United States Patent

Candor et al.

[15] **3,657,069**

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[54] METHOD AND APPARATUS FOR TREATMENT OF SHEET-LIKE MATERIAL

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[52] **U.S. Cl.** **162/205,** 8/158, 34/151, 162/206, 162/297, 162/313, 162/358

[51] **Int. Cl.** **D21f 11/00,** D21f 5/08

[58] **Field of Search** 162/205, 210, 297, 312, 313, 162/314, 358, 361; 34/111, 155; 8/158, 159, 149.1, 149.2, 149.3, 151

[56] **References Cited**

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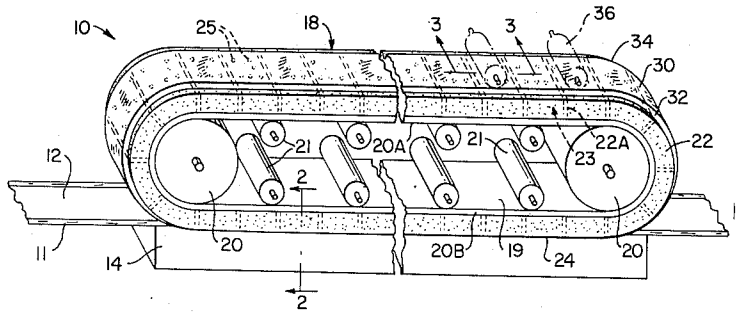
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[57] **ABSTRACT**

A sheet-like material such as a paper web or fabric web is treated with a fluid, for example, hot air or liquid dye. The material is carried by a permeable felt wire on which it is subjected to both pressure and direct fluid flow from a movable nozzle element. The nozzle element includes an endless support member driven by a pair of rollers and an outer flexible, chambered belt or sheet. The chambers of the flexible belt are provided with inlets through which the treating fluid, under pressure, is delivered thereto. The chambers are further provided with outlets or openings which allow the treating fluid to pass from the chambers. A porous sheet or belt is placed and secured around the flexible, chambered belt. In operation the sheet-like material passes through the apparatus on the permeable wire with the nozzle element moving in unison therewith. The treating fluid passes from the chambered belt, through the porous sheet into the material, with the pressure from the treating fluid maintaining the flexible belt, the porous sheet and material in a substantially sealed relation throughout the apparatus.

10 Claims, 6 Drawing Figures



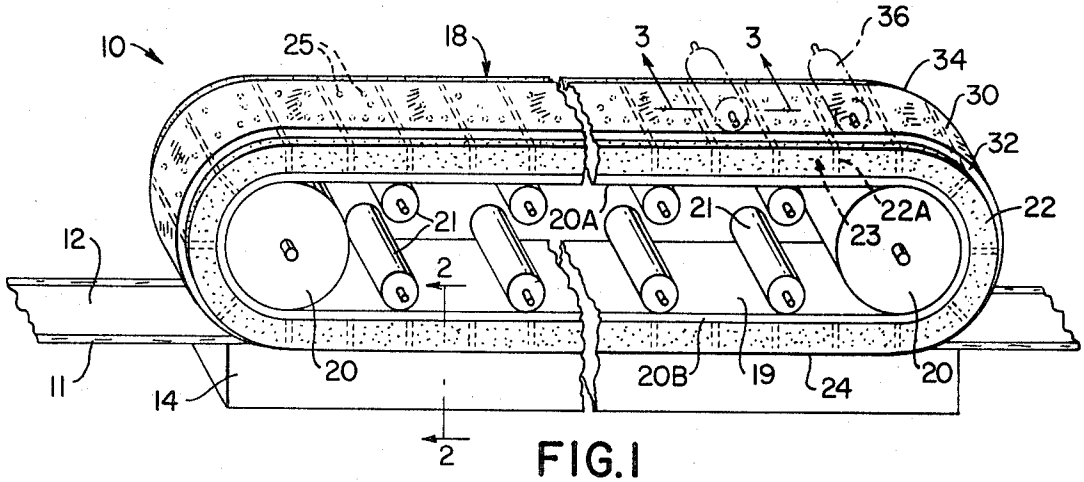


FIG.1

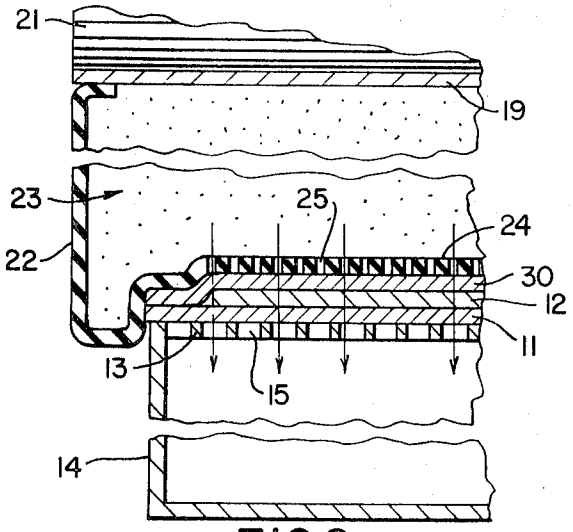


FIG.2

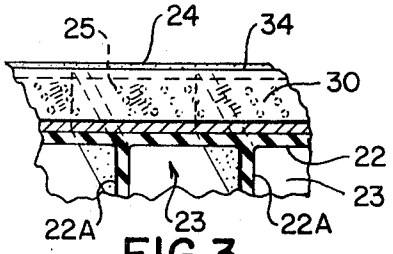


FIG.3

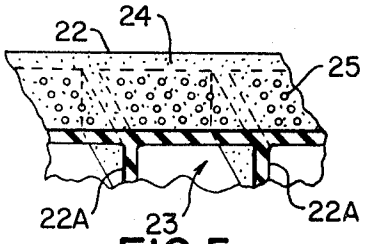


FIG.5

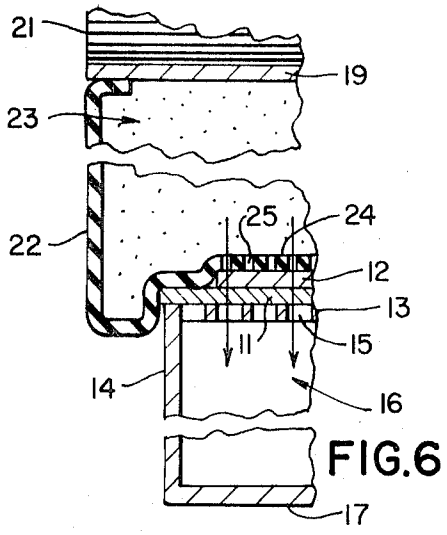


FIG.6

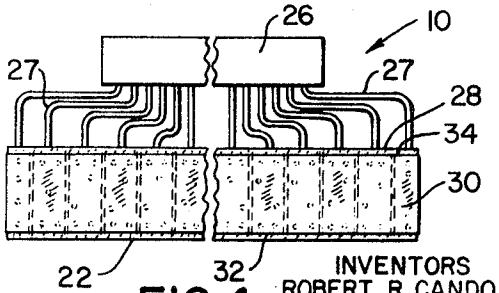


FIG.4

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METHOD AND APPARATUS FOR TREATMENT OF SHEET-LIKE MATERIAL

This application is related to applicant's copending application, entitled "METHOD AND APPARATUS FOR TREATING SHEET-LIKE MATERIAL AND THE LIKE," Ser. No. 868,396, filed Oct. 22, 1969, now Pat. No. 3592585 which is a continuation-in-part application of the copending patent application, Ser. No. 690,636, filed Dec. 14, 1967, now U.S. Pat. No. 3535428 and entitled "LAUNDRY APPARATUS OR THE LIKE," which, in turn, is a continuation-in-part application of its copending patent application Ser. No. 635,848, filed May 3, 1967, and entitled "LAUNDRY APPARATUS OR THE LIKE," now U.S. Pat. No. 3,447,174.

This instant application relates to a method and apparatus for treating sheet-like material such as paper webs, fabric webs, or other sheet material by causing a direct fluid flow between the material while it is being conveyed on a supporting means which may include a permeable sheet means and a flexible nozzle means engaging against the material during a portion of its travel on the supporting means. Such nozzle means may be at least partially covered by a porous sheet means.

In particular, it is well known from the U.S. Pat. to Holden, No. 3,284,285, that in the dewatering of fibrous webs, such as paper webs, a greater amount of dewatering thereof can take place if a pressure differential can be created across the web greater than the pressure differential provided by conventional suction box means. This patent also teaches that if the fibrous web can be under a compressed condition so that the moisture remaining therein will fill all voids in the material, the resulting pressure differential across such compressed web has a tendency to remove a greater amount of moisture therefrom than when the web is in an uncompressed condition.

Therefore, it is a feature of this invention to provide an improved method and apparatus for treating sheet material by providing a pressure differential across the same with a treating fluid whether the treating fluid is gaseous or liquid or both, as will be apparent hereinafter.

In particular, one embodiment of this invention provides a movable supporting means for receiving the sheet material and conveying the same through the apparatus in substantially flat form. Such movable supporting means may include a permeable sheet means. A movable nozzle is carried by the apparatus and has an end means provided with an opening means. Such opening means may be at least partially covered by a porous sheet means. Means are provided for causing the material to have a section thereof disposed between the end means of a nozzle means and to move in unison with the nozzle means and supporting means for a predetermined substantially straight line length of travel through the apparatus. Means are also provided for causing the end means of the nozzle means and the porous sheet means to be disposed in substantially sealed relation with the section of material during the predetermined length of travel through the apparatus. During such predetermined length of travel through the apparatus, a direct fluid flow is provided between the opening means of the nozzle means and the porous sheet means and the section of the material aligned between the opening means and the supporting means to treat that section of material with the fluid. The nozzle means comprises a flexible sheet means at least partially surrounding the opening means and defining the nozzle end means, the means for causing the end means to be disposed in substantially sealed relation with the section of material comprising means for creating a pressure differential across the sheet means to cause one side thereof to tend to press against the material on the supporting means during the predetermined length of travel of that section of material through the apparatus.

Accordingly, it is an object of this invention to provide an improved apparatus for treating a substantially sheet-like material and the like with fluid, the apparatus of this invention having one or more of the novel features set forth above or hereinafter shown or described.

Another object of this invention is to provide an improved method for treating substantially sheet-like material and the like with a fluid, the method of this invention having one or more of the novel features set forth above or hereinafter shown or described.

Other objects, uses and advantages of this invention are apparent from a reading of this description which proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIG. 1 is a schematic perspective view illustrating the improved method and apparatus of this invention.

FIG. 2 is an enlarged, fragmentary, cross-sectional view taken substantially on line 2—2 of FIG. 1 with the inside surface of the flexible wall being stippled to illustrate its flexibility.

FIG. 3 is a schematic perspective view with a front cross-sectional view taken along the line 3—3 of FIG. 1.

FIG. 4 is a schematic top view of the apparatus of FIG. 1 and illustrates the method for supplying fluid under pressure to the nozzle means of the apparatus.

FIG. 5 is a view similar to FIG. 3 and showing the apparatus of FIG. 1 used without the felt belt on the outer surface of the movable nozzle means.

FIG. 6 is a view similar to FIG. 2 but showing the apparatus as used in FIG. 5.

While the various features of this invention are hereinafter described and illustrated as being particularly adapted for treating fibrous webs, such as paper sheets, carpeting, etc., it can be understood that the various features of this invention can be utilized singly or in any combination thereof to provide methods and apparatus for treating other types of material as desired, such as nonmoisture bearing or absorbing materials.

Therefore, this invention is not to be limited to only the embodiments illustrated in the drawings, because the drawings are merely utilized to illustrate one of the wide variety of uses of this invention.

Referring first to FIGS. 1, 5 and 6, the improved method and apparatus of this invention is generally indicated by the reference numeral 10 and comprises a movable foraminous supporting means 11 formed of metal, fibre or any other suitable material and being adapted to convey flat sheet-like material 12 from left to right in FIG. 1 through the apparatus 10, the flat sheet-like material 12 being fibrous paper stock, carpeting, etc., as will be apparent hereinafter.

The supporting belt 11 is adapted to pass over the upper side 13 of conventional section box means 14 having the upper side 13 thereof provided with perforations or openings 15 leading to the internal chamber means 16 thereof which is adapted to be evacuated by conventional suction means in a manner well known in the art or merely remain at atmospheric condition and be provided with suitable drain means in the bottom wall 17 thereof for removing moisture from the chamber 16 as the same accumulates therein in a manner hereinafter described.

As previously stated, the U.S. Pat. to Holden, No. 3,284,285, clearly teaches that it is desirable to create a high pressure differential across the sheet-like material 12 to remove moisture therefrom in a dewatering operation by causing a flow of high pressure air through the material 12 and the foraminous supporting means 11 into the chamber 16 at a force greater than can be provided solely by the result of the chamber 16 being evacuated by conventional suction means. In addition, the U.S. Pat. to Holden, No. 3,284,285, teaches that if the material 12 can be compressed so as to cause the moisture therein to fill all of the voids of the fibrous material 12 so as to provide a substantially continuous, sheet-like moisture layer therein, such pressure differential across the sheet means 12 removes the moisture in a manner more effective than merely by an entrainment of such moisture in the air rushing through the material 12.

However, the U.S. Pat. to Holden, No. 3,284,285, does not provide means for effectively compressing the sheet-like material 12 in a sealed manner while conforming to the exterior contour of the sheet material 12.

It will be apparent that the features of this invention do provide means for providing the high pressure differential across the sheet-like material or sheet means **12** for the aforementioned dewatering purposes as well as for applying or impregnating liquid, such as dye or the like, into the material **12**, if desired, while compressing such material **12** against the support means **11** and effectively sealing against the sheet-like material **12** regardless of its exterior contour.

Therefore, a flexible nozzle means is provided for the apparatus **10** of this invention to act on the sheet-like material **12** while it is being conveyed in substantially flat form through the apparatus **10**, the nozzle means being generally indicated by the reference numeral **18** in FIGS. **1–6**.

The flexible nozzle means **18** comprises a continuous backing member **19** formed of metal, plastic or other suitable material to permit the same to be looped around a pair of roller means **20** and be driven thereby in a counterclockwise direction at substantially the same speed of movement of the foraminous supporting means **11** from left to right in FIG. **1**, the upper and lower runs **20A** and **20B** of the supporting member **19** being supported intermediate the outboard rolls **20** by a plurality of backup rolls **21** as diagrammatically illustrated and sufficiently close to each other to maintain the runs **20A** and **20B** substantially straight and parallel to the path of movement of the support means **11**. If desired, the rolls **20** and **21** can be closer or spaced more than illustrated to maintain the runs **20A** and **20B** substantially straight as previously described.

A plurality of flexible sheet means **22** are interconnected to the backing member **19** in such a manner that each flexible sheet means **22** defines a chamber **23** separated by integral radial or outward walls **22A** connected to the backing member **19**. Each chamber **23** has a bottom or outer wall means **24** (in FIGS. **2** and **6**) provided with a plurality of perforations or opening means **25** passing therethrough and being so controlled in the size and relationship thereof relative to each other that such opening means **25** will be arranged to engage against the sheet material **12** when the same is aligned therebetween in the manner illustrated in FIG. **6**.

The flexible nozzle means **18** of this invention can be used without a surrounding porous belt in such a manner that the flexible sheet means **22** will be arranged to engage directly against the sheet material **12** as shown in FIGS. **5** and **6** when the apparatus of FIG. **1** is sued without the felt or porous belt to be later described in connection with FIGS. **1, 2** and **3**.

The flexible sheet means **22** can be one continuous sheet means with internal chambers **23** being formed therein separate from each other to produce the same effect as provided by the individual sheet means **22** illustrated in FIGS. **1, 2** and **3**, of the copending application entitled "METHOD AND APPARATUS FOR TREATING SHEET-LIKE MATERIAL AND THE LIKE."

In any event, the interiors of the chambers **23** of the flexible sheet means **22** of the instant application are adapted to be supplied with fluid under pressure from a valving means **26**, FIG. **4**, in any of the manners set forth in the last-named copending application or in the aforementioned U.S. Pat. No. 3,447,174, and/or the copending patent application, Ser. No. 635,848 through individual conduit means **27** fluidly interconnected to the chambers **23** of the flexible sheet means **22** at the side wall means **28** thereof as illustrated in FIG. **4** whereby as each individual chamber **23** moves in a counterclockwise direction in FIG. **1**, its respective conduit means **27** will follow such movement at both ends thereof and continuously supply fluid pressure thereto.

However, it is to be understood that the valve means **26** could be so constructed and arranged that when a particular chamber **23** passes to the right beyond the right-hand roller **20** to cross the top run **20A** and just before the same engages against the sheet means **12** at the left-hand roller means **20**, no fluid pressure would be supplied to that particular chamber **23**, as desired.

Therefore, it can be seen that as the particular flexible sheet means **22** of FIG. **1**, **5** and **6** engages against the travelling sheet means **12** at the left-hand roller means **20**, such sheet means **22** moves in unison therewith for a substantially straight line path through the apparatus **10** until that particular sheet means **22** begins to move around the right-hand roller means **20**. However, while that particular sheet means **22** is moving between the left-hand and right-hand roller mans **20** at the lower run **20B** of the nozzle means **18**, the fluid pressure being directed into the chamber **23** thereof creates a pressure differential across the wall **24** and causes the same to pressure and squeeze against the sheet means **12** to compress the sheet means **12** against the foraminous means **11** to not only tend to squeeze the liquid therefrom, but also to tend to cause the remaining liquid in the material **12** to fill all voids of the material **12** for the advantageous reasons set forth in the aforementioned U.S. Pat. to Holden, No, 3,284,285, the sheet means **22** at the same time directing fluid under pressure out through the perforations **25** thereof and directly through the sheet material **12** and foraminous supporting means **11** into the opening means **15** of the box means **14**. If desired, the interior **16** of the box means **14** can be interconnected to a vacuum source so as to further enhance the pressure differential acting across the sheet means **12** for the dewatering or drying purpose previously described.

Of course, the fluid under pressure being delivered to the chambers **23** of the sheet means **22** can be heated air or the like to further enhance the drying effect of the apparatus **10** on the material **12**.

Also, it is to be understood that the fluid being directed to the chambers **23** of the sheet means **22** could be a liquid, such as a die or the like, so as to effectively impregnate the material **12** in a believed to be more efficient manner than prior art devices for such purposes.

In any event, it can be seen that since the sheet means **22** each has a flexible lower end **24**, (when located as in FIG. **6**) such lower end **24** fully conforms to the exterior contour of the sheet means **12** so as to provide effective sealing around each perforation **25** thereof against the sheet means **12** and by so arranging the perforations **25** across the lower wall **24**, such perforations **25** can be located just in the region of the sheet means **12** so that there is no escape of fluid from the chamber means **23** through the supporting means **11** outboard of the sheet means **12**, if desired. However, it is to be understood that if the perforations **25** are sufficiently sized, even perforations **25** outboard of the sheet means **12** will not adversely affect the operation of the sheet means **22** forcing fluid through the other perforations **25** inboard of the sheet means **12** for the reasons previously set forth.

Therefore, it can be seen that the flexible nozzle means **18** of the apparatus and method **10** of this invention engages against the material **12** for a predetermined substantially straight line length of travel thereof through the apparatus **10** with the flexible sheet means **22** pressing against the material **12** to not only squeeze the same, but also to seal the openings **25** thereof against the sheet means **12** so that a direct flow will be provided between the chambers **23** of the sheet means **22** through the sheet means **12** to remove moisture therefrom or to drive liquid therein, the squeezing and sealing action being provided by the resulting pressure differential being created across the end walls **24** of the sheet means **22** with such pressure differential being increased by providing suction means on the other side of the sheet means **12**, such as by the suction box means **14** illustrated and previously described.

If desired to further understand the function and operation of the sheet means **22** previously described, reference is made to applicants' previous copending application, Ser. No. 868,396, filed Oct. 22, 1969, and entitled "METHOD AND APPARATUS FOR TREATING SHEET-LIKE MATERIALS AND THE LIKE," wherein in FIGS. **4** and **5** a single nozzle means is described in connection with a laundry apparatus as set forth in the aforementioned issued U.S. Pat. No. 3,447,174, it being understood that while the nozzle means

moves in a circular path and the supporting means is cylindrical, the hereinafter described features and functions can be readily applied to a straight run moving sheet means in the manner provided by the nozzle means 18 of the apparatus 10 previously described.

Said previous copending application also refers to applicants' U.S. Pat. No. 3,344,447 and explains certain principles. However, it is believed unnecessary to repeat such explanations in the instant application.

In the embodiment disclosed in the instant application, FIG. 1, taken with FIGS. 2, 3 and 4, the main action is the same as previously described in connection with FIGS. 1, 5 and 6 except that an outer porous sheet means or porous belt 30, with edges 32, 34, and made of felt or similar material, is placed and secured around the flexible sheet means 22. The belt 30 may be secured to the flexible sheet means 22 by any suitable means, such as by an adhesive or the like.

The lower run 20B of the belt 30, as shown in FIG. 2, presses against the sheet material 12. The flow or pressure of air, or the like, from chamber means 23 passes through openings 25 of the flexible lower end 24 of sheet means 22. Then the flow or pressure is through the outer porous sheet means or porous belt 30, and against and through the sheet material 12.

The sheet material 12 is then pressed against permeable sheet means 11 which may be a felt sheet, or a metal screen or a combination of a metal screen and permeable sheet means or felt sheet, as desired.

The permeable sheet means 11 may be supported on the foraminous supporting means 13 with perforations or openings 15.

Thus the dewatering action on the sheet-like material 12, as illustrated in FIG. 2, may include downward pressure by a porous sheet means and 30 downwardly pressed by the flexible lower end 24 of the sheet means 22.

Such dewatering action may also include the upward supporting action of the foraminous supporting means 13 supporting the permeable sheet means or permeable felt sheet 11 with or without an intermediate metal screen (not shown) between the felt sheet 11 and the foraminous supporting means 13.

Thus the sheet-like material 12 is compressively dewatered between an upper porous sheet means or felt means 30 and a lower permeable sheet means or felt means 11.

Alternatively, the lower permeable sheet means 11 may be a metal screen without the felt means.

If desired, removing means may be provided for removing dirt and/or gas or liquid from the porous sheet means 30 during the upper or return run 20A of said porous sheet means 30. For example, such removing means may include one or more suction rolls 36 adjacent said porous sheet means 30 at said upper or return run 20A of said porous sheet means 30. The porous sheet means or felt belt 30 then returns to the lower run 20B after being beneficially improved by such removing means.

However, the felt belt 30 may be made longer than the flexible sheet means 22 during such upper run 20A, so that such felt belt may be treated separately from the flexible sheet means 22. Thereafter the separated felt belt 30 may be returned into contact with flexible sheet means 22 for travel together in the run 20B.

In view of the above, it can be seen that the nozzle means 18 of FIGS. 1, 2, 3 and 4 of this application can provide an improved dewatering action by the selection of an upper porous sheet means or felt belt 30 and a lower permeable sheet means or felt sheet 11.

Also, if desired, in such FIGS. 1, 2, 3 and 4 the lower permeable sheet means 11 may be combined metal screens supporting a felt sheet, or the metal sheet screen can be used alone.

In FIGS. 5 and 6, with partial reference also to FIG. 1, it can be seen that the flexible sheet means 22 of FIGS. 5 and 6 may be used without the felt belt 30, so that the bare flexible sheet means 22, with its bare bottom or outer wall surface 24 engaging the upper surface of the sheet-like material 12, in FIG. 6, and applying its air pressure and air flow through openings 25 against and through such upper surface of material 12. The lower surface of material 12 may be supported by the permeable sheet means 11 which may be a permeable felt sheet, a metal screen, or a combined metal screen and felt sheet as desired.

The nozzle means 18 of FIGS. 1-6 can have the size and number of openings 25 formed in the end wall 24 so controlled relative to the magnitude of the fluid pressure being directed into the chambers 23 that the optimum results are obtained on the sheet means 12 without squeezing the same to an adverse degree while still substantially forcing and removing the moisture in the manner previously described.

Accordingly, it can be seen that this invention provides an improved apparatus and method for treating sheet-like material and the like.

What is claimed is:

1. Apparatus for treating sheet-like material comprising movable engaging means including a permeable sheet means for engaging said material and at least assisting in the conveying of the same through said apparatus in substantially sheet form, movable nozzle means carried by said apparatus and having an end means provided with at least one opening, said end means and opening being at least partially covered at least part of the time by a flexible porous sheet means wherein said material has a section thereof disposed between said porous sheet means while said porous sheet means is covering said nozzle end means and said engaging means to move in unison with said porous sheet means and said engaging means for a predetermined length of travel through said apparatus, means for causing said end means of said nozzle means and said porous sheet means to be disposed in substantially sealed relation with said section of material during said predetermined length of travel through said apparatus, and means for causing a direct fluid flow from said opening and through said porous sheet means and into said section of material aligned between said opening means and said engaging means to treat said section of material with said fluid, said nozzle means comprising flexible sheet means including said opening and defining said nozzle end means, said means for causing said direct fluid flow also causing said end means and porous sheet means to be disposed in said substantially sealed relation with said section of material by creating a pressure differential across said flexible sheet means and porous sheet means to cause one side thereof to tend to press against said material and thereby press said material against said engaging means.

2. Apparatus as set forth in claim 1 wherein said means for causing said direct fluid flow comprises means for directing said fluid under pressure to said nozzle means and out through said opening means thereof and through said porous sheet means into said particular section of material.

3. Apparatus as set forth in claim 1 wherein said porous sheet means is a felt sheet means and wherein said permeable sheet means is another felt sheet means.

4. Apparatus as set forth in claim 1 wherein said engaging means and said nozzle means convey said section of material in a substantially straight line length of travel through said apparatus.

5. Apparatus as set forth in claim 1 wherein said engaging means comprises supporting means for receiving said material thereon and for conveying the same through said apparatus.

6. Method for treating sheet-like material comprising the steps of said material on supporting means including a permeable sheet means, moving said supporting means to convey said material providing an engaging means that includes a permeable sheet means for engaging said material to at least assist in conveying said material in substantially sheet form, causing said material to have a section thereof disposed between an end means of a movable nozzle means at least partially covered at least part of the time by a flexible, porous sheet means and said engaging means while said end means is covered by said porous sheet means to move in unison with

said nozzle means and said porous sheet means and said engaging means for a predetermined length of travel, moving said end means of said nozzle means and said porous sheet means in substantially sealed relation with said section of material during said predetermined length of travel of said section of material, and creating a direct fluid flow through at least one opening in said end means of said nozzle means and through said porous sheet means and into said section of material aligned between said porous sheet means and said engaging means to treat said section of material with said fluid, said step of moving said end means of said nozzle means and said porous sheet means in substantially sealed relation with said section of material comprising the step of creating a pressure differential across a flexible sheet means of said nozzle means and that includes said opening thereof and defines said end means and said porous sheet means to cause one side of said flexible sheet means and said porous sheet means to tend to press against said material and thereby press said material against said engaging means.

7. A method as set forth in claim **6** wherein said step for creating said direct fluid flow comprises the step of directing said fluid under pressure to said nozzle means and out through said opening thereof and through said porous sheet means into said particular section of material.

8. A method as set forth in claim **6** wherein said porous sheet means is a felt sheet means and wherein said permeable sheet means is another felt sheet means.

9. A method as set forth in claim **6** wherein said step of causing said material to have a section thereof disposed between said end means of said movable nozzle means and said engaging means includes the step of conveying said section of material in a substantially straight line length of travel in a particular direction as said nozzle means, porous sheet means, engaging means and section of material move in unison.

10. A method as set forth in claim **6** wherein said engaging means comprises supporting means and including the steps of disposing said material on said supporting means, and moving said supporting means to convey said supported material.

* * * * *

Disclaimer

3,657,069.—*Robert R. Candor*, Miami Township and *James T. Candor*, Washington Township, Montgomery County, Ohio. METHOD AND APPARATUS FOR TREATMENT OF SHEET-LIKE MATERIAL. Patent dated Apr. 18, 1972. Disclaimer filed Apr. 16, 1971, by the inventors.

Hereby disclaims the portions of the term of the patent subsequent to Jan. 18, 1989.

[*Official Gazette March 13, 1973.*]