform products at high output rates.

As disclosed herein, the product characteristics are selectively obtained by conditioning the flow of furnish through the channel so as to establish turbulent flow of the furnish within at least the upstream end of the channel and by moving the furnish through the channel at a substantially constant velocity along the entire length of the channel while maintaining the furnish which exits the downstream end of the channel at a relatively low consistency even though the volume of furnish is continually being reduced as it flows along the channel, due to suction applied through the foraminous molds. Preferably, the furnish velocity along the flow channel is established and maintained by selective reduction of the channel cross section along the direction of furnish flow. Also in a preferred embodiment, the volume of furnish overflowing from the channel at its downstream end is held at a substantial amount of the volume of the furnish introduced to the channel at its upstream end thereby aiding in maintaining the desired state of fiber distribution within the confined channel and aiding in a relatively low consistency in the furnish at the downstream end of the channel. The term "consistency" as used herein denotes the percentage, by weight, of fibrous matter in a furnish comprising fibrous matter and a liquid vehicle (normally water).

Apparatus for carrying out the described method includes means defining an elongated channel along which pulp furnish is moved under controlled conditions of flow, means for moving a series of molds along one boundary of the channel in correlation to the flowing furnish and means for applying suction to draw liquid through the molds and collect pulp fibers on that side of each mold exposed to the flowing furnish. A de-

scription of a preferred embodiment of the apparatus follows.

With reference to the accompanying drawings, one embodiment of apparatus for carrying out the method includes a furnish makeup system 5 supplying furnish to a forming unit 6 through which the furnish and molds are moved concurrently to deposit a layer of pulp on the molds, and one or more dewatering systems 7, 8, 9 remote from the forming unit 6 where a substantial part of the water is removed from the wet pulp layers on the molds. The dewatered products are removed from the molds and collected.

Referring specifically to FIG. 2, a pulp furnish is pumped by a pump 10 from a furnish makeup system 5 through a conduit to a headbox 11. Within the headbox, the furnish may be agitated and may include means to recirculate a portion of the furnish to the pump 10 for mixing with the incoming stream from the furnish makeup system. Also, overflow means comprising a standpipe 12 (FIG. 2) leads from the headbox to a machine chest 13 to establish a preselected liquid level, hence pressure head, in the headbox 11. From the headbox 11, the furnish flows through a header 14 into an elongated forming tank 15. Preferably, the header 14 is wide enough to deliver furnish over substantially the entire width of the tank 15 and terminates adjacent the bottom of the tank to minimize the entrainment of air.

This forming tank 15 is generally rectangular in form and comprises parallel side walls 16, 17 (see FIG. 3 also) and end walls 18 and 19. Within the tank 15 there is provided a contoured bottom wall 20 defining a first, generally planar, downwardly inclined portion 21 adjacent the upstream end of the tank (the end adjacent the end wall 19) and an arcuate portion 22 which forms a concave bottom wall extending downstream from the portion 21 to a point adjacent, but spaced from, the downstream end of the tank 15 (the end adjacent the end wall 18) as illustrated. At the downstream end of the arcuate bottom portion 22, a transverse partition, defining a weir 23, establishes the vertical level 100 of the furnish overflowing the tank. This overflow is indicated by the arrow 23a in FIG. 2 and the overflowing furnish is collected in the machine chest 13 from which it may be recirculated to the furnish makeup unit 5 by suitable means (not shown).

An elongated suction box 24 having an arcuate bottom wall 25 is disposed centrally of the interior of tank 15. Preferably the suction box 24 is of a width equal to the width of the tank 15 but, if desired, the suction box 24 may be somewhat narrower than the interior of tank 15 so as to facilitate insertion or removal of the suction box 24 if necessary for maintenance or the like. As may be seen in FIG. 2, the arcuate bottom wall 25 of the suction box 24 is disposed above and spaced from the arcuate portion 22 of the bottom 20 of tank 15 so as to define the upper boundary of an arcuate channel 26 between the suction box bottom wall 25 and the bottom wall of tank 15. The side walls 16 and 17 of the tank define the sides of channel 26. At the inlet 27 of the channel 26 and downstream of the point at which the furnish is admitted to the tank 15, there preferably is provided a distribution roll 28 mounted between the sides of the tank on stub shafts 29 (only one such stub shaft 29 is shown) which is rotated by a suitable source of power (not shown). Preferably, distribution roll 28 comprises a hollow shell defined by end supports, such

as the end discs 30 which are spaced apart and interconnected by means of a plurality of circumferentially spaced apart rods 32 which are connected at each of their ends with the discs 30. As the furnish is admitted to the tank 15 from the headbox 11, the rotation of the distribution roll 28 enhances pulp dispersion and stabilizes and conditions the flow of furnish.

As may be best seen from FIG. 5, the suction box 24 preferably includes transverse partitions 33, 34 which divide the suction box into three compartments 38a, 38b, 38c each of which is independently connected to a source of suction (not shown) by pipes 101a, 101b and 101c, respectively. The three compartments 38a, 38b, 38c establish independently controllable areas for applying vacuum as will be hereinafter set forth. Each of the compartments 38a, 38b, 38c is preferably provided with a pressure indicator 41 for indicating the level of vacuum in each compartment. Further, each of the compartments 38a, 38b, 38c is provided with a liquid removal system comprising a collector pipe 35 having a flared lower end 44 whose mouth is disposed in close proximity to the inner side of the wall 25 which defines the bottom of the suction box 24 and positioned at or near the lowest point of the compartment. Each collector pipe 35a, 35b, and 35c is connected to a pump (shown for pipe 35b only) so as to permit removal of liquid in the compartments and accumulated at the collectors.

FIG. 4 is a view of the exterior of the arcuate bottom wall 25 of the suction box 24. As illustrated a plurality of openings 44 are provided in the bottom wall 25 which communicate with the respective compartments 38a, 38b, 38c. Each of the openings connect with one end of a series of grooves 45 (see FIG. 6) which are milled into the bottom wall 25 of the suction box 24 and serve to channel liquid to each of the openings 44 and thence into the compartments 38a, 38b, 38c. Two parallel rows of the grooves 45 and associated openings 44 are shown since the illustrated unit is adapted to simultaneously form two rows of molded articles. The inner side of each of the openings 44 is provided with a standpipe 46 which is secured uprightly in its respective opening 44 in the suction box bottom. Thus, liquid collected in the several grooves 45 flows into the standpipe 46 through which it is drawn into the respective compartment 38a, 38b, or 38c by the suction provided within that compartment. The liquid is withdrawn from the compartments for disposal or reuse as desired.

A plurality of foraminous molds 47 (FIG. 2) are carried across the outside of the arcuate bottom wall 25 of the suction box in the direction of the flowing furnish by means of an endless, flexible and liquid impervious belt 48 held in sliding contact with the bottom wall 25. With specific reference to FIGS. 7 and 8, each mold 47 is disposed over an opening 49 in the belt 48 and sealably joined along its periphery to the belt 48. The openings 49 in the belt 48 are aligned so that they ride along the rows of openings and grooves 44 and 45 in the bottom wall 25 of the suction box 24.

More specifically, each mold 47, illustrated, comprises a first frame 50 having a marginal groove 51 for receiving one or more liquid pervious foraminous mold units 50a shaped to define the desired product. For example, the mold units 50a may include a perforated rigid base member 52 and first and second complementary screens 53 and 54, respectively, overlying the base member 52 to provide a means for collecting pulp on

the mold as liquid is drawn through the screens 53, 54 and base 52. In the depicted mold 47, the base and screen members 52-54 are retained in the groove 51 by a retainer 55 which clamps the base 52 and screens 53, 54 in the groove 51 in the frame 50. The retainer 55 may be held in position by means of bolts 56 or the like.

The mold 47 conveniently may be attached to the belt through the medium of a resilient mounting 57 interposed between the frame 50 and the belt 48. This resilient mounting 57 advantageously may be joined to the belt and to the frame by an adhesive, e.g. epoxy resin, thereby securely joining the mold 47 to the outer side of the belt 48 without requiring projections on the side of the belt 48 which is intended to ride upon and sealably contact the bottom wall 25 of the suction box 24. It will be noted from FIG. 7 that the resilient mounting 57 provides flexibility which aids in providing some conformance when the belt is caused to move around a sprocket or along the arcuate bottom of the suction box.

The frame 50 and retainer 55 may be fabricated as separate units from a metal or hard rubber or plastic (having a Durometer A hardness reading of the order of 80). Alternatively, the frame 50 and the retainer 55 may be integrated as by molding the two members as a single unit using hard rubber or plastic. In the latter instance, it is preferred that the marginal groove 51 open inwardly of the frame to readily receive the base and screen members. Additionally, rubber or plastic of 80 Durometer A hardness will provide, in most instances, the desired resiliency in connection with attachment of the mold to the belt.

The belt 48 is liquid impervious and is of a construction which insures reasonable flexibility and stability of length, several acceptable types being commercially available. It also possesses at least one surface which will develop a sliding seal with the bottom 25 of the suction box 24 and preferably is not destroyed by frictional engagement therebetween over extended periods of operation. Belts having an acceptable surface are available from commercial sources, such as belts identified as Style 2410 distributed commercially by Globe-Albany Felt Company of Albany, New York which comprise polyester fibers impregnated with a plastisol, the plastisol being more heavily concentrated on one surface of the belt than on the other surface. In any event, the belt is desirably constructed of thread or wire reinforced plastic or rubber to give long wear and a good seal.

The preferred seal with minimum stress upon the belt is obtained when the bottom of the suction box is fabricated in an arcuate shape which is coincident with the belt catenary. It is recognized, however, that reasonable deviations from such coincidence may occur, but with a decrease in the desired freeness of belt movement over the arcuate bottom of the suction box.

The belt 48 desirably is of a width somewhat wider than the width of the mold 47 to be secured thereon. As has been pointed out, two or more molds may be mounted in side-by-side relation across the width of the belt, and this invention is not intended to be limited to any particular belt width. The belt may be secured for movement along its intended course of travel by means of a plurality of cross bars 58 traversing the width of the outer surface of the belt at spaced apart locations along the length of the belt and secured thereto as by bolts 59

whose heads (not visible) are recessed within the belt. Preferably each cross bar is provided at each of its ends with a stub shaft 60-61 pivotally received in appropriate links 62-63 of chains 64-65 which parallel the marginal edges of the belt.

The chains 64-65 with the belt 48 disposed therebetween are passed over sets of sprockets 66a, 66b, 66c, and 66d, for example, (see FIGS. 1, 2, 3) to define the course of belt travel. Preferably, the shaft 70 of one or more sets of sprockets (66b for example) is adjustably mounted in an elongated slot 71 in each of spaced apart parallel mounting beams (only one beam 104 is shown in FIG. 2) secured at one of their ends to the apparatus superstructure or other convenient point of attachment with their other end extending angularly upward. The angular position of each set of beams 104 preferably is chosen to coincide with the radial force exerted by the chains and belt trained around the sprockets on the shaft so that adjustment of the shaft position along the slot changes the tension in the chains and belt. This adjustment of the tension is accomplished by moving the sprocket shaft along its slots by means of a threaded shaft 74 and nut means 75 secured on each support member 104 and engaging the shaft. One or more of the sets of sprockets, set 66a for example, is driven by a motor means 76 connected to the sprocket set 66a by a gear reducer 77 and chains means 78 engaging a drive sprocket 79 keyed to the shaft 105 of the sprocket set.

As may be seen in the drawings, the chains 64, 65 with the mold-carrying belt disposed therebetween are trained around the sprocket set 66b, thence downwardly to slidably contact the arcuate bottom 25 of the suction box. As desired, the belt may be guided into contact with the suction box by a flat spring means 106. The chain and belt assembly emerges from the pulp furnish and is trained around a second sprocket set 66c and such other sprocket sets (66d for example) as appropriate to be directed to processing stations located away from the tank 15. Such processing stations are depicted in FIG. 1 and usually comprise dewatering units 7, 8 and 9, respectively, for dewatering the fibrous layer collected on each mold. From these external processing stations, the chain and belt assembly may be directed over a driven sprocket set 66a, thence along a generally horizontal path to the point of beginning at sprocket set 66b. During the time when the chains and belt are horizontally disposed in the span between sprocket sets 66a and 66b, the molds will be noted to be on the uppermost surface of the belt so that the dewatered molded products may be removed from the molds by a jet of air directed from nozzle 82 against the bottom surface of the mold to force the molded product away from the mold to be collected by appropriate means (not shown).

In the drawings, the chains 64, 65 are depicted as unsupported during the interval while beneath the surface of the furnish with the belt being held in contact with the bottom wall 25 of the suction box 24 by the tension on the chains and belt. Alternatively, arcuate channel means may be provided along the opposite bottom edges of the suction box 24 to support and guide the chains, hence at least partly control the frictional engagement between the belt 48 and the bottom 25 of the suction box 24.

With reference to the apparatus described above, in the method of the invention, the furnish, e.g. wood fi-

bers suspended in water, is pumped from a furnish makeup unit 5 into the headbox 11 to the liquid level determined by the height of the overflow 12. Depending upon the product, these fibers may be of a particular kind and present in a selected quantity. One product frequently produced by pulp molding processes is a paper plate. The pulp for a paper plate may comprise groundwood, reclaimed fibers and/or other types of fibers. For purposes of simplicity and clarity, a paper plate product will be referred to in describing the invention, but it is not intended that the invention be limited to any specific product.

Control over the concentration and distribution of the fibers in the furnish at all points along the length of the confined channel has been found to be important in achieving the desired molded product. The pulp furnish is metered under the force of gravity from the headbox 11 into the upstream end of the forming tank 15, preferably entering the tank at a point beneath the surface of the body of furnish so as to minimize the entrainment of air. The quantity of furnish entering the tank 15 per unit of time is selected by adjustment of the pressure head at the headbox 11, i.e., by selection of the height of the overflow 12. The surface level of the furnish in the tank 15 is selected by the height of the weir 23 at the downstream end of the channel 26.

Within the tank, the furnish flows from the upstream end of the tank 15 along the arcuate channel 26 defined by the arcuate bottom 25 of the suction box 24, the side walls 16, 17 and the contoured bottom 20 of the tank 15. Contrary to the prior art where the furnish was merely pumped into large open tanks to create a pond of furnish with little or no control over either the direction or conditions of the flow of the furnish through the tank, the movement of the furnish through the tank 15 is channeled along an arcuate path in a confined flow pattern generally parallel to the line of travel of the molds for effective transfer of fibers from the furnish to the molds in response to suction applied across the molds as will be further discussed. Additionally, this arcuate channel reduces the amount of furnish in active use at any time. Other advantages will appear from the subsequent description.

Preferably, the incoming furnish is conditioned by the distributor roll 28 disposed transversely between the side walls 16, 17, adjacent the upstream end of the tank and downstream of the point at which pulp enters the tank from the headbox 11. The rotational axis of the distributor roll is disposed transversely of the desired direction of furnish flow so that upon rotation of the roll, the flow of incoming furnish is interrupted to insure dispersion of the fibers into a nonagglomerated state and to properly condition the flow. Specifically, as the incoming stream of furnish flows past the several transverse rod elements 32 of the distributor roll 28, the flow is provided with a large number of eddy swarms or turbulence which disbursts the fibers causing them to advance with the flowing stream to be presented to the molds in a highly disoriented state. Preferably, the distributor roll is rotated relatively slowly to prevent accumulation of fibers on the leading edges of its transverse rods and also to insure against the development of channelized flow conditions.

In the absence of an appropriate volume of furnish overflowing from the downstream end of the channel, the fibers within the furnish in the channel become oriented due to the lack of agitation, contrary to the de-

sired random orientation imparted to the fibers at the upstream end of the channel and which has been found to produce the disclosed product. Accordingly, in the preferred method, about 25 percent of the incoming furnish volume is caused to overflow from the downstream end of the channel. This preferred overflow insures that there is sufficient volume of furnish adjacent the downstream end of the channel as will result in good agitation of the furnish in this part of the channel under the selected flow conditions and the fibers of the furnish continue in their disoriented state and in a relatively low concentration substantially throughout their period of residence in the channel. Significantly greater percentages of overflow introduce less economical operating conditions due to the necessity of recirculating large volumes of furnish. Low overflow percentages, however, result in such fiber concentration and orientation as causes the molded products to exhibit less improvement in their strength.

The desired fiber distribution within the furnish is also a function of the fiber population in the furnish, i.e., the pulp consistency. To produce an economical molding operation employing the prior art methods and apparatus, it has been common heretofore to use a furnish which contains a relatively large population of fibers so that many fibers would be readily available for accumulation on a mold in a minimum of exposure time of the mold in the furnish. As noted before, such prior art concepts have been found unsuitable to produce products having the uniform strength and other characteristics as found in the disclosed product at relatively high production rates. In accordance with one aspect of the present invention, the consistency of the furnish employed is initially established at a relatively low value, e.g. 0.3 percent and kept at a low value throughout the length of the channel through which the furnish is flowed and during the time when the molds are exposed to the furnish. Preferably, the consistency of the furnish in the channel does not rise to over about 1 1/2 percent at any time so that the flow controls set forth herein are effective to disperse the fibers in good random orientation in the furnish and maintain them so dispersed when they are introduced to a mold at any point along the channel.

As noted above, the belt 48, with the molds 47 secured on its outer side, is guided beneath the surface of the flowing furnish along the arcuate bottom of the suction box in sliding contact with its bottom wall 25. In this manner, one side of each of the molds is exposed to the furnish for a selected period of time depending upon the rate of belt movement and the length of the belt course beneath the surface of the furnish. By virtue of its mounting on the belt, each mold is sealably joined at least along its periphery to the belt so as to establish fluid flow communication through the belt and mold assemblage. Since the belt lies relatively flat against the bottom wall 25 and in sealing engagement therewith as the molds on the belt are moved along the bottom wall 25 and over the grooves 45 and openings 44 therein, the partial vacuums in the respective compartments of the suction box create a suction which draws liquid from the furnish through the foraminous molds to cause an accumulation of fibers on the outer surface of each mold as it is exposed to the furnish. By selection of the groove positions, including their relative spacing, and with a view to the particular mold geometry, continuous and constant suction may be applied to each

mold over substantially the entire arcuate length of the suction box. Specifically referring to FIG. 4 which shows two parallel rows of grooves 45 and cooperating openings 44 in the bottom of the suction box, one row for each row of molds carried on the belt 48, each opening 44 is preferably provided with two grooves 45 radiating from the opening with an angle therebetween such as will cause the two grooves at their extremities to be spaced apart by about the diameter or width of the mold passing thereover. The two grooves thus form a "V" whose apex is at the opening 44. The several "V"s accompanying the several openings making up each row are aligned with their apices directed in a single direction, that is, along the row. The grooves each terminate on a line extending perpendicularly transversely through the opening associated with the successive "V" in the row. Thus, as a mold is moved along and over a row of "V"s, the mold is constantly subjected to suction. Further, the suction experienced by each moving mold remains substantially constant because the total area of the grooves and/or openings under each mold at any given point along a row is substantially constant. Thus, the accumulation of the fibers on each mold preferably commences immediately upon immersion of the mold in the furnish slurry and continues until the mold emerges from beneath the surface of the furnish.

In the preferred method, the molds are moved forwardly with the furnish at approximately the same rate of progression as the furnish so that relative movement between the molds and furnish does not disrupt the fiber accumulation process, such as by "sweeping" the fibers off the mold or having them deposit in an undesirable relation with each other due to the mold moving faster than the fibers. For example, when moving the furnish forward at 150 feet per minute (fpm), moving the molds forward at a rate more than about 160 fpm or less than about 140 fpm creates streaks and resultant weak regions in the product. Whereas differences in the relative speeds of the furnish and molds of about 10 feet per minute (fpm) will result in improved fiber accumulation, it is preferred to maintain these speeds with less than about 5 fpm difference therebetween. At other flow rates of the furnish, the speed of mold movement relative to the rate of furnish flow must likewise be adjusted to avoid the noted undesirable disruption of the accumulated fibers.

Preferably, the molds are immersed in the furnish at the head or upstream end of the tank where the fibers quickly cover the mold surface in response to suction. This rapid accumulation of fibers has been found to result in an improved product. The rate of deposition diminishes rapidly as the fiber layer builds up and reduces the porosity of the mold. Deposition of the fibrous layer on the mold continues, however, for a time determined by the duration of applied suction. Preferably, the duration of suction and mold residence beneath the surface of the furnish are approximately coterminal in point of time so as to avoid possible washing of fibers off the mold by the flowing furnish after removal of the suction.

The molds with their respective accumulations of fibers are moved out of the tank to subsequent processing stations where the fibrous product is subjected to further suction, pressure and/or heat to remove the residual moisture and produce dry self-sustaining products. The dried products may be conveniently separated

from the molds by a jet of air through the molds as through the nozzle 82, and collected by appropriate means (not shown). The overflow of furnish may be recycled to the furnish makeup section for mixing with incoming furnish.

In addition to the advantages afforded by the foregoing processing concepts, the pulp layer may be dewatered and the smoothness of the surface of the product opposite the mold may be enhanced by contacting the deposited pulp layer on the mold with an endless, thin, pliable belt 90 as the mold emerges from the furnish and while maintaining suction on the mold.

As shown in FIG. 9, as the molds 47 move from the tank 15, the pulp layer on each of the molds is contacted by the thin flexible belt 90, preferably rubber or other air impervious material, which is preferably substantially coextensive in width with belt 48 carried between chains 64, 65 (65 not visible in FIG. 9). In the desired operation, belt 90 is trained around a lead roll 91 disposed at the exit of tank 15 thence around rolls 92, 93 and 94. Each of the rolls 91-94 is mounted beneath the assembly of chains 64, 65 and belt 48 with the rotational axis of each of the rolls 91-94 extending transversely of the belt 48 which carries the molds 47. Roll 94 may be advantageously driven by a belt 95 which connects sprocket 79 to a pulley 96 keyed to a shaft 97 which rotatably supports roll 94. As roll 94 is rotated by sprocket 79 (the power sprocket for advancing chains 64, 65), the belt 90 is caused to advance in the same direction and at the same forward rate of progression as the molds 47 which are moved by chains 64, 65. Each of the rolls 92, 93 and 94 are preferably of a resilient construction so that as molds 47 pass thereunder, the roll surface conforms generally to the contour of the mold as the mold passes thereunder thus causing belt 90 to also conform to the contour of the mold. On the side of belt 48 out of contact with belt 90 a suction box 98 is provided. As the belt 90 engages the outer surface of the molds 47, suction applied through the suction box 98 draws the belt 90 into intimate contact with the pulp layer on the mold thereby forcing the belt 90 against the pulp layer with sufficient pressure to cause water to be squeezed from the pulp and drawn off by way of the suction box 98. In addition to the dewatering action of the aforescribed assembly, the pressure of belt 90 against the outer surface of the pulp layer on each mold smooths the pulp surface to provide a product of improved surface characteristics. This pressure also may be employed to densify the pulp and reduce the thickness of the molded product.

Desirably in the present method, the pulp furnish is moved along the channel 26 in a state of turbulent, i.e., nonlaminar, flow at least in the upstream region of the channel and during at least the initial period of fiber accumulation on the molds. The dispersion of the fibers within the channel 26 accompanying the turbulent flow is believed to introduce the fibers to every part of each mold surface in a nonaligned state with respect to each other, with some fibers being oriented perpendicularly, or approximately so, to the mold surface. Observation of the product indicates that as the fibers are accumulated onto each mold which is moving at about the same rate of forward travel, a substantial number of fibers appear to lie in planes which extend through the thickness of the accumulated layer, thereby interlocking the fibers and consequently enhancing the strength of the product. Further, it has been noted that a prod-

uct produced as outlined above, exhibits unexpected bulk per unit weight as compared to a product made by the prior methods. This is also indicative of substantial interlocking of fibers. The benefits accruing from the method as described include the capability (1) to produce a product of equal strength with the prior art but using fewer fibers, with concomitant savings in raw material costs, or (2) at the same cost in raw materials, to produce a stronger product than the prior art, which in many instances is critical to the commercial acceptability of the product.

In carrying out the described method, it is preferred that the elongated channel 26 be arcuate, that is, curved along its length to promote economical operation. For example, less expensive apparatus is required to move the molds through the arcuate channel than through a straight channel due to the problems associated with maintaining the necessary sealing engagement of the belt with the suction box. Moreover, controlled flow of the furnish is established as described herein at minimum cost in equipment and readily maintained over extended periods of operation.

In operation of the apparatus shown in the Figures, the flow of furnish through the arcuate channel 26 in the tank 15 may be regulated principally by the cross-sectional area of the channel along its length. Initially, a predetermined flow of furnish from the headbox 11 into the upstream end of the tank 15 is established. The magnitude of this flow is chosen to provide sufficient furnish within the tank 15 at the upstream end of the channel 26 at all times as will cause the furnish to flow through the channel at a desired velocity. This velocity is maintained constant along the length of the channel preferably by reducing the cross-sectional area of the channel in the downstream direction. It has been found that the continual withdrawal of liquid from the furnish through the molds reduces the velocity of furnish flow within the channel. Maintaining a gross pressure differential across the length of a channel of constant cross section has been found insufficient to produce the product disclosed herein, due in part to the facts that liquid is continually being withdrawn at different rates through each of several moving molds, and that the withdrawal rate through each mold is continually changing as a function of the fiber build-up on the mold. In the method and apparatus disclosed herein, the cross section of the channel 26 is decreased in the direction of furnish flow by an amount sufficient to compensate for the noted velocity decrease due to liquid withdrawal and thereby maintain a relatively constant velocity of furnish flow along the entire length of the channel for any flow rate selected through adjustment of the pressure head at the upstream end of the channel. In the absence of this relatively constant velocity along the length of the channel, the molded pulp product obtained lacks the desired improved strength and other characteristics described hereinafter.

It has been found, for example, that at furnish flow rates along the channel of 150 feet per minute, the desired constant velocity is readily obtainable along an arcuate channel of constant width having a radius of about 8 feet within which the vertical depth of furnish varies from about 18 inches at the upstream end of the channel to about 6 inches at the downstream end of the channel. If desired, in some instances it may be advantageous to narrow the width of the channel with or without decreasing the depth thereof.

Employing the method and apparatus described herein, a furnish comprising about 70 percent groundwood and about 30 percent kraft fibers made up with water to about 0.3 percent fiber consistency and having a freeness of about 200 was moved through an arcuate channel as described hereinbefore at a flow rate, i.e., velocity, of about 150 feet per minute. This velocity was sufficient to establish turbulent flow of the furnish in at least about the first half of the length of the arcuate channel. About 25 percent of the incoming volume of furnish overflowed from the downstream end of the channel. This overflowing furnish had a consistency of about 0.8 percent. A plurality of molds, each defining a 9 inch diameter circular plate, were moved with the furnish at a rate of about 150 feet per minute. Two molds were positioned side-by-side on the belt as depicted in FIG. 7 of the accompanying drawings.

In this example, reduced pressures of 3, 5 and 7 inches of mercury (with respect to atmospheric pressure) were established within the suction box chambers 38c, 38b and 38a, respectively, thereby creating a suction within each chamber which drew liquid through the molds as they moved along the bottom wall 25 of the suction box 24. The fibrous layer collected on the outer side of each mold was about 0.047 inch (after dewatering).

The fibrous layers on the molds were passed to drying stations where applied heat and vacuum removed the residual moisture in the layers. The dried layers were ejected from the molds with air jets and collected.

This group of plates weighed about 16.4 grams (dry product) each. A 9-inch diameter molded pulp plate of the type referred to above made by a prior art dipping process weighed about 21.6 grams. Such prior plates and the present plates were tested for rigidity by clamping each plate along a 4.7 inch chord on the plate edge between two flat clamping surfaces so that the plate extended in cantilevered fashion from the clamp. The deflection of the plate occasioned by a 26.6 gram weight applied 1 1/2 inches inwardly from the cantilevered edge of the plate and on a line extending perpendicularly from the center of the chord through the center of the plate was noted and recorded. The 21.6-gram plates of the prior art deflected about 1.2 inches or about 237 percent further than the 16.4-gram product of the present invention which deflected about 0.5 inch, indicating the greatly enhanced strength afforded by the present product even though about 25 percent fewer fibers were consumed in producing the present product.

As is usual in order to obtain a suitably smooth surfaced product by means of the prior art dipping process, the 21.6-gram prior art plate had been compressed in a die subsequent to its formation on a mold. This pressed plate was 0.035 inch thick as compared to the 0.047 inch thickness of the 16.4-gram product. The present plate, which was not pressed, possessed a surface which was suitably smooth for use as a dinner plate. Accordingly, with significantly fewer fibers, the present plates exhibited about 25 percent more bulk and were stronger than the prior art plates. These improved properties and suitable surface smoothness were obtained without die pressing as practiced in the prior art.

Another 9-inch plate weighing 12.4 grams was made in accordance with the present invention. This plate was 0.0322 inch thick and when tested for strength as above, this product deflected one inch or about 20 per-

cent less than the 21.6-gram prior art product referred to above, thereby showing the capability of the present process to produce a product comparable to the prior art in physical characteristics but requiring about 40 percent less fibrous content.

The surfaces of the plate products made as above indicated were smooth and free of streaks indicative of uneven fiber deposition. They exhibited no evidence of fiber agglomeration, rather the texture of the product indicated good uniform fiber dispersion throughout the product. The present plates were of uniform thickness showing the uniform and consistent manner in which the fibers are accumulated.

As noted, the product was stronger and required significantly less raw material for its manufacture than the prior art product. The economic advantage of the present process are therefore apparent. Among the other advantages is the hereinbefore noted ability to use lower pulp consistencies, e.g. about 0.3 percent. This ability to use lower pulp consistencies is occasioned at least in part by the general concept of moving the molds and furnish along a confined channel as distinguished from the relatively stagnant ponds of furnish or the uncontrolled furnish flows used in the prior art. These lower pulp consistencies permit improved dispersion of fibers in the furnish, better control over the process and production of an improved product.

As a further matter, the production rates which may be achieved with the disclosed apparatus and method far exceed the production rates of any known prior art. This capability is made possible by moving the molds and furnish concurrently while maintaining good dispersion of the fibers, all in a continuous manner. Still further, the disclosed method and apparatus provides increased flexibility of choice of the period of time during which the molds are exposed to the furnish thereby permitting the accumulation of more or less fibrous matter on the molds as desired.

It is contemplated that multiple units of the kind depicted in FIGS. 1 and 2 may be placed in series to manufacture products comprising differing layers of fibers. For example, the molds may be moved on a continuous belt through a first tank containing one kind of fibers, thence through a second tank containing a second kind of fibers to produce a bifacial molded product, each face exhibiting different physical characteristics.

One embodiment of apparatus for manufacturing multi-layered products is illustrated in FIG. 10 and includes arranging two or more units 150, 150a of the general type depicted in FIGS. 1 and 2 in series, with the molds being fed forwardly through the units in succession. Each of these units 150, 150a includes a tank 15a having a channel 26a through which a plurality of molds 47a are moved concurrently with a furnish. In their construction and function, these units 150, 150a are substantially identical to the unit depicted in FIG. 2 and described hereinbefore. The units 150, 150a are supplied with furnish from furnish makeup systems through headboxes 11a, 11b, respectively, and the furnish in each unit flows through the respective unit in the manner described earlier herein. In accordance with this alternative, each unit is provided with a different kind of pulp furnish and the molds are fed successively through the units in a continuous manner. The molds pick up a layer of pulp as they pass through each unit to produce a multi-layered molded product.

More specifically, the molds 47a secured on a chain and belt assembly 162 are fed forwardly through the channel 26a of the first tank 15a where they receive a first layer of fibers. Prior to moving the molds to a dewatering station, they are passed over a sprocket 163 and into and through the channel 26b of the second tank 15b of the series where the molds receive a second layer of fibers. The molds with the multiple layers of fibers thereon are next moved through one or more dewatering stations depicted generally at 164, 165, 166, 167. The dried molded products are ejected from the molds by a jet of air from a nozzle 82a as the molds pass over the nozzle. Means is provided for collecting the ejected products but such is not shown in FIG. 10. Multiple idler sprockets 169, 170, 171, 172 and 173 assist in supporting the chain and belt assembly 162 during its course of travel externally of the tanks 15a, 15b. Power means 174 connected to a drive sprocket 175 by means of a chain 176 furnishes power for moving the chain and belt assembly 162 along its course of travel.

One specific product contemplated for manufacture by this latter illustrated method and apparatus is a dinner plate comprising a bottom layer of groundwood pulp having a top layer of chemical pulp to provide the plate with a pleasing white appearance on that surface intended to receive food. Pulp fibers of different kinds may be employed in the several units or one unit may employ synthetic fibers. Other treatment series will be apparent to one skilled in the art when presented the present disclosure.

Contrary to the prior art, the illustrated method and apparatus provides for rapid and substantially complete evacuation of the water drawn from the furnish through the molds during the fiber accumulation process. Heretofore, the known water withdrawal systems either operated with a head of water on the reverse side of each mold, i.e., on that side of the mold opposite the furnish, or maintained the molds in a generally nonhorizontal position so that the water drawn through the molds would flow away from the molds. Such a head of water created a pond on such reverse side of the mold and the water often flowed reversely through the mold and washed away accumulated fibers. Even in those prior art devices where the water was prevented from actually flowing back through the mold, the water functioned as a type of barrier against the withdrawal of water through the mold, permitting only limited flow rates of the water and resulting in poorly formed products. Where the molds were held in nonhorizontal positions while exposed to the furnish, the relative movements of the molds and furnish (as the molds were introduced or removed from the furnish or the furnish was flowed past the molds for example) caused many fibers to be swept from the molds and resultant poor products and inefficient operation.

The method and apparatus disclosed herein includes maintaining the molds in a generally nonvertical orientation, that is, the water drawn through the molds is pulled generally vertically upwardly. This mold orientation presents the outer surface of the mold to the furnish in the preferred position, relative to the fibers in the furnish, for good accumulation and retention of the fibers on the mold surface in that there is minimal relative movement between the molds and furnish and minimal sweeping of fibers off the molds.

This preferred mold position during fiber accumulation is principally possible by virtue of the suction box construction described hereinbefore. Specifically, the suction box is provided with separate means for performing the functions of (1) creating a suction to draw water through the molds from the furnish, and (2) evacuating the water after it has been drawn through the molds. Referring to FIG. 5, a vacuum is established in compartments 38a, 38b and 38c through pipes 101a, 101b and 101c, respectively. These pipes are connected to a conventional vacuum pump (not shown). The vacuum within the respective compartments creates the suction desired for drawing water through the molds, the magnitude of the suction within each of the compartments being chosen to insure rapid movement of water from the molds into the respective compartments. Once the water is in a compartment, it is prevented from flowing back to the molds by the standpipes 46 in the bottom wall 25 of the suction box. The water accumulated within each compartment is evacuated before it rises above the height of the standpipes. As illustrated, this evacuation is accomplished by collectors 44a, 44b and 44c disposed adjacent the inner surface of the bottom wall 25 of the suction box and connected to a conventional pump (not shown) by pipes 35a, 35b and 35c, respectively. Thus, the withdrawn water is accumulated and evacuated without its interfering with the withdrawal of further water through the molds. Consequently, there is minimal ponding of water on the reverse sides of the molds and importantly, the applied suction is efficiently utilized with resultant enhancement of the flow rates of water through the molds. The enhanced flow rates create greater pull upon the fibers collected on the molds to more tenaciously hold them against dislodgment and produce the improved product as previously noted herein.

While preferred embodiments have been shown and described, it will be understood that there is no intent to limit the disclosure, but rather, it is intended to cover all modifications and alternate constructions falling within the spirit and scope of the invention as defined in the appended claims. For example, it is contemplated that fibers of many kinds may be molded into various products employing the method and apparatus disclosed herein. Specifically, glass and synthetic fibers of the order of staple length are particularly suitable as raw materials for producing molded products and the term "pulp" as employed herein is not intended to limit the invention to paper fibers.

What is claimed is:

1. A method for the manufacture of molded fibrous products comprising the steps of
 flowing a fibrous furnish through a confined furnish channel at a preselected rate of flow,
 moving a plurality of porous molds along one stationary wall of said furnish channel in the same direction as said flow of furnish through said channel, said molds and said furnish having correlated rates of progression,
 applying suction to one side of each of said molds while submerged in said furnish to draw liquid upwardly from said furnish through each mold and form a deposit of pulp on that side of each mold exposed to said furnish,
 conducting said withdrawn liquid along a plurality of flow channels extending along that surface of said

stationary wall facing said molds, thence through a plurality of openings through said wall at least during a portion of the time when said molds are submerged in said furnish, and

accumulating said withdrawn liquid at a location remote from said openings through said wall and on that side of said wall opposite said furnish and out of direct fluid communication with said openings whereby said accumulated liquid is prevented from returning through said openings.

2. The method of claim 1 wherein said fibrous furnish is moved through said confined channel at a rate of flow sufficient to establish turbulent flow of said furnish within at least a portion of said channel.

3. The method of claim 1 wherein said fibrous furnish is flowed at a preselected rate of flow through a confined channel which is reduced in cross section progressively in the direction of furnish flow.

4. The method of claim 1 wherein said molds are moved along said channel at approximately the same rate of progression as said pulp furnish.

5. The method of claim 1 and including the step of conducting said accumulated liquid away from its point of accumulation.

6. The method of claim 1 wherein the flow of said furnish is maintained at a rate whereby substantially more furnish is introduced into the upstream end of said channel per unit of time than is withdrawn from said channel per unit of time by the suction applied through said porous molds and about 25 percent of the furnish introduced to the upstream end of the channel flows from the downstream end of the channel without passing through said molds.

7. The method of claim 1 wherein the consistency of said furnish does not rise above about 1 1/2 percent at any time while flowing through said channel.

8. The method of claim 1 wherein the consistency of said furnish does not rise above about 0.8 percent at the downstream end of said channel.

9. The method of claim 1 wherein the consistency of said furnish introduced to the upstream end of said channel is about 0.3 percent.

10. The method of claim 1 and including the step of increasing said applied suction in the direction of forward movement of said molds.

11. The method of claim 10 wherein said suction is increased in steps.

12. The method of claim 1 and including the step of exposing that side of each of said molds opposite said furnish to not more than two openings through said wall at any given time.

13. The method of claim 12 and including the step of exposing that side of each of said molds to a plurality of flow channels extending along that surface of said wall over which said molds pass and terminating in fluid communication through said wall whereby liquid withdrawn from said furnish through said molds is conducted along said flow channels and through said openings through said wall.

14. The method of claim 13 including the step of maintaining constant the total area of said flow channels and openings through said wall to which each mold is exposed during its movement through said furnish.

15. A method for the manufacture of molded fibrous products comprising the steps of

flowing a fibrous furnish through a confined furnish channel including a stationary wall having a plural-

ity of flow channels extending along that surface thereof disposed inwardly of said furnish channel and leading to openings through said wall, advancing a series of liquid pervious molds on an endless belt successively through said furnish channel along said wall and in a direction generally parallel to the direction of flow of said furnish through said furnish channel, sealing at least the side edges of said belt and said wall against the flow of fluid therebetween, applying suction to that side of each mold facing said wall to draw liquid upwardly from said flowing furnish through said molds and accumulate a layer of fibers on respective ones of said molds, conducting said withdrawn liquid along said plurality of flow channels extending along that surface of said stationary wall facing said molds, thence through said openings through said wall at least during a portion of the time when said molds are submerged in said furnish, and accumulating said withdrawn liquid at a location remote from said openings through said wall and on that side of said wall opposite said furnish and out of direct communication with said openings whereby said accumulated liquid is prevented from returning through said openings.

16. The method of claim 15 wherein said fibrous furnish is moved through said confined channel at a rate of flow sufficient to establish turbulent flow of said furnish within at least a portion of said channel.

17. The method of claim 15 wherein the flow of said furnish is maintained at a rate whereby substantially more furnish is introduced into the upstream end of said channel per unit of time than is withdrawn from said channel per unit of time by the suction applied through said porous molds and about 25 percent of the furnish introduced to the upstream end of the channel flows from the downstream end of the channel without passing through said molds.

18. The method of claim 15 wherein the consistency of said furnish does not rise above about 1 1/2 percent at any time while flowing through said channel.

19. The method of claim 15 wherein the consistency of said furnish does not rise above about 0.8 percent at the downstream end of said channel.

20. The method of claim 15 wherein the consistency of said furnish introduced to the upstream end of said channel is about 0.3 percent.

21. A method for the manufacture of molded fibrous products comprising the steps of:
 flowing first and second furnishes through first and second fibrous confined furnish channels at respective preselected rates of flow along the respective furnish channels, each of said furnish channels including a stationary wall having a plurality of flow channels extending along that surface of said wall disposed inwardly of said furnish channel, said flow channels leading to openings through said wall, maintaining the flow of said furnish in each of said furnish channels at that rate which progresses said furnish along said furnish channel at a substantially constant velocity and which provides an excess of furnish exiting said furnish channel, advancing a plurality of porous molds on an endless belt successively through said first and second furnish channels in the same direction as said respective flow of furnish through said respective furnish

channels, said molds having a rate of forward progression substantially equal to the rate of forward progression of said furnish in that furnish channel through which said molds are moving, withdrawing liquid upwardly from said furnish through said molds at least during a portion of the time when said molds are submerged in each of said furnishes to form a deposit of fibrous matter on that side of said mold exposed to said furnishes, conducting said withdrawn liquid along said plurality of flow channels along said wall surface and through said openings through said wall of each furnish channel, and accumulating said liquid withdrawn from each furnish at a location remote from said openings through said wall of each furnish channel and on that side of said wall opposite said furnish and out of direct fluid communication with said openings whereby said accumulated liquid is prevented from returning through said openings.

22. Apparatus for the manufacture of molded fibrous products comprising
 means defining a confined furnish channel for receiving a quantity of fibrous furnish and including a stationary wall portion having a plurality of flow channels extending along that surface thereof disposed inwardly of said furnish channel, said flow channels leading to openings through said wall portion, means adapted to move said furnish through said furnish channel, liquid impervious belt means movable along a course including travel inside and outside said furnish channel and travel along said wall of said furnish channel, a plurality of spaced apart openings through said belt, mold means covering each of said openings through said belt and movable with said belt through said furnish channel beneath the surface of said furnish, means open at its bottom adapted to apply suction to that side of said molds opposite said furnish whereby liquid is withdrawn upwardly from said furnish through said mold and fibrous material is accumulated on that side of said mold exposed to said furnish in said furnish channel and, means on that side of said wall opposite said furnish for accumulating liquid withdrawn from said furnish through said openings through said wall portion, said means adapted to prevent said accumulated liquid from returning through said openings.

23. The apparatus of claim 22 wherein said furnish channel comprises an arcuate flow path for said pulp furnish and which is of reducing cross-section in the direction of furnish flow.

24. The apparatus of claim 22 wherein said means moving said furnish through said channel includes flow regulating means establishing turbulent flow in at least a portion of said channel.

25. The apparatus of claim 22 and including means for evacuating said accumulated liquid.

26. The apparatus of claim 22 wherein the total area of said flow channels and openings in said wall covered by a mold at any point along its path is substantially constant.

27. The apparatus of claim 22 and including means sealing at least the side edges of said belt against the outflow of furnish between said belt and said wall of said furnish channel along which said belt travels.

28. The apparatus of claim 22 and including means adapted to establish suction which increases in the direction of forward movement of said molds through said furnish channel.

29. The apparatus of claim 22 wherein said wall along which said molds travel while submerged in said furnish comprises the bottom wall of a suction box.

30. The apparatus of claim 29 wherein said suction box is compartmented.

31. The apparatus of claim 30 and including means adapted to develop a vacuum within each compartment which is controllable relative to the vacuum in each other compartment.

32. The apparatus of claim 22 wherein said flow channels comprise grooves disposed on that surface of said wall along which said molds travel and opening outwardly therefrom.

33. The apparatus of claim 32 wherein said grooves are disposed in at least one row of aligned "V's," the apex of each "V" being in fluid communication with an opening through said wall.

34. The apparatus of claim 33 wherein the maximum distance between the diverging legs of each "V" is less than the maximum lateral dimension of a mold moved thereover.

35. Apparatus for drawing liquid through a foraminous mold having one of its sides disposed in a furnish and disposing of said withdrawn liquid without creating a liquid backpressure against said mold comprising means open at its bottom for applying suction to that side of said mold opposite said furnish, said means including a chamber having a reduced pressure rel-

ative to the pressure of said furnish and including a bottom wall having flow channels extending along that surface thereof facing outwardly of said chamber and openings leading from said flow channels through said wall into said chamber and conduit means disposed in selected ones of said openings, said conduit means including an upstanding portion extending to a height above said wall of said chamber whereby liquid drawn upwardly through said mold is further drawn through said conduit means and accumulated in said chamber on that side of said wall opposite said furnish, whereby said accumulated liquid is prevented from returning through said openings,

means for evacuating said liquid from said chamber, said evacuating means being separate from said suction means and comprising a vertically oriented collector pipe through which said liquid is withdrawn, and means connected to said collector pipe for applying suction therethrough.

36. A molded pulp product made in accordance with the method of claim 1 having a strength such that about 16.4 grams of substantially dry pulp comprising about 70 percent groundwood and about 30 percent kraft fibers molded into a nine inch diameter circular plate and having a thickness of about 0.047 inch, when clamped between two flat clamping surfaces along a 4.7 inch cord on the plate edge with the remainder of the plate extending from said clamping surfaces in cantilevered fashion, deflects not more than about one inch when a 26.6 gram weight is applied to said plate at a point 1½ inches inwardly from the cantilevered edge of said plate on a line extending perpendicularly from the center of said chord and through the center of said plate.

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