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APPARATUS FOR FORMING FIBROUS STRUCTURES

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Fig. 1

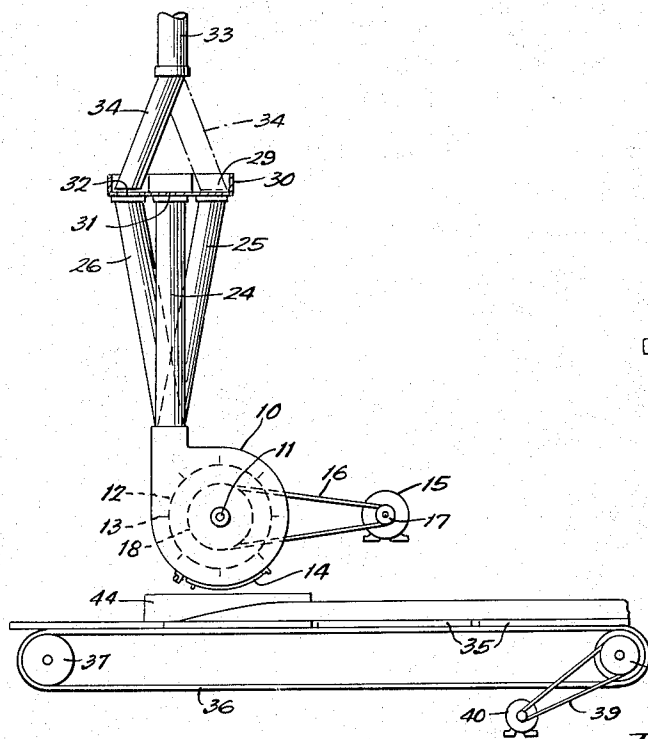


Fig. 2

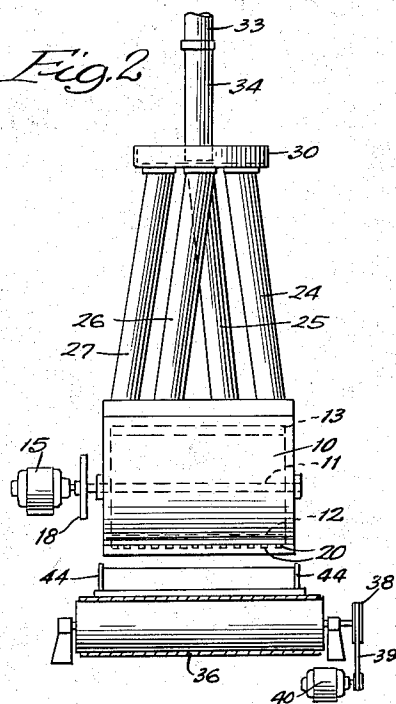


Fig. 3

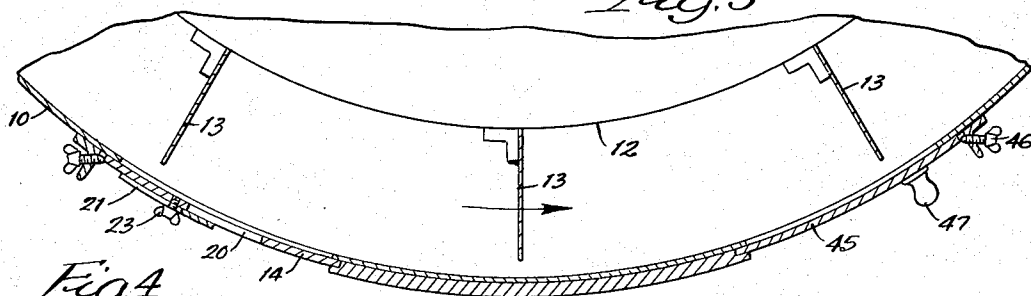
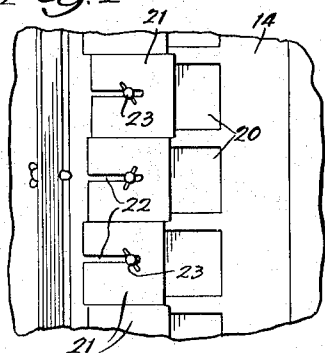


Fig. 4



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APPARATUS FOR FORMING FIBROUS STRUCTURES

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7 Claims. (Cl. 19—156)

This invention relates to the manufacture of fibrous structures and more particularly to apparatus for the deposition of fibrous elements in the manufacture of composite fibrous structures such as webs or molded panels and boards. This application is a continuation-in-part of my copending applications Serial No. 61,674, filed on November 23, 1948, and Serial No. 110,212, filed on August 13, 1949, now Patent No. 2,698,271.

As described in my copending applications, use is made therein of an air stream traveling at high velocity to entrain fibers for conveyance through a separating wall having openings therein dimensioned to permit passage of separated fibers to a foraminous collecting wall where the fibers deposit on the surface in interfelted arrangement to form a fibrous structure having some degree of self-sufficiency.

In order to achieve passage of fibers in uniform concentration through the openings in the separating wall for deposition in interfelted arrangement in the collecting wall, a mechanical scrabbler is provided in the fiber depositing head to keep the fibers from blocking the predetermined spaced openings in the separating wall and other means are provided to permit the space between the separating wall and the collecting wall to remain open to the atmosphere without blowing fibers out into the atmosphere and without disturbance of the substantial linear movement of the fibers during travel from the separating wall to the collecting wall.

It has been found that in many respects the system described and claimed in these copending applications for the deposition of fine fibrous filaments is not entirely adaptable to the manufacture of fibrous structures with larger and coarser elements such as the types described and claimed in my copending application Serial No. 229,375, filed on June 1, 1951, now abandoned.

For example, slivers and wafers of the types described having substantial dimension cannot as readily be entrained in high velocity air streams for conveyance in uniform distribution through a separating wall onto a collecting wall. Such coarse fibrous elements are also less responsive to the dimension or distribution of openings employed for separation and distribution in the copending application previously described and the elements are substantially incapable of interfelting as they are deposited on the collecting wall and therefore pose a particular problem with respect to transfer of the layers formed on the collecting wall to the mold plate for consolidating into a hard molded structure, such as board. Should the fibrous elements be deposited on a collecting screen of the type described in the copending application for separation of the fibrous elements from the air stream, it becomes necessary to displace the layer subsequently without disturbance of the deposited fibrous elements, onto a smooth surfaced caul plate or molding surface adapted under molding pressure to impart smoothness of the desired character to the surface of the molded product. The inability of the coarse fibrous elements to embody sufficient mass integrity for its self support makes

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it more difficult to employ the usual simple techniques for effecting transfer and usually involves a separate, expensive and somewhat complicated vacuum transfer process. In view of the above, it is an object of this invention to produce a new apparatus and method for depositing coarse fibrous elements in uniform distribution in layers for use in the molding of panels and boards.

Another object is to provide a new method and apparatus for depositing fibrous elements of the type described in a uniform layer without the use of air or other conveying means.

A further object is to provide a new method and apparatus for depositing fibrous elements of the type described in uniform distribution directly on a smooth surfaced plate which forms the mold surface in the subsequent step of consolidating under heat and pressure.

A still further object is to provide a method and apparatus which involves the use of a shower-head principle for the uniform deposition of fibrous elements of the type described in the absence of a high velocity air stream for carrying the fibers and without limitation as to the distance between separating wall and collecting wall or the characteristics thereof with respect to the size and distribution of openings.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawings in which—

Figure 1 is a schematic elevational view showing the arrangement of parts embodying features of this invention;

Figure 2 is a side elevational view of the assembly shown in Figure 1;

Figure 3 is an enlarged sectional elevational view showing a portion of the separating wall of the distributing head embodying features of this invention, and

Figure 4 is an enlarged fragmentary view of a portion of the separating wall shown in Figure 3.

In brief, invention herein resides in a method and apparatus for depositing coarse fibrous elements by introducing such elements in substantially uniform quantities across a fiber depositing head having a foraminous separating wall formed on the underside thereof and a scrabbler therein. The fibers are fed to the depositing head in amounts in excess of that capable of immediately passing through the openings of the separating wall so that a layer of such fibrous elements are caused to move constantly over the surface of the separating wall and thereby insure a uniform passage of fibers through each of the openings thereof for subsequent deposition in uniform distribution on a collecting wall. The condition existing in the depositing head or cylinder with a stream of fibers passing constantly over the openings in the separating wall in amounts in excess of that capable of immediately passing therethrough corresponds generally to the characteristics of a shower-head whereby substantially equal amounts of fluid are caused constantly to pass through each opening. Thus a uniform and controlled amount of fibrous elements are caused to pass through the separating wall and fall principally by gravity in a chiefly radial but somewhat tangential direction onto a collecting wall adapted preferably to move in the same lateral direction for receiving wafers in uniform distribution thereon.

As shown in the drawings, the fiber depositing head embodying the features of this invention comprises an elongate cylinder 10 having a width corresponding to the width of the layer of fibers to be deposited for the board to be manufactured therefrom. Rotatably mounted to extend crosswise through the center portion of the cylin-

der is a shaft 11 mounting a cylindrical drum 12 having a plurality of circumferentially spaced apart scrubber blades 13 extending radially therefrom by an amount to provide a spaced relation of about $\frac{1}{4}$ to $\frac{1}{2}$ inch (depending on the coarseness of the elements) from the surface of the foraminous separating wall 14 forming the underside of the cylinder. The shaft is adapted to be adjustable for varying the spaced relation with the separating wall portion in accordance with the type and dimension of fibers to be distributed therefrom. The shaft and the drum with the attached scrubber blades are adapted to be rotated by a motor 15 for transmitting rotational movement to the shaft 11 by means of a belt 16 operatively connecting a sheave 17 on the motor shaft with a sheave 18 on the end of shaft 11. For normal operation, the blades are adapted to be rotated counter-clockwise in the figures at a peripheral speed of about 500 to 2500 feet per minute and preferably at a linear speed of about 1000 feet per minute.

The underside of the cylinder is, as previously described, formed with a removable separating wall 14 having a plurality of circumferentially extending laterally spaced slots 20 arranged in side by side relation across the cylinder and provided with shutter plates 21 for circumferential adjustment relative the slots to increase or decrease the effective lengths thereof thereby to increase or decrease the amount of fibers passing therethrough depending upon the rate of feed, the dimension of the fibers and the distribution desired across the collecting wall for use in manufacture of the final product. The shutter plates 21 constitute rigid metal members or the like of curvilinear contour corresponding to the curvature of the cylinder. They are held in position by fastening bolts 23 which extend from the cylinder through aligned slots 20 in the plate thereby to permit sliding movement of the shutter plates 21 to a desired position of adjustment in which position the shutters are secured by tightening the bolts 23. While it will be sufficient merely if one row of slots extends across the separating wall, more than one row may be used and the slotted portions may be joined to form a continuous slot across the lower portion of the cylinder or else separated by straps as shown.

In order to feed fibrous elements in uniform distribution across the cylinder, there is provided a plurality of feed chutes 24, 25, 26 and 27 spaced in side by side relation across the top of the cylinder and leading from a distributor head 28. The distributor head comprises a horizontally disposed annular pan 29 having upright side walls 30 and a bottom wall 31 formed with equally spaced openings 32 in the peripheral portion thereof. Each opening is in connection with one of the distributor chutes 24 to 27 inclusive leading to equally spaced apart inlets across the distributing cylinder 10. A main feed duct 33 in alignment with the center portion of the pan 29 is provided with an offset arm 34 in the lower end which terminates adjacent the pan surface in the portion in which the openings 32 are arranged. The main feed duct assembly is mounted for rapid rotational movement about a vertical axis whereby fibrous elements fed through duct 33 are distributed about the periphery of the pan for admission in substantially equal amounts into each of the feed chute openings 32. Thus substantially uniform amounts of fibers are fed into each opening and subsequently across the cylinder head for transfer to the collecting wall.

In the absence of a high velocity air stream for carrying the fibrous elements through the separating wall to the collecting wall, deposition of the fibrous elements is more in the nature of settling by gravitational and centrifugal flow after they pass through the separating wall with the result that the collecting wall may be formed of separate caul plates 35 advanced in end to end relation onto an endless belt 36 operating about rollers 37 and

38. One of the rollers may be driven by a belt 39 or the like operatively connected to a driving motor 40 or else rotational movement may be achieved by other suitable means. As the caul plates 35 pass below the depositing cylinder 10, preferably in the direction of rotation of the scrubbers, fibrous elements are deposited thereon to form a continuous layer having a thickness depending upon the speed of the belt and the rate of fiber feed. As the belt turns about the roller 38, the caul plates 35 having the fibers deposited thereon as a layer 41 may be advanced over an adjoining roller conveyor 42 or other conveying means for further processing the fibrous elements in the formation of a molded product. Stationary side plates may be provided adjacent to but in from the sides of the caul plates in the fiber depositing zone, as shown, to form the fibrous elements perpendicularly along the side edges of the deposited layer.

A light weight clean-out plate 45 may be provided in the cylinder surface. Like the separating wall plate, the plate may be fastened in position by means of thumb screws 46 and may also be provided with handles 47 to simplify its manipulation.

The slotted openings 20 in the separating wall 14 are preferably dimensioned in the circumferential direction to correspond to about one-half to equal the maximum dimension of the fibrous elements in length or width and substantially equal to or greater than the largest dimension of the fibers in the crosswise direction. The openings are preferably adjusted or dimensioned to be slightly larger because little, if any, air is present to carry the fibers through the openings, as compared to the reliance on the air streams traveling at high velocity in the aforementioned copending applications. In addition, the distribution of fibrous elements in advance as they are admitted to the depositing head and the lack of cohesion between fibers provides for the desired uniformity in transmission of the fibers through the openings located across the separating wall, particularly when an excess of fibrous elements is present to maintain the desired shower-head principle.

In this connection, it is important to maintain the rate of feed of the fibrous elements in balance with the number and the dimensions of the openings so as to keep the zone adjacent the separating wall covered with a transient layer of the elements. In the event the feed of the elements becomes too great the cylinder will become clogged. On the other hand, if the feed becomes insufficient an adequate layer of transient fibers cannot be maintained and the fibers will, as a result, issue in non-uniform distribution through the openings.

With tapered end fibers dimensioned to be about $\frac{1}{2}$ inch in length and about 1 inch in width prepared in accordance with the copending application Serial No. 192,284, filed October 26, 1950, a single row of openings 20 spaced 2 inches apart across the bottom of the cylinder and dimensioned to be $1\frac{1}{2}$ inches square with the shutters closed down to cover about $\frac{1}{2}$ inch in the direction of travel of the scrubber blades 13, is sufficient to produce a felted layer of such fibrous elements at the rate of 5 pounds per minute per foot of width. With crosscut fibers of lesser thickness as disclosed in my copending application Ser. No. 9,482, filed May 3, 1949, openings of about $\frac{3}{4}$ inch in diameter and spaced about $\frac{1}{4}$ inches apart and arranged in two rows spaced closely about the periphery of the cylinder have been found to felt fibrous elements on the collecting wall at the rate of about 4 pounds per foot of width per minute. With dry Asplund fibers, made by grinding wet chips of wood between blades at elevated temperatures and pressures, a plurality of rows formed with slots preferably dimensioned to $\frac{3}{8}$ by $1\frac{1}{2}$ inches may be used to give a satisfactory rate of feed.

The normal setting of the scrubber blades 13, as previously pointed out, is adapted to range from $\frac{1}{16}$ to $\frac{1}{2}$ inch from the surface of the blade and for this purpose

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the bearings for the shaft 11 are preferably made adjustable vertically to secure the optimum spaced relation.

Various binder compositions such as dry binder or resinous binder in aqueous emulsion or in solution may be sprayed or otherwise applied onto the surfaces of the fibers incident to their deposition on the caul plates or such dry binders in powder form may be introduced with the fibers to the depositing cylinder for applying the desired amount of binder onto the fiber surfaces prior to or subsequent to its passage through the separating wall. In the absence of a high velocity air stream, it will be apparent that one layer of fibers from one depositing head may supply the surface for receiving additional layers of fibers of similar type or of different types from subsequent depositing heads of the type described and that each layer may be individually treated as by a roughening agent or with a coating composition or with an interlayer composition for producing a specific fibrous structure as defined in my copending application Serial No. 110,212.

It will be obvious that in place of a plurality of feed pipes to the cylinder, as shown in Figures 1 and 2, these may be replaced by a single pipe receiving a constant supply of fibrous elements at its upper end, which is pivoted and which is oscillated uniformly back and forth across an opening in the top of and the width of the cylinder, so as to deliver the elements fairly uniformly across its width. However, because of the pause and return of the lower end of the swinging pipes at the ends of the stroke, such a uniform distribution is not achieved as with the device shown in the figures.

It will be understood that various other changes may be made in the details of construction, arrangement and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. Apparatus for preparing structures of fibrous elements of substantial dimension comprising an elongate cylinder having a separating wall in the underside thereof formed with a plurality of openings arranged in spaced apart relation across the separating wall, a collecting wall spaced below the separating wall, means for feeding fibrous elements in uniform distribution into the cylinder across the length thereof in amounts exceeding that capable of passing immediately through the openings but insufficient to fill any portion of the cylinder, means for imparting rotational movement to all of the fibers contained therein constantly to move the excess as a layer across the forminous surface of the separating wall.

2. Apparatus as claimed in claim 1 in which the means for feeding the fibrous elements in uniform distribution across the cylinder comprises feed openings spaced uniformly across the top of the cylinder, a distributor pan having openings therein corresponding in number with the feed openings in the cylinder and spaced equidistantly in the peripheral portion of the pan, a feed chute mounted for

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rotational movement over said pan having an outlet adapted to rotate in uniform communication with each of said openings, ducts communicating each of the openings in the pan with feed openings in the cylinder, and means for feeding fibrous elements at predetermined rate into said feed chute.

3. Apparatus as claimed in claim 1 in which means are provided to permit adjustment of the size of the openings in the underside of the cylinder.

4. Apparatus as claimed in claim 1 which includes a clean-out plate forming a portion of the cylinder adjacent the separating wall, and means for securing the clean-out plate in position of use.

5. Apparatus for preparing structures of fibrous elements of substantial dimension comprising an elongated curvilinear housing having a separating wall in the underside thereof with openings arranged in spaced apart relation across the separating wall dimensioned to enable fibrous elements to pass through, a collecting wall spaced below the separating wall upon which the fibrous elements which pass through the separating wall are deposited for formation of the fibrous structure, means for feeding fibrous elements in uniform distribution across the housing in amounts sufficient to maintain an excess of that capable of immediately passing through the openings of the separating wall but substantially less than that required to fill any portion of the housing, a scrubbler mounted for rotational movement in the curvilinear housing having blades which rotate with the ends just out of contact with the surface of the separating wall to cause all of the fibrous elements within the housing to rotate rapidly about the housing and constantly to move the fibrous elements as a layer across the surface of the separating wall.

6. Apparatus as claimed in claim 5 in which means are provided for adjusting the scrubbler to maintain a spaced relation ranging from $\frac{1}{16}$ to $\frac{1}{2}$ inch between the edges of the blades and the surface of the separating wall during operation.

7. Apparatus as claimed in claim 5 in which the scrubbler comprises a cylinder and means for rotating the cylinder to provide a linear speed of about 500 to 2500 feet per minute.

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