METHOD FOR PRODUCING NONWOVEN FABRICS

Original Filed July 21. 1971 3 Sheets-Sheet 1

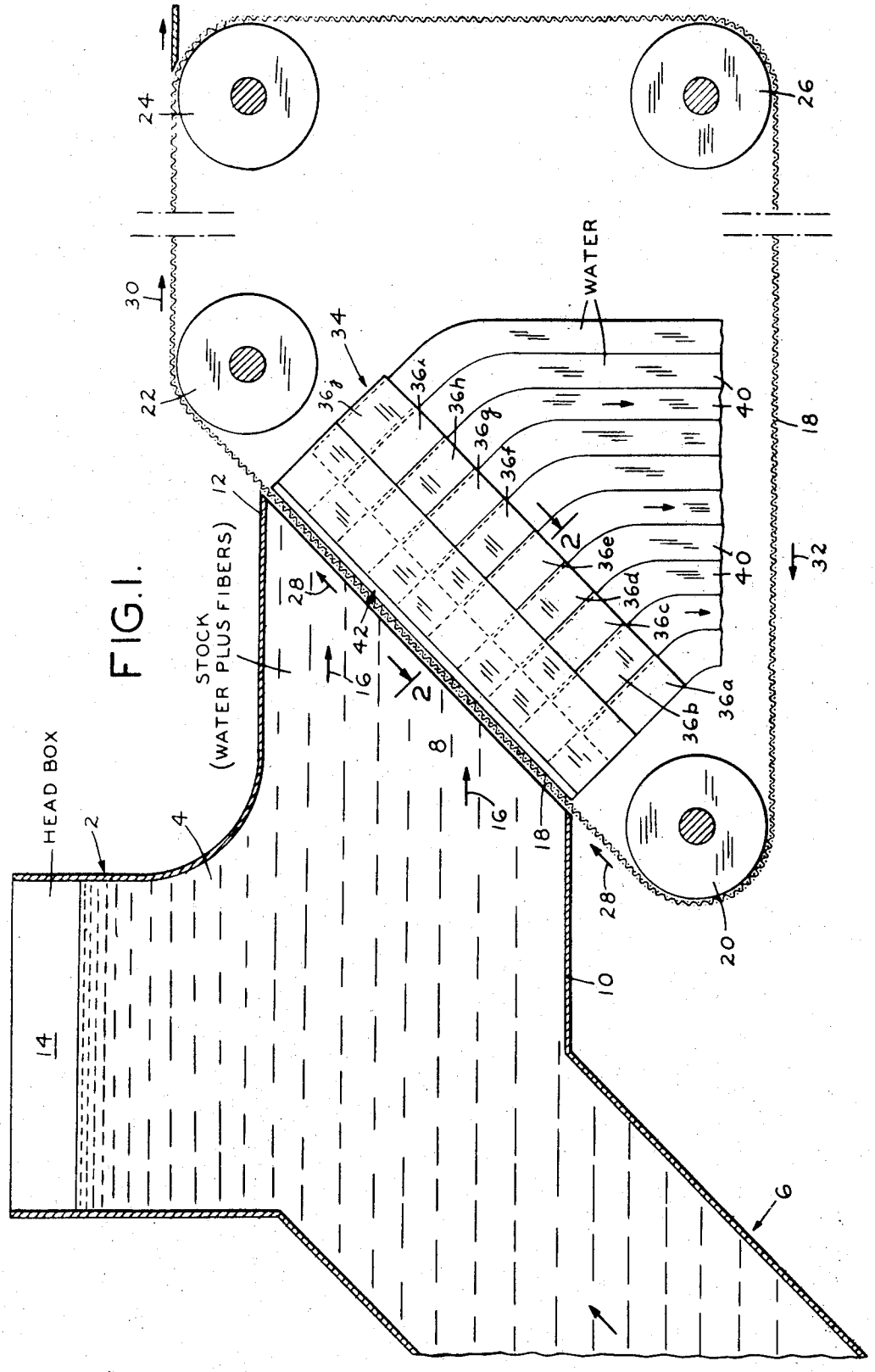


FIG. 1.

METHOD FOR PRODUCING NONWOVEN FABRICS

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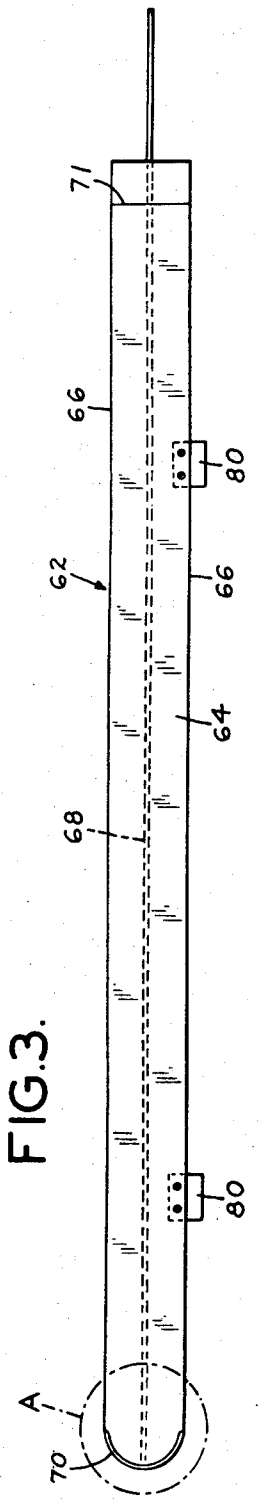


FIG.3.

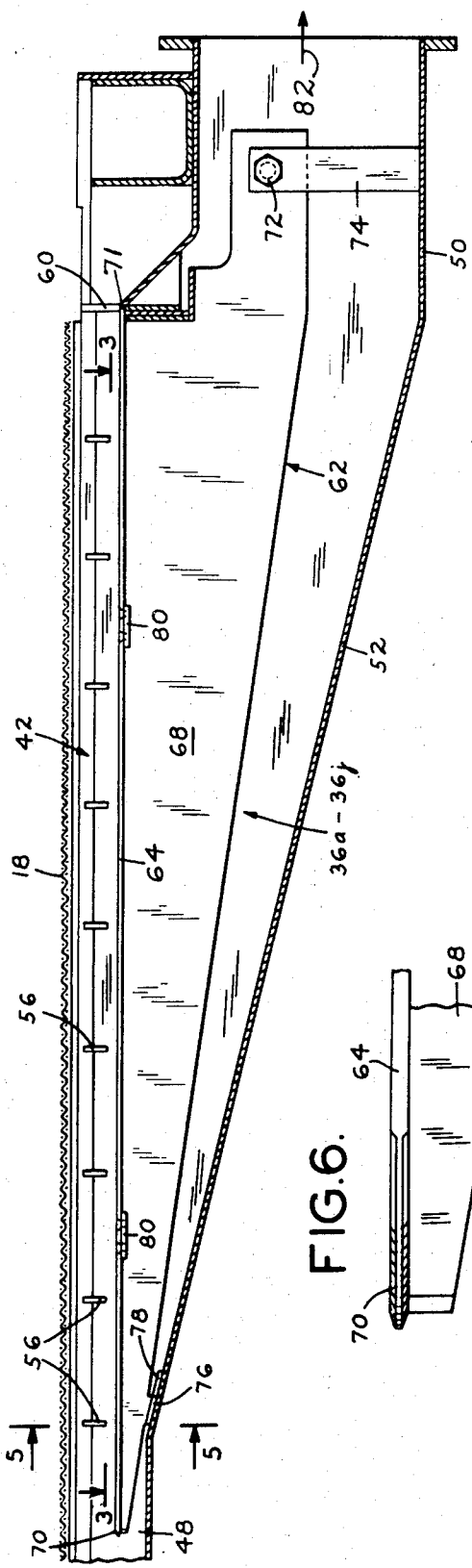


FIG.2.

FIG.6.

METHOD FOR PRODUCING NONWOVEN FABRICS

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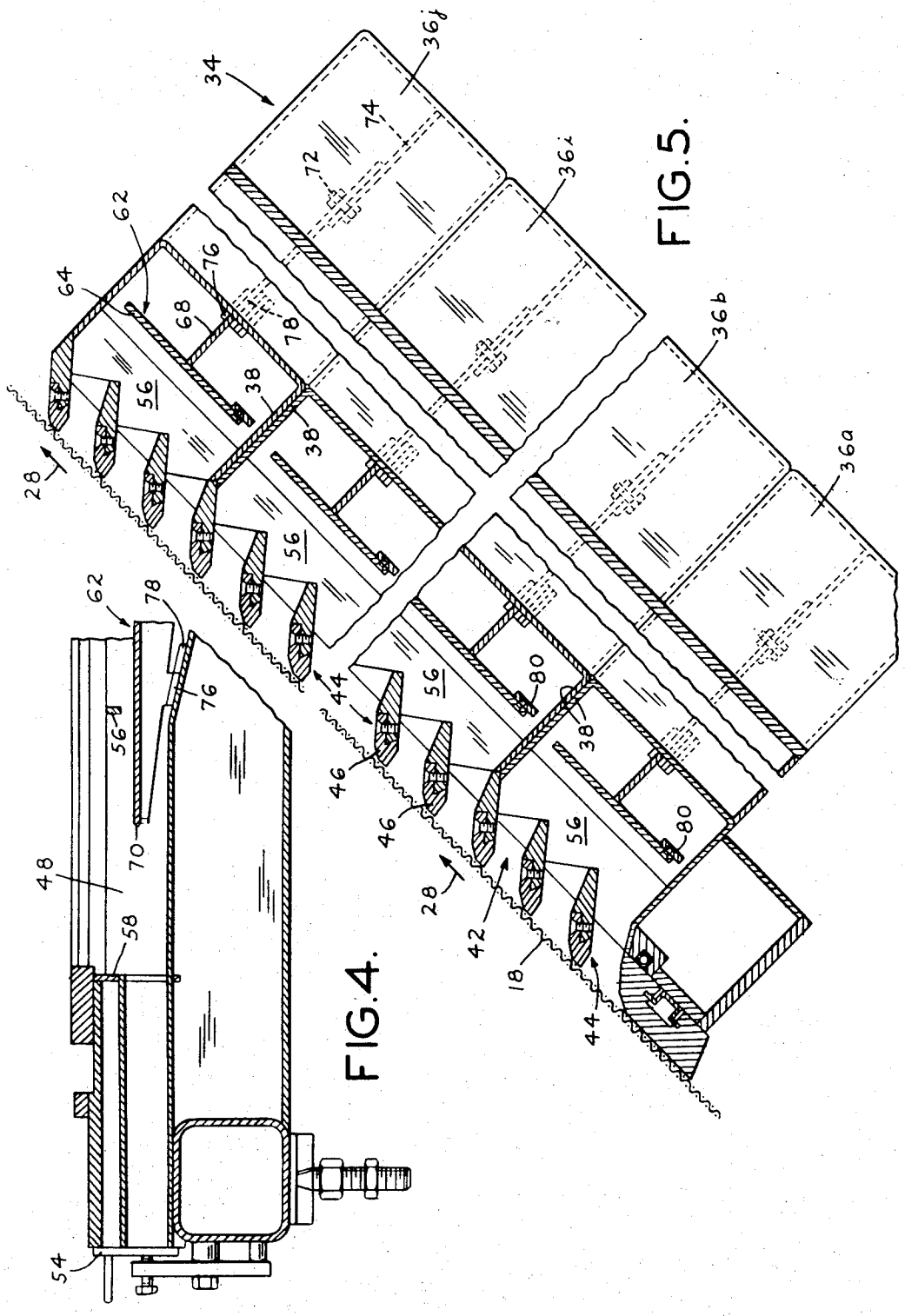


FIG.5.

FIG.4.

United States Patent Office 3,832,283 Patented Aug. 27, 1974

3,832,283

METHOD FOR PRODUCING NONWOVEN FABRICS

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Continuation of application Ser. No. 164,499, July 21, 1971, now Patent No. 3,764,465, dated Oct. 9, 1973.
This application Aug. 15, 1973, Ser. No. 388,438
The portion of the term of the patent subsequent to Oct. 9, 1990, has been disclaimed
Int. Cl. D21f 11/02
U.S. Cl. 162—211 1 Claim

ABSTRACT OF THE DISCLOSURE

A method for making nonwoven fabrics wherein water and fiber stock is delivered to a Fourdrinier wire moving endlessly through a stock tank, the fibers being deposited on the wire in a forming zone and the water passing through said wire into a suction box comprising a plurality of adjacent and individually controlled compartments, each of said compartments having a bottom sloping in a direction transverse to the direction of travel of said wire and each of said compartments having a flow restricting device such as a baffle mounted therein, wherefor a substantially uniform pressure differential through the moving wire across its width is obtained so as to result in an even deposit of fibers thereon.

This application is a continuation of application Ser. No. 164,499, filed July 21, 1971, now U.S. Pat. 3,764,465, issued Oct. 9, 1973.

This invention relates to a method for making nonwoven fabrics from fibrous material, and more particularly to a method for controlling the flow of liquid in a suction chamber operating beneath the forming wire on the wet end of a papermaking machine of the Fourdrinier type.

Nonwoven fabrics may be made by a wet process wherein fibers from a water plus fiber stock are deposited on a Fourdrinier wire driven endlessly through a stock tank along an inclined path on a papermaking, or papermaking type of machine. The endless wire enters at the bottom of the tank and is discharged from the top of the tank. As the wire travels upwardly along the inclined path through the tank, the fibers are deposited on the top of the wire, which we refer to as the "papermaking interface," and the liquid drawn through the wire is discharged through a suction chamber located beneath the wire. The area in which the fibers are deposited on the wire is referred to as the forming zone. In machines of this type it is desirable to have an even deposit of fibers across the width of the wire as it travels along its inclined path through the forming zone. This will aid in achieving a uniform basis weight in the nonwoven fabric produced, i.e., a fabric wherein every sheet of the same size will have the same weight.

It is known to provide a suction box beneath an inclined, endlessly moving Fourdrinier wire in which the suction box is open toward the bottom of said wire and is comprised of a plurality of individually controlled compartments in side-by-side relationship, thus forming a continuous train of suction chambers over which the endless wire passes. Such a structure is shown in Ploetz et al. Pat. No. 3,190,790. However, we are aware of no device in which the pressure drop across the papermaking interface and thus the rate of flow of liquid through the Fourdrinier wire in the forming zone can be controlled to assure a relatively uniform deposit of fibers across the

width of the wire as it passes over each of the several compartments of the suction box in the forming zone.

It is the object of the present invention to provide a suction box in association with a papermaking machine of the Fourdrinier type in which the flow of liquid through the moving Fourdrinier wire as it passes through the forming zone may be controlled to provide a substantially uniform flow of liquid therethrough, thus producing an even deposit of fibers across the width of the moving wire.

Another object of the invention is to achieve a substantially uniform pressure differential or pressure drop through a moving Fourdrinier wire in a direction across the width of the wire as the wire passes through the forming zone of a papermaking machine.

Another object of the invention is to achieve a substantially uniform pressure below the moving wire at points across the width of the wire and in a direction transverse to the direction of travel of the wire in order to obtain a uniform flow of liquid through the wire.

Another object of the invention is to provide a suction box comprising a series of separate compartments in side-by-side relationship, each of the compartments having separate and individually controllable means to regulate the rate of flow of liquid passing therethrough and to provide a substantially uniform rate of flow within each compartment across the width of a moving Fourdrinier wire at the papermaking interface as the wire passes through the forming zone.

We have found that these and other objectives may be accomplished by providing a suction box having a plurality of identically shaped and individually controlled compartments each of which has a bottom sloping in a direction transverse to the direction of travel of a Fourdrinier wire and within each of which is mounted a flow restricting device such as a baffle as hereinafter described.

The invention will be more fully understood from the following description and patent drawings in which

FIG. 1 is a fragmentary elevational view, partly in section, schematically representing a papermaking machine embodying the apparatus of the instant invention.

FIG. 2 is a detailed view, partly in section, taken through one of the compartments of the sloping bottom suction box, and including one of the baffles of our preferred form. The view is taken in the direction of the arrows substantially along the line **2—2** of FIG. 1.

FIG. 3 is a top plan view of one of the baffles taken in the direction of the arrows substantially along the line **3—3** of FIG. 2.

FIG. 4 is an enlarged view of the small end of the suction box, taken in the same direction as FIG. 2, and showing the relationship between the tip of one of the baffiles and the small end of one of the compartments of the suction box.

FIG. 5 is a fragmentary detailed view, partly in section, taken in the direction of the arrows substantially along the line **5—5** of FIG. 2, and showing several of the individual compartments of the suction box.

FIG. 6 is an enlarged side elevational view of that portion of the tip of the baffle shown within circle A of FIG. 3.

Referring to the drawings, and particularly to FIG. 1, the apparatus of the invention includes a head box or stock tank generally designated **2** containing stock **4** consisting of water plus fibers in suspension, supplied to the head box through stock inlet **6** located at one end portion of the head box.

End **8** of the head box a discharge opening inclined upwardly in the direction of stock discharge between bottom wall portion **10** and upper wall portion **12**. The upper and lower wall portions, together with side walls **14** (only one of which is shown) of the head box form a discharge

channel through which the stock flows, generally in the direction of arrows **16** toward the inclined opening in the head box. The precise shape of the head box is not directly relevant to the present invention and need not be further described.

An upwardly inclined portion of an endless Fourdrinier wire **18** which is driven in conventional manner around breast roll **20** and rolls **22, 24, 26** in the direction of the arrows **28, 30, 32** passes adjacent and beneath the upwardly inclined discharge opening of the head box.

Between breast roll **20** and roll **22** there is a suction box generally designated **34** comprising a plurality of individual compartments **36***a* through **36***j* joined together in side-by-side relation at the side walls **38** thereof as by welding (see FIG. 5). Each of the several compartments **36***a–j* is provided at one end with a separate discharge pipe **40** connected through a separate control valve (not shown) to a separate barometric drop leg (not shown) for removal of liquid from each of the compartments **36***a–j*. Conventional flow meters are also connected to each of the individual compartments **36***a–j* of the suction box *34* to measure the rate at which liquid is discharged therefrom. One or more of the uppermost compartments of the suction box, for example, those designated **36***h–j*, may also be individually connected to separate vacuum pump means for removal of air therefrom should it be desirable to operate the upper compartments of the suction box other than when completely filled with liquid.

Suction box **34** encloses that portion of the wire **18** which passes beneath the inclined opening in head box **2** (the forming zone) and has a length essentially the same as the enclosed length of the inclined portion of the wire **18** as it passes beneath the inclined opening of the head box. The width of suction box **34** is essentially the same as the width of wire **18**. Suction box **34** is open toward the bottom of wire **18** and is provided with a slotted cover generally designated **42** having deflector foils **44** mounted therein (FIGS. 2 and 5). Deflector foils **44**, the tips of which **46** may be made of a replaceable plastic material, such as polyethylene, extend transversely across the width of wire **18** and provide slidable support for the moving wire as it passes in its inclined path from roll **20** to roll **22** through the forming zone.

It should be understood that appropriate means are provided to tension the wire and effect seals between the wire and the head and suction boxes as the wire passes through the forming zone. These tensioning and sealing devices are not directly relevant to the present invention, have been omitted from the drawings, and do not require further description.

Referring to FIG. 2, there is shown one of a plurality of comparments **36***a–j* of suction box **34**. Each of the compartments has a small end **48**, a discharge end **50** for connection through conventional means (not shown) to a discharge pipe **40** (see FIG. 1), a bottom portion **52** sloping in a direction transverse to the direction of travel of the Fourdinier wire **18**, and parallel transverse side walls **38** (see FIG. 5). The small end of one of the compartments, shown in enlarged section in FIG. 4, may be closed as by a removable cap **54** for ready access to the interior of the compartment for cleaning. Each compartment in its upper portion is provided with a plurality of cross ribs **56** extending between the side walls **38**, and end members **58** and **60** to upport slotted cover **42** with is deflector foils **44**.

Within each of the compartments **36***a–j* of suction box **34** is shown one embodiment of a baffle that may be utilized in our invention. The baffle is generally designated **62** and is of T-shaped cross section. The baffle has a flat top portion **64** with parallel sides **66** and a perpendicularly depending flat sided web portion **68** located intermediate the longitudinal edges of the top portion. The top portion has an arcuately shaped tip **70**, the edges of which may be beveled slightly, as is clearly shown in FIG. 6. Web section **68** is essentially triangular in shape, conforming generally to the cross sectional shape of each compartment **36***a–j* of the suction box as shown in FIG. 2. Baffle **62** is rigidly supported at the discharge end **50** of compartment **36** as by a pin **72** mounted in bracket **74**. The small end of baffle **62** is provided with foot or pad **76** which is in supporting engagement with the sloping floor **52** of compartment **36** near its small end **48**. The foot or pad **76** is secured against side-to-side movement within the compartment by engagement with suitable short strips **78** welded to the sloping floor of the compartment. Suitable guide members **80** may be attached to the top portion **64** of the baffle for alignment purposes.

In the embodiment shown, baffle **62** is positioned within compartment **36** so that the parallel sides **66** of top portion **64** are equally spaced from but parallel to the transverse side walls **38** of compartment **36**; the bottom edge of web **68** is above but spaced from the floor **52** of compartment **36** except for that portion of foot **76** thereof that is in supporting engagement with the floor. The tip **70** of the baffle extends substantially but not completely into the full depth of compartment **36**. As most clearly shown in FIGS. 2 and 4, in the illustrated form of our invention the arcuate tip **70** of the baffle **62** approaches but does not contact the end wall at the small end **48** of compartment **36**; the baffle extends substantially completely across the width of the inclined discharge opening of the head box except for an opening at one side thereof. The upper surface of the top plate **64** of the baffle **62** is spaced from but parallel to the open top of compartment **36**. Baffle **62** is thus positioned within compartment **36** in a manner such that liquid passing from the head box through the moving wire **18**, through the slotted cover **42**, and into compartment **36** may flow freely around the tip and edges of the baffle.

Referring particularly to FIG. 5, suction box **34** is shown in operating position beneath the Fourdrinier wire **18** which moves over the open end of the suction box in the direction of arrows **28**. It will be observed that the top portion **64** of each of the T-shaped baffles **62** is parallel to the plane defined by the upwardly inclined direction of travel of the moving Fourdrinier wire **18** as it passes through the forming zone.

In operation the level of the stock **4** in head box **2** may be maintained either above or below the level of the uppermost compartments **36** of suction box **34**. This is not critical provided each of the uppermost compartments below which the stock level may be permitted to drop is provided with vacuum producing means to remove air drawn into the system due to the low level of stock in head box **2**. Thus, if it is contemplated that in operation the level of stock **4** in head box **2** will fall below the open end of compartments **36***h–j*, but not below **36***g*, each of the uppermost compartments **36***h–j* may be provided with conventional vacuum producing means (not shown) to remove air drawn into the system through the moving wire **18**.

For purposes of describing the invention it will be assumed that the level of stock in the head box **2** is maintained higher than the opening of the uppermost compartment **36***j* of the suction **34**. Under this condition, each compartment of the suction box will be completely filled with water, the water having passed through the upwardly inclined discharge opening of the head box **2** and through the moving wire **18**, the fibers of the water-fiber stock being deposited on the wire as it moves in its inclined path through the forming zone. Water may be caused to flow through the moving wire and fibers being deposited thereon by removing water through the discharge pipes **40**. The rate at which water passes through the papermaking interface and is evacuated from each of the compartments **36***a–j* is regulated by means of the individual control valve associated with each compartment. It will be understood that movement of the water out of the discharge opening of the head box and through the wire in the forming zone will cause the stock in head box **2** to flow generally in the

direction of the arrows **16** (FIG. 1) with the fibers of the stock being deposited on the top of the moving wire **18**. The suction box disposed beneath the Fourdrinier wire in the portion of the travel thereof that passes beneath and adjacent the discharge opening of the head box draws off water from the wire.

Because the thickness of the web or mat of deposited fibers will increase upwardly along the inclined path of the moving wire **18**, the pressure differential required to pass water through the wire and the mat of deposited fibers will be greater for that area of the wire in the forming zone served by compartment **36***j* of the suction box than that area of the wire served by compartment **36***a*. Stated in another manner, the pressure differential required to cause water to pass through the wire from the head box side to the suction box side of the papermaking interface will be less in the lower portion of the wire than in the upper portion of the wire as it moves in its inclined path through the forming zone. However, the pressure differential or pressure drop across or through the papermaking interface should be substantially uniform across the width of the wire within the area served by each of the several compartments **36***a–j*. Thus, again referring to FIG. 2, in order to achieve a uniform deposit of fibers across the width of the moving Fourdrinier wire the differential in static pressure in the stock immediately above wire **18** and in the water immediately above the top plate **64** of baffle **62** should be substantially the same across the width of wire **18**, i.e., from that portion of the wire that passes over the small end **48** of the compartment **52** to that portion that passes over the discharge end **50** of the compartment.

Because the rate of flow or velocity of water passing through the wire depends upon the difference in static pressure in the head box and in each compartment of the suction box, a uniform pressure differential in a direction across the width of the wire will result in a relatively uniform flow of the liquid passing through the wire in a direction transverse to the direction of travel of the wire. An even deposit of fibers across the width of the moving wire will result when the flow rate of liquid through the wire is uniform across the width of the wire.

Referring once again to Fig. 2, movement of the liquid from the head box will be vertically downward through wire **18** into each of the compartments **36***a–j* and out of the compartment in the direction of the arrow **82** through discharge end **50** of the compartment.

In order to enhance the immediate discharge of the large quantity of liquid that passes through each compartment of the suction box, each compartment is provided with a bottom wall portion **52** that slopes in a direction transverse to the direction of travel of the Fourdrinier wire **18**, as previously described.

However, it is believed that use of the sloping bottom results in two separate phenomena within each compartment of the suction box. First, there is a restriction to the liquid flow toward the small end **48** of the compartment resulting in a high "back pressure" in that area of the compartment. This high back pressure tends to reduce the velocity of the liquid through the system at the small end of the compartment. Second, the large volume of liquid passing through each compartment produces a high velocity flow near the sloping bottom of the compartment, particularly towards the discharge end **50**. This produces a lower static pressure towards the discharge end of the compartment. This in turn causes a greater quantity of liquid to be sucked or pulled through the screen near the discharge end of the compartment, resulting in an uneven deposit of fibers across the width of moving wire **18**.

We have found that creating a pressure drop within each compartment **36***a–j* of the suction box **34**. Other flow ing the papermaking interface of the forming zone, tends to isolate the papermaking interface from these two phenomena and even out the velocity of flow through the system. One such way of producing the pressure drop is by placing a flow restricting device such as a baffle within each compartment **36***a–j* of the suction box **34**. Other flow restricting devices positioned in a zone beneath the Fourdrinier wire and extending substantially completely across the width of the discharge opening of the head box may be used. In the embodiment of our invention shown in the drawings we have used a baffle as previously described.

The effect of using a flow restricting device such as a baffle **62** in each compartment **36***a–j* of the suction box **34** may be shown by taking static pressure readings within the headbox at points above the Fourdrinier wire and also in the suction compartment at several points across the width of the forming zone, i.e., between the small end **48** and the discharge end **50** of the compartment, just beneath the papermaking interface and at locations between each of the supporting ribs **56**. These readings, taken in a direction transverse to the direction of travel of the Fourdrinier wire as it moves in its upwardly inclined direction, enable one to determine the pressure drop through the wire at points across the width of the wire.

Readings were taken both without and with a baffle mounted within the compartment. Without the baffle in place, and at a flow rate of between about 2000 and 2500 gallons per minute through the compartment, the pressure variation across the width of the forming zone was in the order of 6" to 7" of water. A variation of this degree is unacceptable as it results in an uneven deposit of fibers across the width of the Fourdrinier wire **18** as it passes through the forming zone. Baffle **62** was thereafter installed within the compartment and the static pressure readings were again taken. At a flow rate of 2275 gallons of water per minute through the compartment, the pressure variation was less than ¼" of water, and at reduced flow rates of 1820 and 1370 gallons per minute, the variation was ⅛" and 1/16" of water, respectively. This amount of pressure variation is acceptable in producing a substantially uniform deposit of fibers across the width of the Fourdrinier wire as it passes through the forming zone.

While the precise configuration, dimensions and placement of the baffle within each compartment of the suction box may vary and still effectively isolate the papermaking interface from the previously described effects of a sloping bottom, our preferred and illustrated form of baffle is T-shaped in cross section with the sides of the upper portion or cross member of the T being parallel to each other. The tip of the baffle in its preferred embodiment should be arcuate in form. We have found that a semicircular tip enables us to achieve a minimum pressure variation within the compartment, particularly near the small end thereof.

The dimensions of the baffle will, of course, vary with the dimensions of head box, suction box compartments, etc. However, in order fully to describe one preferred form of baffle, the following dimensions are given. These dimensions may be taken as typical but are not to be considered as limiting the scope of the invention. For an exposed Fourdrinier wire opening of 72" measured in a direction transverse to the direction of travel of the wire **18**, the overall length of the flat top portion of the baffle is 62½". In our preferred form, the top flat portion of the baffle is flush with one side of the wire opening but does not extend completely across the full width of the wire opening. The top portion of the baffle is ¼" thick and of metal, although other materials such as plastic or wood may be utilized. The baffle is 5 11/16" wide and the width of the gap between the parallel sides of the baffle and each of the side walls of the comportment is approximately ½". We have found that as the width of this gap is increased, the pressure variation across the width of the wire tends to increase and control of the flow is reduced. A reduction in the gap width results in better control of the flow (i.e., a reduced pressure variation across the width of the wire), but lowers flow through the system. The supporting rib **68** of the baffle has previously been described as triangular in shape. The bottom

edge thereof should conform, generally, to the sloping bottom wall of the compartment **36**.

In its preferred embodiment, the flat top portion of the baffle is maintained parallel to the papermaking interface and is positioned in close proximity (within about ½") to the cross ribs **56** which support the slotted cover **42**. The top portion of the baffle is approximately 4" from the Fourdrinier wire as it passes through the forming zone.

It will be understood that the form and structure of the suction box compartment and baffle may be varied from the preferred embodiment just described. For example, the bottom portion **52** of each compartment **36** may slope continuously and uninterruptedly from its small end **48** to its discharge end **50** rather than having a sloping portion intermediate two portions parallel to the papermaking interface as shown in FIG. 2. In addition the tip **70** of the baffle may have a nonrounded end, such, for example, as a square end, and may be made to extend into the small end of the compartment **36** so that the baffle tip will abut the end member **58** of the compartment. The baffle may also be constructed so that its width is adjustable, and thus the width of the gap between sides **66** of top portion **64** and the transverse side walls **38** of compartment **36** may be changed.

The baffle may also be constructed and positioned within the compartment so that the ends **70, 71** of the baffle may be adjustably spaced from the end members **58** and **60** of compartment **36**, thus enabling the operator to produce a web or mat with heavy or light edges, as desired.

Further variations in the form of the flow restricting device may be helpful under certain circumstances. For example, the baffle may be constructed with one or more open slots extending substantially the full length of the top portion of the baffle and with the longitudinal edges **66** of the baffle abutting rather than being spaced from the side walls **38** of compartment **36**. In this form of construction the flow of liquid would be essentially through the baffle rather than around it. As will be understood by those skilled in the art, various means for mounting the baffle within the compartment may be employed.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

Having fully described our invention, what we claim is:

1. The method of producing nonwoven fabrics and the like by depositing fibers from a water-fiber stock onto a Fourdrinier wire comprising the steps of

(a) passing a portion of said wire in an upwardly inclined direction adjacent and beneath the discharge opening of a head box, said discharge opening being inclined upwardly in the direction of stock discharge from said head box,

(b) discharging stock from said head box onto the top of said wire,

(c) drawing water off from the bottom of said wire by means of a suction box disposed beneath and adjacent said wire in said upwardly inclined portion threof, said suction box having a bottom sloping in a direction transverse to the direction of movement of the wire and having a discharge end for evacuating water therefrom, and

(d) restricting the flow of said water within said suction box by a flow restricting device to create a pressure drop within said suction box in a zone immediately beneath and adjacent said wire whereby the static pressure in the liquid in said zone is maintained substantially constant across the width of said wire, and whereby a uniform pressure drop is maintained between said zone and said sloping bottom.

References Cited

UNITED STATES PATENTS

3,190,790	6/1965	Ploetz et al.	162—212
3,149,027	9/1964	Mih	162—208

S. LEON BASHORE, Primary Examiner

R. V. FISHER, Assistant Examiner

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,832,283 Dated August 27, 1974

Inventor(s) T. S. Bartley et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 2, line 53, "baffllles" should be --baffles--

Col. 3, line 64, "upport" should be --support--

Col. 5, line 71, delete "of the suction box 34. Other flow" and insert therefor --in a zone beneath but approach- --

Col. 6, line 66, "comportment" should be --compartment--

Col. 8, line 18, "threof" should be --thereof--

Signed and sealed this 12th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents