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APPARATUS FOR THE AIR DEPOSITION OF FIBERS IN THE MANUFACTURE OF FIBROUS STRUCTURES

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Fig. 1

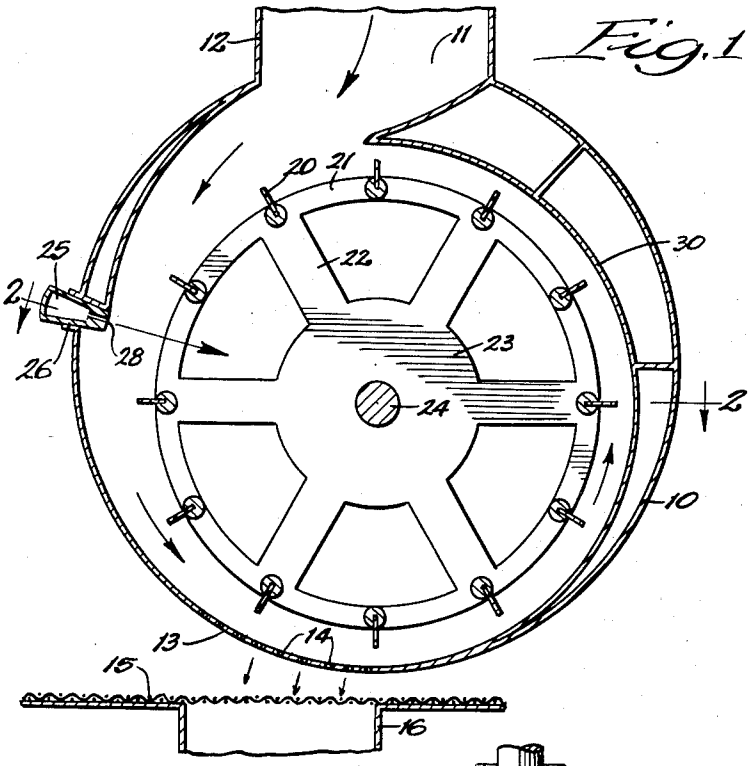
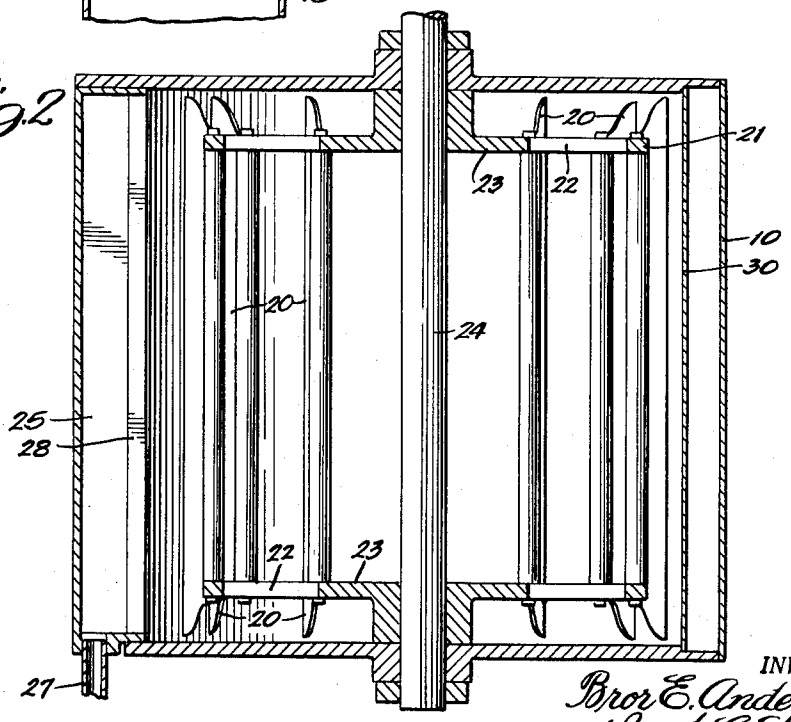


Fig. 2



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APPARATUS FOR THE AIR DEPOSITION OF FIBERS IN THE MANUFACTURE OF FIBROUS STRUCTURES

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9 Claims. (Cl. 19—156)

This invention relates to the manufacture of fibrous structures and it relates more particularly to apparatus for the air deposition of dry fibers to produce fibrous structures and embodies an improvement in the method and apparatus described and claimed in the copending application of James d' A. Clark, Ser. No. 61,674, filed on November 23, 1948.

Briefly described, the apparatus of the aforementioned application comprises a cylindrical housing having an inlet opening in one portion and a separating wall defining another portion in which a plurality of spaced openings are provided through which separated fibers are able to pass. Mounted within the housing for rotational movement about an axis parallel to that of the cylinder is a paddle wheel, herein referred to as a scrabbler, having a plurality of blades extending radially from the periphery thereof and in which the axis of rotation is offset to position the plates in closer proximity to the inner face of the separating wall with increase in the spaced relation between the ends of the blades and the remainder of the walls of the cylindrical housing.

Spaced a short distance from the foraminous separating wall is a collecting wall having foramens dimensioned to separate out fibers on the surface of the wall while the air stream passes therethrough. The separating wall may be of some particular shape to produce a fibrous preform or it may comprise an endless foraminous belt traveling in one direction to form a continuous web of interfelted fibers on the surface thereof.

When suction means are provided in connection with the underside of the collecting wall, the fibers deposited on the surfaces thereof are strongly anchored and when the volume of air withdrawn through the collecting wall is greater than the volume which is able to pass through the separating wall, then the deficiency is made up by a slight inflow of air from the surrounding atmosphere into the space between the separating wall and the collecting wall thereby to permit the space to remain open to the atmosphere without interference of fiber flow or without blowing the fibers out into the room.

In operation, substantially separated or loosely associated fibers are introduced at a predetermined rate through the feed opening into the cylindrical housing and are caused rapidly to circulate about the cylindrical housing responsive to mechanical actuation from the rapidly rotating scrabbler blades. The air, drawn into the housing by the scrabbler blades, and fibers are thus caused to travel as a constantly moving layer over the face of the separating wall under slight positive pressure to establish conditions similar to that of a shower-head whereby uniform volumes of air and fiber are caused to pass through the openings of the separating wall to the collecting wall.

It has been found in operation that a fairly high percentage of the fibers fed into the cylindrical housing are incapable of passing through the separating wall for deposition to form a fibrous structure on the collecting wall. The cause for such loss of fiber transmission is traceable to the formation of the separated fibers into balls or "rice" which are unable to pass through the openings in the separating wall and present a critical problem of elimination, otherwise the scrabbler section would be quickly filled with such agglomerates and the build-up of such fiber balls would interfere with the operation of the fiber depositing system. Obviously it would be impractical periodically to stop the operation of the fiber depositing unit to rid the cylindrical housing of such fiber balls or rice. As a result, various systems have been devised to effect the continuous removal of such fibers or balls but such techniques have been found insufficient because they are not only expensive and complicated in operation but they permit a waste of fiber.

Instead of providing a more efficient separator to eliminate the balls of fibers from the scrabbler system, it is an object of this invention to provide means for reducing the amount of fibers formed into such balls or rice thereby markedly to increase the utilization of the fibers introduced and greatly to increase the efficiency of the fiber depositing system.

Another object is to produce an improvement in apparatus for the air deposition of fibers to form fibrous structures, and it is a related object to provide means in apparatus of the type described which reduces to a minimum those factors which give rise to the formation of fiber balls and rice from the separated fibers fed into the scrabbler section.

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

Figure 1 is a sectional elevational view through a fiber depositing head embodying features of this invention, and

Figure 2 is a sectional view taken along the line 2—2 of Figure 1.

It has been found that when suitable means are provided for removing fibers caught on the ends of the scrabbler blades, the amount of rice formed may be reduced from as much as 30 percent of the fiber introduced to less than 0.5 percent or up to a sixty-fold reduction in the formation of such clots and bundles. This represents a marked increase in the efficiency and in the operation of the fiber depositing machine. While mechanical wipers might be used for the removal of such fibers from the ends of the blades, it has been found more expedient to make use of a blade cleaning system which depends upon the reaction with air and which imparts some function in maintaining the desired turbulence of the air streams thereby to effect better distribution of fibers in the fiber depositing head.

In accordance with the practice of this invention, the ends of the blades are kept substantially free of fibers by blasting the ends with one or more air streams positioned to engage the blades preferably immediately in advance of passage into the separating wall section where the ends of the scrabbler blades approach closest to the walls of the cylindrical housing. It is believed that it is primarily within this area that such fiber balls and rice are formed as by a rolling or rubbing action between the fibers on the ends of the blades and the surface of the separating wall.

The blast of air may be directed against the ends of the blades from any angular direction but it has been found best to direct the blast radially against the edges of the scrabbler blades as they pass by, as for example from a number of air nozzles arranged across the cylindrical housing in spaced apart relation or from a single air outlet in the form of an elongate nozzle for directing a substantially continuous blast of air against the ends of the scrabbler blades.

As shown in the drawing, a fiber depositing head for the air deposition of dry fibers comprises an elongate cylindrical housing **10** having an inlet opening **11** extending substantially continuously across the upper portion thereof. A feed duct **12** communicates directly with the feed opening substantially throughout its length for introducing separated fibers into the housing and for enabling a relatively large volume of air to be drawn by the scrabbler blades or else introduced in predetermined volumes under positive pressure through suitable duct work in communication with an air blower or the like, as more specifically defined in the aforementioned application. Practically diametrically opposite the feed opening, the cylindrical housing **10** is provided with a separating wall section **13** having openings **14** dimensioned to permit passage of separated fibers and preferably spaced by a distance which prevents fibers entering two openings at the same time so as to cause a block and a source for fiber agglomeration. The separating wall **13** may form an integral part of the cylinder wall but it is preferred to provide one or more separate curvilinear plates for attachment to the wall of the housing and having openings of different dimension and spacing for use with various types of fibers and lengths of fibers calculated to secure best results.

Positioned a short distance from the separating wall but in spaced relation therewith is a collecting wall **15** having openings dimensioned to permit passage of air or to separate out fibers from the air stream onto the surfaces thereof whereby the fibers collect in interfelted relation and conform to the contour of the collecting wall in the formation of a fibrous preform. When the collecting wall is a relatively flat member adapted to form panels or webs, the wall may comprise an endless foraminous member adapted to move in one direction at a rate balanced with the amount of fibers to produce a felted layer of fibers of desired thickness.

The underside of the collecting wall may be in communication with ductwork **16** through which air is withdrawn, as by the blower, or by other means to generate a suction which anchors the separated fibers onto the surface of the collecting wall. When the amount of air withdrawn from the underside of the collecting wall exceeds the amount of air issuing with the fibers through the separating wall, the deficiency is adapted to be made up by a slight inflow of air from the atmosphere into the space between the separating wall and the collecting wall. This condition prevents fibers from being blown out into the atmosphere and provides for the smooth flow of air and fibers from the separating wall and collecting wall. Thus, this critical area in an air deposition system can be allowed to remain open to the atmosphere without causing nonuniform distribution of fibers, agglomeration of fibers into bundles or blowing fibers out into the atmosphere. By being able to leave this area between the separating wall and collecting wall open to the atmosphere, it is possible to introduce various substances, such as dry binders, or the like, onto the fibers prior to or just as they are being deposited.

The desired movement of fibers and air for transfer in uniform volumes and distribution through the openings of the separating wall is effected by a mechanical scrabbler in the form of a plurality of resilient blades **20** formed of rubber, metal or the like extending radially from their mounting in the periphery of spaced rims **21** secured by spokes **22** to a hub **23** mounted on a shaft **24** axially positioned for rotational movement in the ends of the housing **10**. The rotatable scrabbler is positioned to be offset in the direction of the separating wall so that the tips of the blades are just short of the separating wall.

As the scrabbler blades rotate at high speed within the housing, the fibers and air entering the housing are caused to revolve rapidly about the periphery of the housing, causing a layer of air and entrained fibers to move constantly across the face of the separating wall under positive pressure whereby conditions exist similar to that of a shower-head and equal volumes of air and fibers pass through the openings of the separating wall to the collecting wall.

In the illustrated embodiment, the ends of the scrabbler blades **20** are acted upon by a continuous blade of air blasted onto the blades prior to their passage into the area of the separating wall. The air blast means comprises an elongate header **25** in the form of a rectangular tubing extending through a corresponding opening **26** in the outer wall of the housing. The header is connected by a tubular passage **27** to a source of air under pressure and a narrow slot **28** is provided through the end portion of the header extending laterally into the housing through which the air issues under high pressure as a continuous blade directed radially from the housing for removing fibers caught on the ends of the scrabbler blade. It will be understood that the desired effect may be secured by a plurality of separate air inlets spaced across the housing and that all or part of such air nozzles may be adapted to reciprocate so as to secure a more complete coverage of the scrabbler blades. It will also be understood that the air blast may be directed at an angular relation with the blades to sweep the fibers off the ends thereof.

It has been found in actual practice that conditions which have heretofore resulted in the formation of rice or balls from 30 percent of the fibers fed into the cylinder can be reduced to about 0.5 percent merely by modification of the same structure to embody the cleaning or fiber removing blast described herein. Thus by the modification described, more efficient use can be made of the fiber depositing head and fibrous products can be produced with less interruption or interference with the operation of a machine and with a more efficient utilization of fiber.

A further improvement in apparatus for deposition of dry fibers of an air stream circulating rapidly about the cylindrical housing and over the face of a foraminous cylinder wall, as effected by the mechanical scrabbler means just described or by air scrabbler means described in the copending application of James d'A. Clark et al., Ser. No. 313,316, filed on October 6, 1952, entitled "Air Scrabbler System for Fiber Deposition in the Manufacture of Fibrous Structures," resides in the modification in the contour of the wall defining the interior of the housing whereby a suction zone is generated in the fiber feed area to prevent interference with the rotational movement of the air and fibers about the housing and to avoid such turbulence in the fiber feed zone as would interfere with the smooth operation of the machine.

To achieve this result, the wall portion **30** beyond the separating wall and in advance of the fiber feed opening is formed substantially to elliptical shape having a lesser radius than that of the housing so that the end of the wall terminates below the fiber feed opening and preferably projects beyond a portion thereof. As a result, the rapid circulation of air and fibers at high speed about the housing forms in effect a venturi which causes a slight vacuum to be generated within the fiber feed opening smoothly and uniformly to draw the fibers and air into the cylindrical housing for joining with the air and fibers circulating therein.

The air blast for cleaning the blades adds to the turbulence for fiber entrainment and separation and also adds to the volume of air as will permit the existence of more desirable conditions for effecting the shower-head principle by which uniform volumes of air and fibers are caused to pass through the separating wall. Using the air blast, no auxiliary air beyond that drawn in by the vacuum created by the swirling mass in the housing need be added. Under such circumstances an air lock feeder for the fibers, such as described in the aforementioned copending Clark application, is unnecessary. In fact, the feed opening may be left substantially open to the atmosphere and the fibers fed freely in through the opening.

It is unnecessary to make use of a separate baffle plate to regulate the air flow within the fiber depositing head. Instead, the desired relationship between walls in the vicinity of the fiber inlet opening may be embodied as an integral part of the cylindrical housing by forming the housing **30** to curvilinear shape so long as the leading angle is considerably less than the trailing angle *b*. The former corresponds to the angle which the wall portion in advance of the inlet opening makes with the direction of fibers introduced through the inlet which generally corresponds to the angle of incline of the inlet member. The latter corresponds to the angle made by the direction of the fiber inlet and the wall portion of the housing immediately beyond the inlet.

Use may be made of the concepts described without making use of the mechanical scrabblers for achieving the desired air and fiber movement. For example, the desired movement of fibers may be achieved by the use of air scrabbler means employing streams of air introduced at high velocity into the housing in a radial direction to achieve the desired movement. A system of the type described is more fully described in the Clark application Ser. No. 313,316.

It will be understood that 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.

We claim:

1. Apparatus for the air deposition of dry fibers in the preparation of fibrous structures comprising a cylindrical housing having an inlet in one wall portion through which fibers and air are fed into the housing and a separating wall in another portion having openings dimensioned to permit passage of separated fibers, a collecting wall spaced a short distance from the separating wall having openings dimensioned to prevent passage of fibers, a paddle wheel having a plurality of scrabbler blades mounted for rotational movement within the housing, means for introducing air and fibers through the inlet into the housing whereby they are caused by the rotating paddle wheel to turn about the housing and provide a constantly moving layer of air and fibers across the face of the separating wall whereby some of the fibers and air are caused to pass through the openings in the separating wall to the collecting wall which separates fibers out of the air stream on the surface thereof to form the fibrous structure, and air blast means for removing the fibers from the edges of the scrabbler blades during rotational movement.

2. Apparatus for the air deposition of dry fibers in the preparation of fibrous structures comprising a cylindrical housing having an inlet in one wall portion for the introduction of air and fibers and a separating wall in another portion having openings dimensioned to permit passage of separated fibers therethrough, a collecting wall spaced a short distance from the separating wall having openings dimensioned to prevent passage of fibers therethrough, a paddle wheel having a plurality of blades about the periphery thereof mounted for rotational movement within the housing, means for introducing fibers through the inlet whereby they are caused by the paddle wheel to rotate at high velocity about the housing and form a constantly moving layer of air and fibers across the face of the separating wall whereby some of the fibers and air are caused to pass through the openings in the separating wall to the collecting wall, and air inlet means for directing a blast of air onto the blades of the paddle wheel in advance of the separating wall for removing fibers caught on the edges of the blades.

3. Apparatus for the air deposition of dry fibers as claimed in claim 1 in which the paddle wheel is mounted for rotational movement about an axis parallel to that of the housing but about a center offset from that of the housing in the direction of the separating wall whereby the rotating blades are spaced a lesser distance from the separating wall than from the wall defining the housing portion immediately in advance thereof to the inlet.

4. Apparatus for the air deposition of dry fibers in the preparation of fibrous structures comprising a cylindrical housing having an inlet in one wall portion and a separating wall defining another wall portion having openings dimensioned to permit passage of dry fibers, a collecting wall spaced a short distance from the separating wall and having openings dimensioned to prevent passage of fibers therethrough, a paddle wheel having a plurality of blades mounted for rotational movement within the housing, means for introducing air and fibers through the inlet into the housing whereby they are caused by the paddle wheel to rotate at high velocity about the housing and form a constantly moving layer of air and fibers across the face of the separating wall whereby fibers and air pass through the openings of the separating wall to the collecting wall where the fibers are separated on the surface of the collecting wall to form the fibrous structure, the interior wall of the housing beyond the separating wall having an elliptically shaped portion terminating below the inlet opening to cause the stream of air and fibers rotating about the housing to generate a vacuum in the feed opening to draw the air and fibers into the housing.

5. Apparatus for the air deposition of dry fibers in the preparation of fibrous structures comprising a cylindrical housing having an inlet in one wall portion and a separating wall defining another wall portion having openings dimensioned to permit passage of dry fibers, a collecting wall spaced a short distance from the separating wall and having openings dimensioned to prevent passage of fibers therethrough, a paddle wheel having a plurality of blades mounted for rotational movement within the housing, means for introducing fibers through the inlet into the housing whereby they are caused by the paddle wheel to rotate at high velocity about the housing and form a constantly moving layer of air and fibers across the face of the separating wall whereby fibers and air pass through the openings of the separating wall to the collecting wall where the fibers are separated on the surface of the collecting wall to form the fibrous structure, means for directing an air blast onto the edges of the scrabbler blades to remove fibers caught thereon, the housing wall having a curvilinear portion of elliptical shape of decreasing radius between the separating wall and the inlet to create a suction in the feed opening whereby air and fibers are drawn smoothly into the housing.

6. Apparatus for the air deposition of dry fibers in the preparation of fibrous structures comprising a cylindrical housing formed with a curvilinear interior wall having an inlet in one wall portion and a separating wall defining another wall portion having openings dimensioned to permit passage of dry fibers, a collecting wall spaced a short distance from the separating wall and having openings dimensioned to prevent passage of fibers therethrough, a paddle wheel having a plurality of blades mounted for rotational movement within the housing, means for introducing air and fibers through the inlet into the housing whereby they are caused by the paddle wheel to rotate at high velocity about the housing and form a constantly moving layer of air and fibers across the face of the separating wall whereby fibers and air pass through the openings of the separating wall to the collecting wall where the fibers are separated on the surface of the collecting wall to form the fibrous structure, said paddle wheel being positioned to rotate about an axis parallel to that of the housing but about a center offset from that of the housing in the direction of the separating wall, the interior wall of the housing beyond the separating wall being formed with decreasing radius and terminating below the inlet opening.

7. Apparatus as claimed in claim 6 in which the curvilinear wall is of elliptical shape having decreasing diameter

as it approaches the inlet opening thereby to generate a suction within the inlet opening.

8. Apparatus for the air deposition of dry fibers in the preparation of fibrous structures comprising a cylindrical housing formed with a curvilinear interior wall having an inlet in one wall portion and a separating wall defining another wal portion having openings dimensioned to permit passage of dry fibers, a collecting wall spaced a short distance from the separating wall and having openings dimensioned to prevent passage of fibers therethrough, a paddle wheel having a plurality of blades mounted for rotational movement within the housing, means for introducing air and fibers through the inlet into the housing whereby they are caused by the paddle wheel to rotate at high velocity about the housing and form a constantly moving layer of air and fibers across the face of the separating wall whereby fibers and air pass through the openings of the separating wall to the collecting wall where the fibers are separated on the surface of the collecting wall to form the fibrous structure, said paddle wheel being positioned to rotate about an axis parallel to that of the housing but about a center offset from that of the housing in the direction of the separating wall, the interior wall of the housing beyond the separating wall being formed to elliptical shape of decreasing radius and terminating at the inlet opening, and means for directing blasts of air onto the ends of the blades in advance of the separating wall to remove fibers caught thereon.

9. Apparatus for the air deposition of dry fibers in the preparation of fibrous structures comprising a housing having an inlet in one wall portion and a separating wall defining another wall portion having openings dimensioned to permit passage of dry fibers, a collecting wall spaced a short distance from the separating wall and having openings dimensioned to prevent passage of fibers therethrough, a paddle wheel having a plurality of blades mounted for rotational movement within the housing, means for introducing air and fibers through the inlet into the housing whereby they are caused by the paddle wheel to rotate at high velocity about the housing and form a constantly moving layer of air and fibers across the face of the separating wall whereby fibers and air pass through the openings of the separating wall to the collecting wall where the fibers are separated on the surface of the collecting wall to form the fibrous structure, the housing being formed with curvilinear interior walls arranged to form a greater angle between a line parallel to the axis of the inlet at the intersection with the interior wall in advance of the inlet opening than between a similar line at the intersection with the interior wall portion rearwardly of the inlet opening.

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