March 19, 1968 J. R. THYGESON, SR 3,374,106

MATERIAL DRYING METHOD AND APPARATUS

Filed May 14, 1964 3 Sheets-Sheet 1

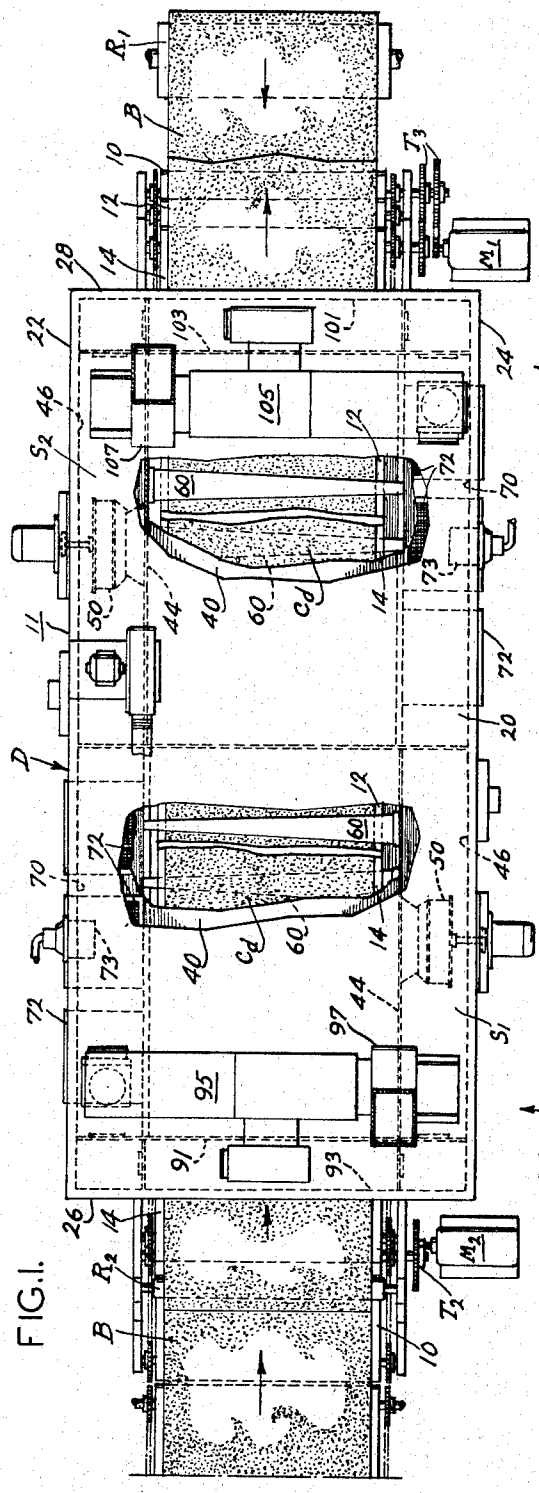

FIG. 1.

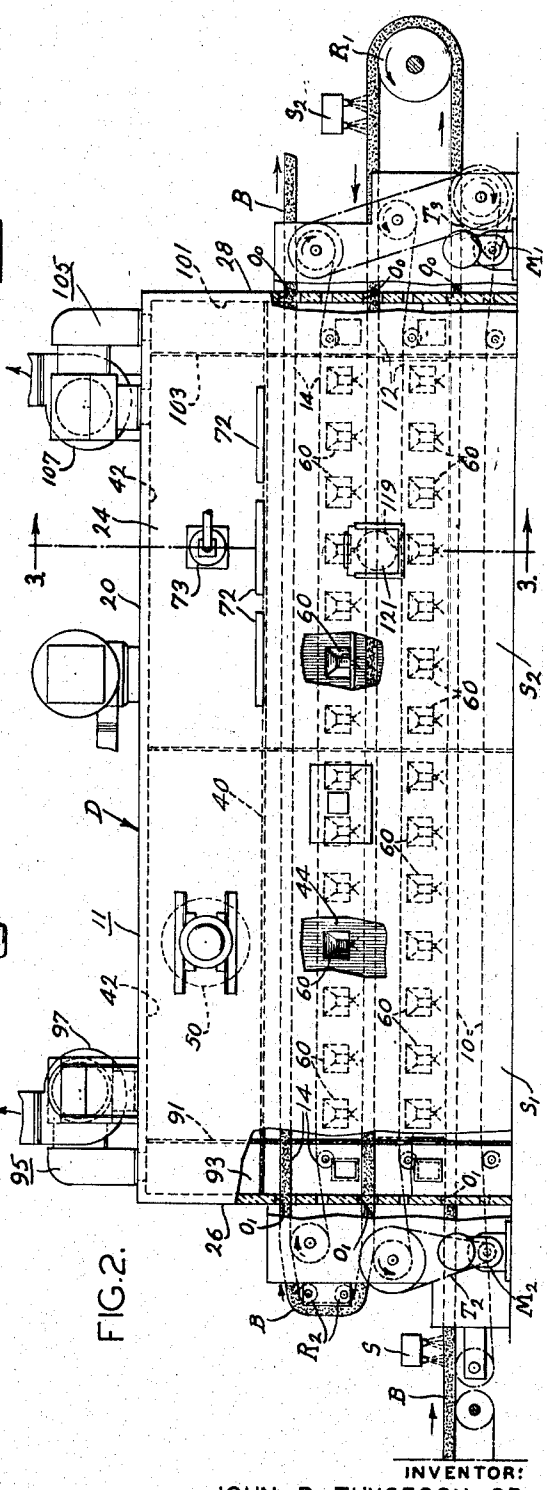

FIG. 2.

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MATERIAL DRYING METHOD AND APPARATUS

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FIG.3.

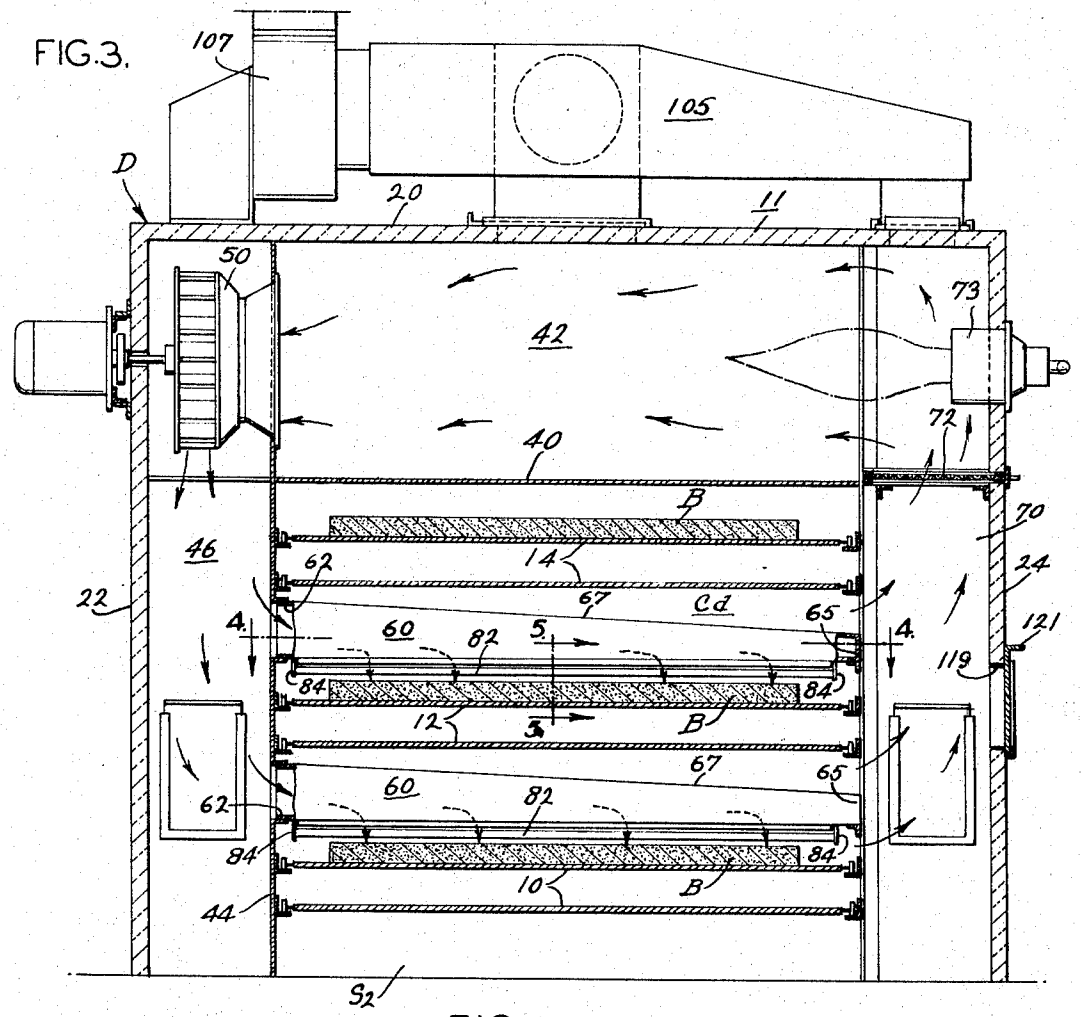
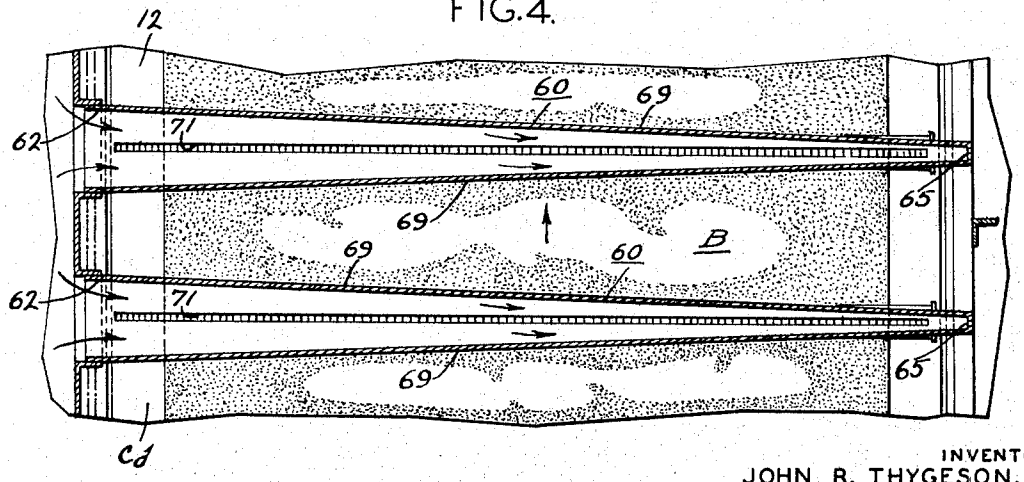


FIG.4.



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MATERIAL DRYING METHOD AND APPARATUS

Filed May 14, 1964 3 Sheets-Sheet 3

FIG 5.

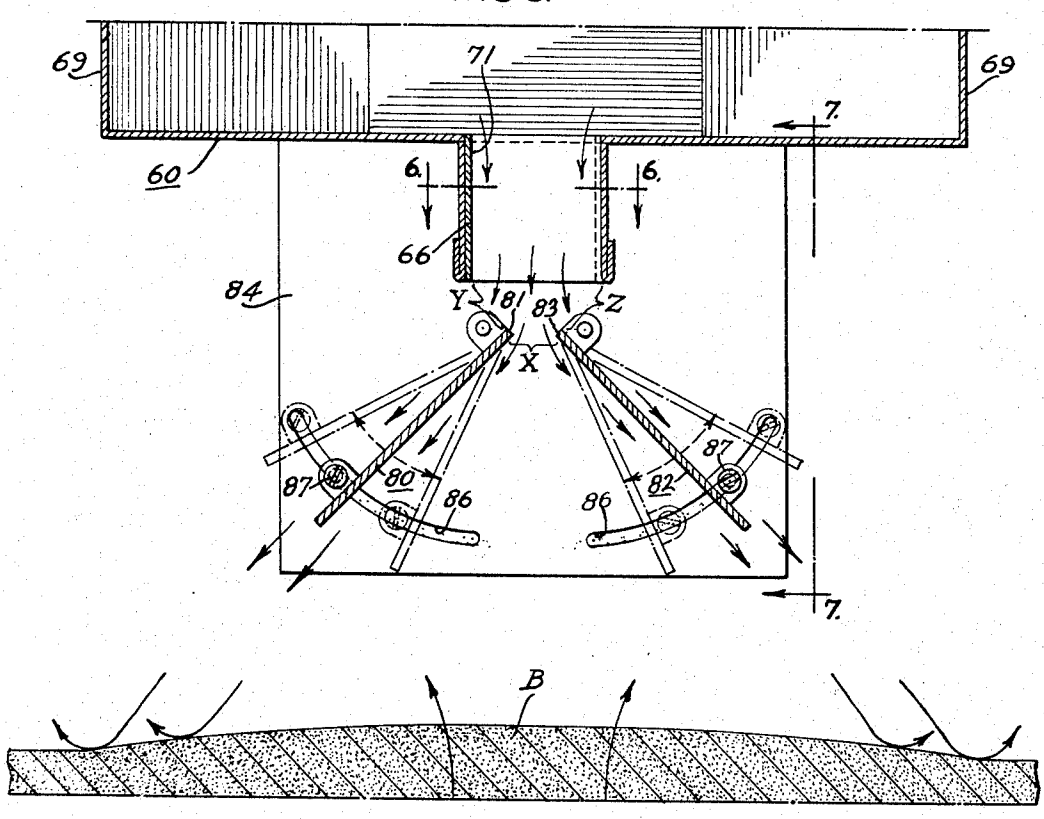


FIG. 6.

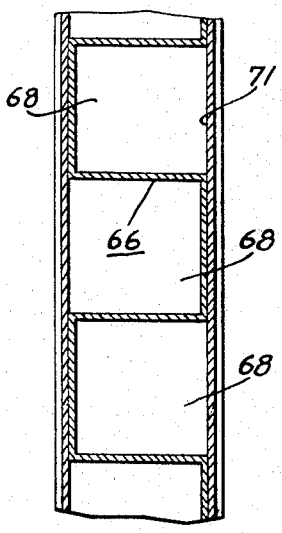
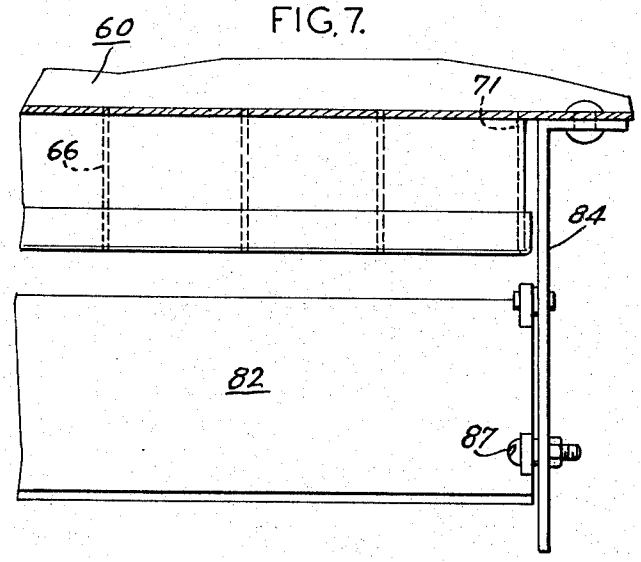


FIG. 7.



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3,374,106

MATERIAL DRYING METHOD AND APPARATUS

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10 Claims. (Cl. 117—105.3)

ABSTRACT OF THE DISCLOSURE

A method and apparatus for treating material, particularly batts or webs of non-oriented, loosely compacted fibrous material, by conveying it through an enclosed housing having a treating chamber and treating medium conditioning means including air distribution means having an outlet port confronting the batt through which treating medium is discharged. In the form of the invention illustrated, the treating medium distribution means consists of an enlongated box having an outlet port, and baffle means comprising a pair of elongated baffle plates is provided which extends coextensively with the outlet port and angularly relative to one another and to the direction of flow of the treating medium from the outlet port. This baffle arrangement divides the flow of treating medium into three zones, two outer zones and a center zone thereby creating a pressure and velocity difference in the zones whereby treating medium diverted to the outer zones creates a suction which draws treating medium up through the batt in the center zone to create a slight lofting of the batt.

This invention relates to method and apparatus for drying materials.

The present method and apparatus are especially adapted for processing batts or webs of non-oriented, loosely compacted fibrous material. Batts of this type are used, for example, as interlinings, filters, etc., and in these applications it is desirable that the batt have certain resilience, loft, density, final thickness and porosity characteristics for most effective results in its use as a liner, filter, etc. In some drying apparatus for drying these batts, the batt or web is sprayed with a binder on one face and after spraying, advanced through the drying chamber of the apparatus. The batt is then reversed so that the other face may be sprayed with the binder and again passed through the drying chamber. A drying medium is circulated through the drying chamber to dry and cure the binder. The binder serves to give the batt body.

The means for circulating drying medium through the drying chamber includes a series of air distribution boxes extending transversely to the direction of travel of the batt and spaced along the entire length of the drying chamber. These air distribution boxes have tapered top and side walls, an inlet opening at one end through which the drying medium enters the box and an elongated narrow slot providing a discharge outlet at the bottom of the box confronting the batt with a plurality of partitions dividing the slot into a plurality of small discharge nozzles. By this arrangement drying medium entering the box is discharged through each of the nozzles directly against the surface of the batt confronting the nozzles, the configuration of the box being such that the discharge velocity of the drying medium through all the nozzles is substantially uniform. It has been found that in order to achieve effective curing of the binder and drying of the batt, that is, processing of the batt, the velocity of the air discharged through the nozzles be in the range of 1500 to 3500 feet per second. However, with this arrangement one of the problems is that the drying medium directly engaging the face of the web tends to flatten or compress the batt so that some of the highly desirable characteristics of the finish processed batt are destroyed. More specifically it has been found that if the batt is prematurely compressed, that is, before the binder is cured, there is a matting together of the fibers which destroys the desired porosity and resiliency of the batt. Thus, if the batt is compressed to too great a degree, the resilience, loft, density, final thickness and porosity thereof are adversely affected and the batt will not be able to be used effectively for its intended purpose.

In accordance with the present invention, means is provided for controlling the circulation of the drying medium in the vicinity of the batt and in such a manner that the final desired condition or characteristics of the batt may be controlled more accurately.

More specifically, in accordance with the present invention, there is provided baffle means in the path of flow of the drying medium from the discharge nozzles, which baffle means serves to diffuse or break up the air flow into zones thereby preventing direct impingement of the air against the face of the batt. In the illustrated embodiment of the invention, baffle means comprises a pair of elongated baffle plates disposed adjacent the discharge nozzles of the air distribution box coextensive therewith. The plates are disposed angularly relative to one another and to the direction of flow of the drying medium from the discharge nozzles. The effect of the baffle arrangement is to cause the air discharged through the nozzles to be diffused or broken up so that the full thrust of the drying medium is not directly onto the surface of the batt.

It has been found that with this baffle arrangement, the air discharged through the nozzles is broken up in such a way that there is actually a slight lofting of the web as it passes through the drying chamber, thereby avoiding harmful compression of the batt as heretofore was the case whereby the finish processed batt is resilient and lofty. Moreover it has been found that the circulation of drying medium effected by the baffle arrangement increases the drying efficiency. Further by this arrangement, the mass movement of air directed toward the batt or circulated through the air nozzles may be increased appreciably thereby increasing the drying rate. Accordingly, with the foregoing in mind an object of the present invention is to provide a method and apparatus for continuously drying material such as batts made of non-oriented, loosely compacted fibers wherein the circulation of the drying medium is controlled in a manner whereby the processed batt is characterized by a predetermined desired resilience, loft, density, final thickness and porosity.

Another object of the present invention is to provide a method for continuously drying material to provide a finished product characterized by optimum characteristics such as loft, resilience, density, final thickness and porosity and apparatus for carrying out the method which is of comparatively simplified construction and may be manufactured and installed economically.

A further object of the present invention is to provide drying apparatus and method characterized by novel features whereby the drying efficiency of the dryer is increased.

These and other objects of the present invention and the various features and details of the operation of the apparatus and method and the construction of the apparatus are hereinafter more fully set forth with reference to the accompanying drawings in which:

FIG. 1 is a plan view of a dryer in accordance with the present invention with parts broken away to show the internal construction thereof;

FIG. 2 is a side elevational view of dryer shown in FIG. 1 also with parts broken away;

FIG. 3 is an enlarged sectional view taken on lines 3—3 of FIG. 2;

FIG. 4 is an enlarged fragmentary sectional view taken on lines 4—4 of FIG. 3;

FIG. 5 is an enlarged fragmentary sectional view taken on lines 5—5 of FIG. 3; and

FIGS. 6 and 7 are enlarged sectional views taken on lines 6—6 and 7—7 respectively of FIG. 5.

Referring now to the drawings and considering now the primary components of the apparatus in terms of function, a batt B of non-woven, loosely compacted fibers is delivered to the feed or entrance end of the dryer by suitable means to the lowermost foraminous conveyor **10** of a series of tiered foraminous conveyors which conveyor **10** is suitably actuated by a motor M_1 and belt transmission T_1 for movement in an endless path to transport the batt through the generally enclosed housing of the dryer D. At the feed end of the dryer D, suitable spray means S is provided to deposit a binder such as latex, an acrylic resin or other thermoplastic material to one face of the batt B. Thereafter the conveyor **10** moves the sprayed batt B through the drying chamber C_d of the dryer. At the opposite or delivery end of the dryer D, the batt B passes around a guide roll R_1 and the opposite face of the batt B is sprayed by a second spray unit S_2. The sprayed batt B is again conveyed back through the drying chamber C_d on the second, or in the present instance, middle conveyor **12** of the tier of conveyors which is actuated for movement in an endless path by a motor M_2 and belt transmission T_2. As the batt approaches the feed end of the dryer D, the direction of the batt B is again reversed by passing around rolls R_2 and by means of the uppermost conveyor **14** the batt B again passes through the drying chamber C_d so that the batt may be discharged at the delivery end of the dryer. This conveyor is actuated from motor M_1 and a belt transmission T_3. The processed batt B then leaves the delivery end of the dryer for further processing. During movement of the batt through the dryer D, a heated drying medium is circulated through the drying chamber C_d to effect curing of the binder and drying of the batt.

Referring now to the drawings and particularly to FIGS. 1 and 2 thereof, the dryer comprises an elongated generally enclosed housing **11**, in the present instance, divided into two sections, S_1 and S_2 of substantially identical construction. These sections S_1 and S_2 are mounted end to end to form a continuous enclosed dryer housing. As best illustrated in FIG. 3, each section of the dryer housing **11** includes a top wall **20** and opposing side walls **22** and **24**. The front section S_1 of the dryer housing includes a front wall **26** having suitable openings O_i therein to accommodate the conveyors and movement of the batt into and out of the housing and the rear section S_2 has a rear wall **28** also having openings O_o therein to facilitate passage of the batt into and out of the housing.

In order to minimize leakage of drying medium from the housing **11** through the openings O_i and O_o, an air curtain may be provided at the feed and delivery ends of the dryer. To this end, there is provided a vertical partition **91** which extends transversely of the housing and which is spaced from the front wall **26** to define an air curtain chamber **93** at the feed end of the housing. Ductwork **95** communicating with the air curtain chamber **93** including a fan **97** is provided to draw air from the air curtain chamber **93** whereby leakage of drying medium from the housing is minimized. A similar air curtain chamber **101** defined by a partition **103** is provided at the delivery end of the housing. Ductwork **105** and a fan **107** are provided to draw air from the air curtain chamber **101**.

Each section of the dryer is subdivided into several compartments including the drying chamber C_d extending lengthwise of the dryer and which, as illustrated in FIG. 3, is defined by a horfzontally extending panel **40** running the length of the dryer and spaced from the top wall **20**, a vertical panel **44** spaced from the side wall **22** and the side wall **24**. The space between the panel **40** and top wall **20** defines a conditioning chamber **42**, and the space between the side panel **44** and side wall **22** defines a distribution chamber **46**.

A motor operated fan **50** is mounted in the panel **44** with its intake or suction side communicating with the conditioning chamber **42** and the impeller, or discharge side, disposed to direct drying medium drawn from the conditioning chamber **42** to the distribution chamber **46** as illustrated in FIG. 3.

A plurality of air boxes **60** is provided along the length of the dryer in two rows, one row above the upper run of the intermediate conveyor **12** and the other row above the lowermost conveyor **10**. Each of the boxes **60** extends transversely to the direction of movement of the conveyors and as illustrated in FIG. 2, the boxes are closely spaced the length of the conveyors. Each box **60** has an open end **62** communicating with the distribution chamber **46** so that air entering the distribution chamber is directed into the box and a closed end as at **65**. Each of the boxes **60** as illustrated, has a top wall **67** and opposing side walls **69**, all of which converge toward the closed end of the box. In the bottom of each box is an elongated generally rectangular outlet port **71** which extends approximately the width of the conveyor and which has mounted therein a honeycomb **66** to divide the outlet port **71** into a series of generally square nozzle openings **68**. By this arrangement, as the drying medium enters the box, it is directed downwardly through the individual nozzle openings **68** and by reason of the configuration of the box, the velocity of air discharged through each of the nozzle openings **68** is substantially uniform. The drying medium discharged through the nozzle openings **68** passes downwardly against the batt on the upper run of the conveyors **10** and **12** and then passes to a discharge chamber **70** running the length of the housing to the side thereof opposite the distribution chamber **46**. A series of lint screens **72** is provided along the upper extent of the discharge chamber **70** through which the drying medium is drawn by the fan **50**. At the side of the conditioning chamber opposite the fan **50** adjacent the lint screens **72**, there is provided suitable heating means, in the present instance, a gas heating unit **73** to heat the drying medium as it is drawn through the conditioning chamber by the fan.

In accordance with the present invention, baffle means is provided adjacent the outlet port **71** of each of the air distribution boxes **60** which serves to control the flow of the drying medium discharged through the air nozzles **68** in a manner to effect slight lofting of the batt and prevent compression or compacting thereof which would harmfully affect the desired characteristics of the processed batt. In the present instance, the baffle means comprises a pair of elongated generally rectangular plates **80** and **82** which are angularly disposed relative to one another and to the direction of flow of the treating medium from the air outlet port **71**. Preferably the plates **80** and **82** openly diverge toward the face of the batt as illustrated in FIG. 5. The ends of the baffle plates are supported on end support brackets **84** which depend from the air box **60** adjacent opposite ends of the outlet port **66**. As best illustrated in FIG. 5, the upper edges **81** and **83** of the plates **80** and **82** are spaced closely together and close to the outlet port. Further, the edges **81** and **83** are spaced inwardly from the sides of the outlet port to divide air discharged therethrough into three zones, zone X between the plates, zone Y outboard of the plate **80** and zone Z outboard of the plate **82**.

The plates **80** and **82** are adapted for adjustment to vary selectively the angular relation of the plates to one

another and to the direction of flow of the air discharged from the outlet port whereby the flow pattern of the air in the vicinity of the batt may be varied to achieve the desired circulation for a given batt being processed. In order to facilitate selective adjustment of the baffle plates relative to one another and to the direction of flow of the treating medium through the air nozzle, each of the plates is pivotally mounted to the brackets **84** at opposite ends adjacent the inner longitudinal edge thereof, that is, the edge closest to the outlet port **71** in the box **60**. Thus each of the plates may be swung in the direction indicated by the arrow to selectively vary the angle of divergence of the plates **80** and **82**. In the present instance, each of the support brackets **84** is provided with an arcuate slot **86** therein to receive a screw fastener or the like **87** so that the plates may be pivoted to a desired position and secured in that position by the fastener **87**. By this arrangement, it has been found that the air from the outlet port diverted to zones Y and Z creates a slight suction or vacuum which draws or induces a small amount of air up through the batt in the zone X and hence creates a slight lofting of the batt. This induced circulation through the batt as indicated in FIG. 5, increases the drying rate and hence the drying efficiency of the dryer.

Consider now the operation of the dryer when processing a continuous run of fibrous material in the form of a batt. The batt B is delivered by suitable conveyor means to the lowermost conveyor **10** at the feed end of the dryer where the spray means S deposits a binder on the top face of the batt B. The conveyor **10** then advances the batt B for its first run through the dryer past the plurality of air boxes **60**. Drying medium circulated by the fan **50** enters the lowermost series of boxes through the distribution chamber **46** and the opening **62** in one end thereof. The air passing through the boxes and out each of the nozzles of the discharge outlet engages the baffles **80** and **82** disposed adjacent the nozzle discharge opening in the path of flow of the drying medium. The baffles serve to disperse the drying medium and divert the flow into three zones X, Y, and Z in a manner shown in FIG. 5 whereby a slight fluffing of the batt occurs in the region between the outer extremities of the baffles **80** and **82**, zone X. It has been found that this slight lofting of the fibers in this region is due to the pressure differential between the top face of the batt and the region below the batt which is caused by deflecting the air by means of the baffles. During the course of movement of the batt along the bottom conveyor **10**, curing of the binder takes place. The batt B then reverses direction around the roll R_1 and a binder is sprayed on the reverse side by the spray unit S_2 adjacent the second conveyor at the discharge end of the dryer. During movement of the batt through the dryer on the intermediate conveyor **12**, the drying medium again is directed into a plurality of air boxes **60** provided along the length of the conveyor which also has the baffle means **80** and **82**. The direction of the batt then is reversed around the rolls R_2 and makes a final pass through the dryer on the outermost conveyor **14**. It is noted that with respect to FIG. 3, the continuous circulation of air in the dryer housing is in the direction indicated by the arrows. Thus, as noted when the drying medium enters the discharge chamber from the air boxes, it passes up through a series of lint screens **72** which purify the air. The drying medium is then circulated by the heating means and drawn through the conditioning chamber **42** by the fan **50** and expelled to the distribution chamber **46**. An inlet opening **119** is provided in one wall of the housing having suitable damping means **121** to permit fresh air to be added to the air circulated in the dryer if desired.

The angular position of the baffles **80** and **82** depends on a number of variables such as velocity of the drying medium at the outlet port, type of fibers being processed, initial thickness of the batt, desired final thickness and density of the batt. The final adjustment of the baffles is therefore dependent on the operator who samples the batt after a short run and adjusts the baffles until the processed batts has the desired characteristics. It has been found that by processing fibrous material in the form of batts in this manner, the desired characteristics of the process batt, such as resilience, loft, density, final thickness and porosity, may be controlled accurately. Moreover, it has been found that efficient drying of the batt and efficient curing of the binder are achieved by the provision of the baffles in the region of the discharge nozzles.

While the present invention has been described in connection with fibrous material in the form of batts, it is readily apparent that it is also useful in treating or drying other fibrous or particulate materials and also thin thermoplastic films such as polypropylene. The invention also may be usefully applied in curing of rubber sheets and the like. In the case of thin films, it has been found that in prior dryers where the air impinged directly on the film there was the problem of rippling or distorting the surface of the film. It has been found that drying these films in a dryer constructed in accordance with the present invention, the baffles serve to effect circulation of the air in a manner to preclude formation of ripples and undesirable surface imperfections in the film.

While a particular embodiment of the present invention has been illustrated and described herein it is not intended to limit the invention and changes and modifications may be made therein within the scope of the following claims.

I claim:

1. Apparatus for treating material comprising an elongated generally enclosed housing, a treating chamber in said housing, means for conveying the material along a predeterminted path through said treating chamber, treating medium conditioning means including air distribution means having an outlet port through which treating medium is discharged confronting the material, and baffle means including at least one baffle plate extending lengthwise of said outlet port disposed angularly relative to the direction of flow of the testing medium and dividing the flow of treating medium into at least two zones on either side of the baffle and creating a difference in the velocity and pressure of the treating medium in said zones, the treating medium diverted to one of said zones creating a suction inducing a small flow of treating medium up through the material being treated in the other zone thereby creating a slight lofting of the material in said other zone.

2. Apparatus for treating material comprising an elongated generally enclosed housing, a treating chamber in said housing, means for conveying the material along a predetermined path through said treating chamber, treating medium conditioning means including air distribution means having an outlet port through which treating medium is discharged confronting the material, and a pair of elongated baffle plates extending coextensive with said outlet port and disposed angularly relative to one another and to the direction of flow of the treating medium from said outlet port thereby dividing the flow of treating medium into three zones, two outer zones and a center zone, said treating medium diverted to said outer zones creating a suction which draws treating medium up through the material in the center zone thereby to create a slight lofting of the material.

3. Apparatus as claimed in claim **2** wherein said baffle plates opently diverge toward the material and including means for selectively adjusting the angular relationship of the plates relative to one another.

4. Apparatus for treating material comprising an elongated generally enclosed housing, a treating chamber in said housing, means for conveying the material along a predetermined path through said treating chamber, treating medium conditioning means including at least one distribution box, said distribution box having an opening at one end and being closed at its opposite end and top and side walls which taper toward said closed end and an elongated outlet port in the bottom wall thereof con-

fronting the material whereby treating medium entering said open end is discharged through said outlet port at a substantially uniform velocity along the length of said outlet port, and baffle means including at least one baffle plate extending lengthwise of said outlet port disposed angularly relative to the direction of flow of the treating medium and dividing the flow of treating medium into at least two zones on either side of the baffle and creating a difference in the velocity and pressure of the treating medium in said zones, the treating medium diverted to one of said zones creating a suction inducing a small flow of treating medium up through the material being treated in the other zone thereby creating a slight lofting of the material in said other zone.

5. Apparatus for treating material comprising an elongated generally enclosed housing, a treating chamber in said housing, conveyor means for conveying the material along a predetermined path through said treating chamber, treating medium conditioning means including a plurality of air distribution boxes extending transversely of said conveyor and spaced along the entire length thereof, each of said boxes having outlet ports confronting the material through which treating medium is discharged and baffle means including at least one baffle plate extending lengthwise of said outlet port disposed angularly relative to the direction of flow of the treating medium and dividing the flow of treating medium into at least two zones on either side of the baffle and creating a difference in the velocity and pressure of the treating medium in said zones, the treating medium diverted to one of said zones creating a suction inducing a small flow of treating medium up through the material being treated in the other zone thereby creating a slight lofting of the material in said other zone.

6. Apparatus for treating material comprising an elongated generally enclosed housing, a treating chamber in said housing, conveyor means for conveying the material along a predetermined path through said treating chamber, treating medium conditioning means including a plurality of air distribution boxes extending transversely of said conveyor and spaced along the entire length thereof, each of said boxes having outlet ports confronting the material through which treating medium is discharged and a pair of elongated baffle plates extending coextensive with said outlet port and disposed angularly relative to one another and to the direction of flow of the treating medium from said outlet port thereby dividing the flow of treating medium into three zones, two outer zones and a center zone, said treating medium diverted to said outer zones creating a suction which draws treating medium up through the material in the center zone thereby to create a slight lofting of the material.

7. Apparatus for drying batts of non-woven, loosely compacted fibers comprising an elongated generally enclosed housing, a drying chamber in said housing, first conveyor means for transporting said batt through the drying chamber in one direction and second conveyor means for transporting the batt through the dryer in the opposite direction, spray means adjacent said first conveyor for applying a binder to one face of said batt and second spray means adjacent said second conveyor for applying a binder to the other face of said batt, drying medium conditioning means including a plurality of air distribution boxes disposed side by side along the length of said first and second conveyor means, each of said boxes having an outlet port through which treating medium is discharged, and baffle means including at least one baffle plate extending lengthwise of said outlet port disposed angularly relative to the direction of flow of the treating medium and dividing the flow of treating medium into at least two zones on either side of the baffle and creating a difference in the velocity and pressure of the treating medium in said zones, the treating medium diverted to one of said zones creating a suction inducing a small flow of treating medium up through the batt being treated in the other zone thereby creating a slight lofting of the batt in said other zone.

8. A method for treating material consisting of the steps of conveying material along a predetermined path through a treating zone, treating said material by means of a treating medium directed against at least one surface of said material, diverting by baffle means including at least one baffle plate extending lengthwise of said outlet port disposed angularly relative to the direction of flow of the treating medium and dividing the flow of treating medium into at least two zones on either side of the baffle and creating a difference in the velocity and pressure of the treating medium in said zones, the treating medium diverted to one of said zones creating a suction inducing a small flow of treating medium up through the material being treated in the other zone thereby creating a slight lofting of the material in said other zone.

9. A method for continuously drying material consisting of the steps of conveying the material along a predetermined path through a generally enclosed treating zone, controlling the treating conditions by means including circulating a conditioned treating medium against the material, and disposing baffle means including at least one baffle plate extending lengthwise of said outlet port disposed angularly relative to the direction of flow of the treating medium and dividing the flow of treating medium into at least two zones on either side of the baffle and creating a difference in the velocity and pressure of the treating medium in said zones, the treating medium diverted to one of said zones creating a suction inducing a small flow of treating medium up through the material being treated in the other zone thereby creating a slight lofting of the material in said other zone.

10. A method of continuously drying batts of non-woven, loosely compacted fibers consisting of the steps of spraying with a binder one face of the batt, conveying the batt through a generally enclosed drying zone, circulating a treating medium through the drying zone so that it is directed against the sprayed surface of said batt, spraying the other face of said batt, again conveying the batt through the drying zone with the second face confronting the treating medium, and providing baffle means including at least one baffle plate extending lengthwise of said outlet port disposed angularly relative to the direction of flow of the treating medium and dividing the flow of treating medium into at least two zones on either side of the baffle and creating a difference in the velocity and pressure of the treating medium in said zones, the treating medium diverted to one of said zones creating a suction inducing a small flow of treating medium up through the batt being treated in the other zone thereby creating a slight lofting of the batt in said other zone.

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