APPARATUS FOR FORMING SHEET PRODUCTS FROM PAPER PULP

Eugene L. Perry, Bloomfield, N. J., assignor to Paper Plastic Products Corporation, Bloomfield, N. J., a corporation of New Jersey

Application May 29, 1945, Serial No. 596,468

3 Claims. (Cl. 92—43)

The present improvements, relating as indicated to methods and apparatus for making a paper pulp product, have more particular regard to the manufacture of so-called paper board, i.e., a sheet product of substantial thickness. The invention further comprehends an improved form of such product which has qualities superior to any paper board heretofore available.

One principal object of the invention is to provide a method and apparatus whereby such paper board may be made continuously in a sheet of indefinite length. Another object is to enable the sheet to be made of the desired thickness without having either the weakness inherent in thick sheets as heretofore made where formed as a single layer or the lack of cohesiveness between layers where formed of a plurality of sheets or layers as in so-called duplex or plural-ply paper.

A further object is to provide a product of the type in question which will be capable of being dried more readily as well as capable of being impregnated with plastic solutions whereby a sheet may be formed capable of subsequent shaping by molding or equivalent operation.

While, as will appear, the present improved sheet product is formed in effect of successively deposited layers, these are so constituted and applied one onto the other as to secure a unique and effective bonding together of such layers. At the same time provision is made whereby the lay of the pulp fibers in different layers may be regulated or controlled so as to produce a sheet product which will have various characteristics as desired.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawings and the following description setting forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but several of various ways in which the principle of the invention may be used.

In said annexed drawings:

Fig. 1 is a central longitudinal vertical section through an illustrative apparatus embodying my present improvements;

Fig. 2 is a transverse vertical section thereof taken on the plane indicated by the line 2—2 Fig. 1, the plane of the section on which Fig. 1 is taken being indicated by the line 1—1 on said Fig. 2;

Fig. 3 is a side elevation of the upper portion of the apparatus as illustrated in Fig. 1;

Fig. 4 is a section similar to that of Fig. 1, but on a somewhat larger scale, of such upper portion of the apparatus thus shown in side elevation in Fig. 3;

Fig. 5 is a view similar to Fig. 4 but showing a modification in construction, or rather a different adjustment of certain parts that enter therein;

Fig. 6 is likewise a view similar to Fig. 4 but showing another modification or difference of adjustment of parts;

Fig. 7 is a view more or less diagrammatic in character of the product made by the apparatus as illustrated in Fig. 1 (see section line L—L) and;

Fig. 8 is a view similar to Fig. 7 but showing one of several other different forms of product which such apparatus is adapted to make.

As illustrated in Figs. 1 and 2, the apparatus comprises a main cylinder A, and associated therewith three auxiliary cylinders B, C and D, of somewhat smaller diameter, mounted for rotation about axes parallel with the axis of said main cylinder and contacting more or less closely with the latter along circumferentially spaced lines. It will be understood, however, that only one such auxiliary cylinder may be employed or that the number thereof may be greater than three, as required to produce the desired product, hereinafter described. Where the number of auxiliary cylinders is thus increased, the diameter of the main cylinder A will necessarily be correspondingly greater, so as to provide for the proper placement of such auxiliary cylinders in contact therewith.

The construction of the individual cylinders may vary among themselves, but as shown such construction is substantially identical not only to the auxiliary cylinders but also the main cylinder. Thus, as best illustrated in Figs. 4, 5 and 6, which show cylinder B in transverse cross section, each cylinder comprises a cylindrical shell I through which pass a closely spaced series of radial perforations 2. Closely fitted to the outer surface of such shell I is a screen 3 of relatively coarse mesh which is in turn surrounded by a closely fitting screen 4 of relatively fine mesh. Preferably said screen 4 will be of the type known in the paper making industry as Fourdriner screen, the object in interposing the coarser screen 2 between such outer screen and the outer shell I being to insure free communication with the latter through the apertures 2 in such shell to the shell interior. Because of the scale on which Figs. 1 and 2 are drawn, no attempt has been made to illustrate there the dif-
different character of such surrounding screens on the shells of any of the cylinders and the radial apertures in the shells are only shown in part. However, it will be understood that, as illustrated in Figs. 4, 5 and 6, the entire shell is thus provided with these apertures so that the entire external surface formed by the outer fourdriner screen is effective as the cylinder is rotated past the several instrumentalities associated therewith.

The ends of the cylinder are preferably left open and the cylinder is supported for rotation upon supporting rollers 4, 5 and 7 which are supported at their ends in suitable side frames 8, 9 that form a part of the general frame of the apparatus, and which are disposed so as to contact with the interior of the cylinder along circumferentially spaced lines. Preferably, as illustrated, one roller 7 will thus contact with the cylinder adjacent its lowermost portion while the two other rollers 4 and 5 will be symmetrically disposed with respect to said roller 7 so as to contact with the cylinder at opposite sides of its vertical diametrical plane.

The pulp suspension is supplied to the respective cylinders through similar tanks or chambers A', B', C' and D' of more or less familiar construction, these tanks being located with their open or discharge faces adjacent one of the upper quarter sections of the outer surface of the corresponding cylinder. Each tank includes a series of reversely disposed baffles 10 so that the pulp supplied through a conduit 11 will be maintained in proper suspension, and if desired, agitating means (not shown) may also be provided for this purpose. The side walls 12 of each tank are designed to closely contact with the adjacent portion of the outer surface of the corresponding cylinder, the lower side of the opening of the tank being provided with a flexible plate or wiper 13 that makes similar close fitting contact with and transversely of such cylinder surface.

As indicated by the direction arrows of Fig. 1, the auxiliary cylinders B, C and D are designed to be rotated in a direction opposite to that of the main cylinder. Thus the latter is shown as being rotated in a clockwise direction, while each of the auxiliary cylinders is rotated in a counterclockwise direction. Having regard to such direction of rotation of the cylinder, it will be noted that the corresponding tanks which are provided to supply the pulp suspension to the corresponding cylinder, open against the upper quarter of the cylinder's surface which, when the latter is rotating, will be moving upwardly across such opening. Any suitable means may be provided for thus rotating the respective cylinders in the direction required, for example a belt driven from a suitable pulley may be applied directly to the outer surface of the cylinder adjacent one of the edges thereof, both such edges, as shown in cross-sectional view Fig. 2, extending beyond the perforated area over which the screens 3 and 4 are disposed, and being preferably of lesser diameter than the main body of the shell which is thus perforated and screened. It will of course be understood that the transverse width of the shell, and thus of such perforated, screened portion thereof, will be varied as desired depending upon the width of the sheet product which it is desired to make within the apparatus.

Located within cylinder A (see Fig. 1) are three suction boxes 5, 6 and 7 so mounted as to have close fitting contact with successively spaced portions of the inner surface of said cylinder. These boxes are preferably supported by means of rocker arms 18, 19 and 20 carried by oscillatory shafts 21, 22 and 23, suitably journalled in the same side frames 8 and 7 which are supported at their ends in suitable side frames 8, 9 that form a part of the general frame of the apparatus, and which are disposed so as to contact with the interior of the cylinder along circumferentially spaced lines. Preferably, as illustrated, one arm 18 will thus contact with the cylinder adjacent its lowermost portion while the two other arms 19 and 20 will be symmetrically disposed with respect to said arm 18 so as to contact with the cylinder at opposite sides of its vertical diametrical plane.

It will be understood that a similar oppositely directed arm will be attached to each of the oscillatory shafts which actuate the several suction boxes associated with cylinder A, as well as the shafts 25 which actuate suction boxes 26 associated with cylinders C and D respectively. It will also be understood that in place of a spring a counterweight may be attached to said arm to secure the same variable contact of the suction box with the corresponding cylinder. It will also be understood that suitable connections such as the conduit 27 leading from suction box 12 (see Fig. 2) will be provided with each of said suction boxes for the purpose of inducing thereinto the desired degree of vacuum.

Referring further to the arrangement of suction boxes provided in connection with main cylinder A, the first such box 15, it will be seen (see Fig. 1), is located so as to be applied to an upper section of the inner surface of the cylinder, the first part of which will be in contact with the upper portion of the body of pulp suspension in tank A', following which cylinder B contacts with the outer surface of the cylinder while subject to the vacuum within said box, and such vacuum continues to be applied to a point well beyond the line of contact of cylinder B with cylinder A, having regard to the direction of rotation of cylinder A. The second such box 16 is applied to a portion of the inner surface of cylinder A which begins substantially at the line of contact of auxiliary cylinder C with the latter and extends well beyond such line of contact, having regard to the direction of rotation of cylinder A. Similarly, suction box 17 is applied to a portion of the inner surface of cylinder A which extends from substantially the line of contact of auxiliary cylinder D therewith to a point well beyond such line, having regard to the direction of rotation of cylinder A. As a matter of fact, suction box 17 will desirably be applied to a considerably larger portion of the inner surface of cylinder A than either of the preceding suction boxes. It has been deemed unnecessary to illustrate the means for producing suction within the respective boxes 15, 16 and 17 thus applied to the inner surface of the cylinder A since any usual form of vacuum pump connection aforesaid with such boxes will be satisfactory for this purpose. However, by means of suitable control valves, or the use of separate pumps if preferred, provision will be made whereby different degrees of vacuum may be maintained within the respective boxes 15, 16 and 17 being increased or successively stepped up. For example, a vacuum of 5 inches may be thus established in box 15, a vacuum of 10 inches in box 16 and a vacuum of 25 inches in box 17. Another illustrative sequence would be a vacuum of 10
Inches in box 15, of 20 inches in box 16 and of 25 inches in box 17. As previously indicated, the first vacuum box 15 in the series is located so as to be applied to a portion of cylinder A which is still in contact with the body of pulp suspension in tank A'. Located immediately below said suction box 15 with an open face applied to the portion of the interior surface of cylinder A which is opposed to the remaining body of pulp suspension in tank A', is a box 28 provided with a drain outlet 29. Each box 28 has close fitting contact with the inner surface of the cylinder along its lower and lateral edges, but is open above, i.e. is under atmospheric pressure merely.

In the case of each of the auxiliary cylinders B, C and D, a single suction box 30 is provided, being located in relation to the corresponding pulp tanks B', C' and D' in the same relation as suction box 15 is located to tank A'. There is also provided in connection with each of said auxiliary cylinders an open drain box 30 located in a relation to the corresponding tank similar to that which suction box 15 of the box in relation to tank A. In other words, both in the case of the main cylinder and each of said auxiliary cylinders, the portion of the outer screened face thereof which at any time is in contact with the body of pulp suspension in the corresponding tank will be subject to whatever vacuum is applied to the suction box insofar as such portion extends over the latter, while the remaining portion will be under hydrostatic pressure merely, i.e. the water, which ordinarily constitutes the liquid vehicle of such suspension, will drain through the lower area of such contact portion while maintaining hydrostatic action of the body of suspension in the tank while the upper portion will be subject to an increased pressure corresponding with the vacuum maintained in the vacuum box.

The operation of the apparatus as thus far described may be conveniently described at this point. Assuming that a body of a suitable pulp suspension is maintained in each of tanks A', B', C' and D', the level of such suspension being indicated by dotted lines in Fig. 1, and that the several cylinders A, B, C and D are caused to rotate in unison, as indicated by the arrows, there will be initially deposited on the outer screen surface of cylinder A a fibrous layer beginning with the line of contact with the lower edge 13 of tank A' to the line of initial contact of vacuum box 15 with the inner surface of said cylinder. This layer will have the characteristics of a cylinder type sheet in that due to the movement of such screen surface there will be a tendency for the fibers as they collect to be laid down in roughly parallel relation. Superimposed on the layer thus strained under hydrostatic pressure will be a second layer formed under influence of the vacuum in suction box 15. This layer will be deposited under conditions very similar to those obtaining in a Fourdriner machine, i.e. the component fibers will be deposited in criss-cross intermingled fashion. At the same time, since the first component is highly saturated with the liquid vehicle, the fibers of the second layer under the suction thus applied will be more or less drawn into and interlocked with the fibers initially laid onto the screen under hydrostatic pressure.

While the initial layers of the sheet are thus being formed, the two lower components of the layers will be simultaneously formed on each of the auxiliary cylinders B, C and D in substantially the same manner, i.e. the lower component of the layer will have the characteristics of a cylinder type sheet in which the grain is predominantly one way and the upper component will have the characteristics of a Fourdriner type in which the stock is indiscriminately laid down. The layer thus formed on auxiliary cylinder B will, where the latter contacts with cylinder A, be applied to the layer formed on the latter, but with its components in reverse relation, while the latter is still subject to the action of suction box 15. Such applied layer will preferably carry a relatively high percent of fugitive, i.e. of the liquid vehicle, so that the effect of the vacuum will be to draw the two layers into close interlocking contact. The additional layers formed on the remaining auxiliary cylinders C and D will be similarly superimposed on such previously assembled layers and successively subjected to the action of the corresponding suction boxes in which, as previously explained, successively higher vacua are maintained. In other words, only after the last superimposed layer has been applied is the maximum degree of vacuum employed, and the extent of its application is controlled so as to reduce the moisture content of the resultant sheet product to the minimum selected.

It will thus be seen that in the apparatus as illustrated four successive layers of pulp will be deposited, each of which is composed in part of fibers laid as in cylinder type board and part as in Fourdriner type. Furthermore, the condition of the successively deposited layers as to moisture content is such as to assure a substantial intermingling of fibers on their respective contacting faces so that all these components are effectively welded together and form a product, i.e. or board which is superior in a number of respects to the multi-ply sheet or board produced on machines and by methods heretofore available. In addition to thus intermingling the pulp fibers, layer after layer on the main cylinder, intermixing the pulp from separate wet ends or vats makes it possible to vary the composition of the pulp mixtures for such constituent layer, so as to produce a finished sheet having various characteristics as desired, both as to the raw material used in making up the several pulp suspensions and as to resins or other materials that may be blended with such suspensions. Thus it is possible to use relatively less expensive materials for the center layers as well as to incorporate in the final product combinations of thermo-plastic and thermo-setting layers which heretofore been impossible. Provision may also be readily made for the separate addition to the sheet product of such resinsous material either in liquid or powdered form, by interposing a trough 31 transversely of the main cylinder A between the first and second auxiliary cylinders B and C, as illustrated in Fig. 1. This trough may be constructed, as will be readily understood, to shake such material into dry powdered form at a uniform rate, or similarly to spray such material or liquid form.

In Figs. 4, 5 and 6 there is illustrated the manner in which, particularly in the case of one or more of the layers deposited by the auxiliary cylinders, such layers may be varied with respect to what for convenience I have termed the cylinder and Fourdriner components. Thus in the case of the auxiliary cylinder B which is the one selected for illustration in Figs. 4 and 5, it will be seen that the rocker arm 35 on oscillatory shaft 24, whereby suction box 26 is held in contact with the interior surface of the cylinder...
der, is formed with a series of apertures spaced at successively greater distances from the axis of such shaft 74. Accordingly, the point of connection of the box with said rocker arm may be correspondingly shifted so as to shift the area of contact to include more or less of that portion of the cylinder which is opposed to the open end of the pulp tank D.

At the same time the lower edge of such open face of tank B' may be shifted so as to correspondingly vary the portion of the cylinder face which is subject only to the hydrostatic pressure of the pulp suspension. Thus instead of using a relatively narrow blade 37 to define such lower edge of the tank, as in Figs. 4 and 6, a wider blade 38 may be substituted as illustrated in Fig. 5. Accordingly, we may have the condition, as illustrated in Fig. 4, where the pulp suspension is deposited from the contacting body of pulp suspension in tank B' onto the screen surface of the cylinder partly under hydrostatic head and partly under the action of the vacuum maintained in suction box 28. The latter, moreover, will extend beyond the portion of the cylinder face thus in contact with the body of pulp suspension so as to subject the deposited layer to a predetermined amount of draining suction. On the other hand, as illustrated in Fig. 5, substantially the entire layer of pulp deposited on the screen may be thus deposited under the action of the vacuum in box 28; or, as illustrated in Fig. 6, substantially the entire layer may be deposited under hydrostatic head and the action of the suction box 28 limited to the withdrawal or draining from the layer thus deposited of water or equivalent vehicle.

Returning to Fig. 1, means such as a pressure roller 45 may be provided if desired for compacting the composite layer of pulp on the main cylinder A after the final component of such layer has been received from the last auxiliary cylinder D. Suitable means will also be provided for stripping the finished sheet product P from cylinder A, such as a roll 47 which will be disposed to contact with the lower face of the cylinder at a point beyond suction box 17, the removal of the sheet being facilitated by discharging jets of air against the interior face of the cylinder from a transversely disposed pipe 42, located as illustrated in relation to said roller 47. Also in order to clean the outer surface of the cylinder, jets of water or steam may be discharged thereagainst from a transversely disposed pipe 43 located immediately below tank A', the discharge which passes through the cylinder being received in the trough 28.

As previously explained, the number of auxiliary cylinders employed in conjunction with the main cylinder may vary so as to build up a composite layer of pulp on the latter which will comprise a corresponding number of components and each of these may in turn be varied in character as described in connection with Figs. 4, 5 and 6. In Figs. 7 and 8 two such typical products are illustrated. The sheet product P shown in cross section in Fig. 3 can be made using only the first auxiliary cylinder B in conjunction with the main cylinder A. In such case the outer strata p of the finished product will have the characteristics of cylinder type board in which the grain is predominantly lengthwise of the sheet having regard to its direction of travel through the machine. The interior of the product, on the other hand, will be made up of the two components of the layers successively deposited on the main cylinder A which are of Fourdrinier type in which the pulp fibers are laid down indiscriminately to form a tangled mass. There will of course be no clear line of demarkation between these several components or strata, but the contacting fibers of each, due to the action of the machine, will be interlocked and the resultant product constitutes in effect a unitary structure of greatly increased strength and at the same time is much more porous than laminated sheet products heretofore made from paper pulp where the successive layers are applied under pressure. Such porosity is an important factor in facilitating the drying of the finished product as made on the described machine as well as in permitting the more ready absorption of liquid thermo-plastic or the thermo-setting resins.

Fig. 3, in contradistinction to Fig. 7, shows a sheet P' such as may be produced by using all three of the auxiliary cylinders illustrated in Fig. 1. Such sheet, in addition to exterior strata p laid as before, will include two such strata p' within its interior in addition to strata corresponding with components p of the previously described structure. Obviously, by varying, as described in connection with Figs. 4, 5 and 6, the manner in which the components of the respective layers formed on the auxiliary cylinders are drawn from the corresponding bodies of pulp p, p' and p" may be made in the finished sheet product.

Other modes of applying the principle of my invention may be employed instead of the one explained, as the change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In a paper-making machine the combination of a main cylinder rotating on a horizontal axis and having a foraminous wall, means for supplying paper pulp to said wall during the rotation of said cylinder in an area above said axis on the upwardly moving side to form thereon a layer of pulp with the fibers extending predominantly in parallel relation to the direction of rotation of said cylinder, a suction box supported in said cylinder above its axis of rotation and underlying the upper portion of said pulp supply, to thereby form a second layer of pulp with the fibers in random arrangement, a second cylinder supported above said main cylinder on an axis of rotation substantially parallel with the axis of said first cylinder and with its surface closely adjacent the surface of the main cylinder at a point overlying said suction box, means for maintaining a supply of pulp in contact with the surface of said second cylinder so as to form thereon a layer of pulp, the suction from said suction box acting to draw said layer of pulp from said second cylinder into contact with the surface of the pulp on said main cylinder, and means to compact said layers into a single sheet of paper board.

2. In a paper making machine the combination of a main cylinder having a perforated wall, means for supplying paper pulp to said wall during the rotation of said cylinder to form thereon a layer of pulp with the fibers extending predominantly in parallel relation to the direction of rotation of said cylinder, a suction box supported in said cylinder above its axis of rotation and underlying the upper portion of said pulp supply to form on said first layer of pulp a second layer with the fibers in random arrangement, a second cylinder supported above said main cylinder on an axis of
rotation substantially parallel with the axis of said first cylinder and with its surface closely adjacent the surface of the main cylinder at a point overlying a portion of said suction box, means for maintaining a supply of pulp in contact with the surface of said second cylinder so as to form thereon a layer of pulp the fibers extending predominantly parallel with the direction of rotation of said cylinders, a suction box in said second cylinder underlying a portion of said pulp supply, the suction from the box in the main cylinder serving to draw the layers of pulp formed on the second cylinder into contact with the surface of the pulp on said main cylinder and means for compacting said layers into a single sheet of paper board.

3. In a paper making machine the combination of a main cylinder having a perforated wall, means for supplying paper pulp to said wall during the rotation of said cylinder to form thereon a layer of pulp with the fibers extending predominantly in parallel relation to the direction of rotation of said cylinder, a plurality of suction boxes supported in said cylinder, one of said suction boxes underlying a portion of said pulp supply, a plurality of secondary cylinders supported adjacent said main cylinder on axes of rotation substantially parallel with the axis of said first cylinder with their surfaces closely adjacent the surface of the main cylinder at points respectively overlying said suction boxes, means for maintaining a supply of pulp in contact with the surface of each of said secondary cylinders so as to form on each cylinder a layer of pulp the fibers extending predominantly parallel with the direction of rotation of said cylinders, suction boxes in certain of said secondary cylinders underlying portions of said pulp supply, the suction from the boxes in said main cylinder acting to draw the webs formed on the secondary cylinders into contact with the surface of the pulp on said main cylinder, and means to compact said layers into a single sheet of paper board.

EUGENE L. PERRY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>924,043</td>
<td>Dart</td>
<td>June 15, 1909</td>
</tr>
<tr>
<td>941,561</td>
<td>Decker</td>
<td>Nov. 30, 1909</td>
</tr>
<tr>
<td>1,347,724</td>
<td>Wagner</td>
<td>July 27, 1920</td>
</tr>
<tr>
<td>1,365,341</td>
<td>Wagner</td>
<td>July 19, 1921</td>
</tr>
<tr>
<td>1,538,788</td>
<td>Fish</td>
<td>May 19, 1925</td>
</tr>
<tr>
<td>1,746,253</td>
<td>Heritage</td>
<td>Feb. 11, 1930</td>
</tr>
<tr>
<td>1,799,350</td>
<td>Barnes</td>
<td>Apr. 7, 1931</td>
</tr>
<tr>
<td>1,833,910</td>
<td>Parker</td>
<td>Dec. 1, 1931</td>
</tr>
<tr>
<td>1,881,014</td>
<td>Parker</td>
<td>Oct. 11, 1932</td>
</tr>
<tr>
<td>2,098,733</td>
<td>Sale</td>
<td>Nov. 9, 1937</td>
</tr>
<tr>
<td>2,208,652</td>
<td>Whitehead</td>
<td>July 23, 1940</td>
</tr>
<tr>
<td>2,269,498</td>
<td>Perry</td>
<td>Feb. 15, 1945</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>151,696</td>
<td>Germany</td>
<td>May 20, 1904</td>
</tr>
</tbody>
</table>