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APPARATUS FOR MAKING A NONWOVEN WEB

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FIG. 1

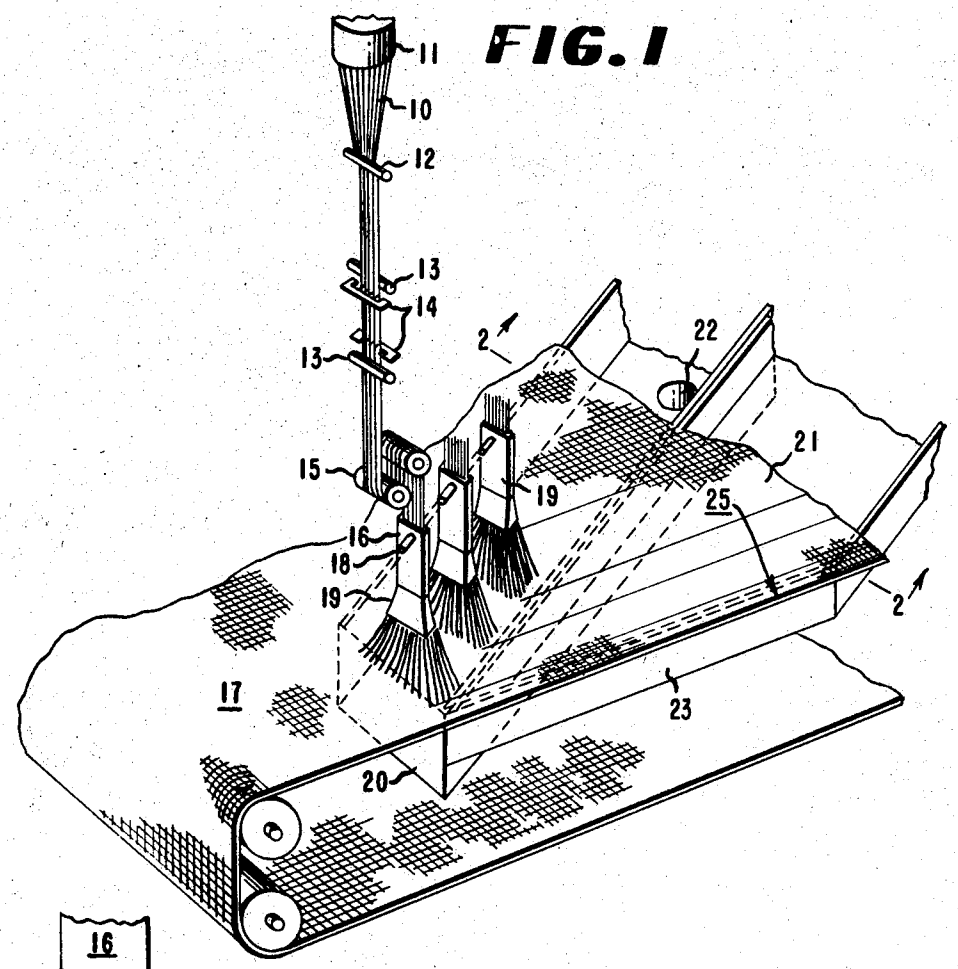
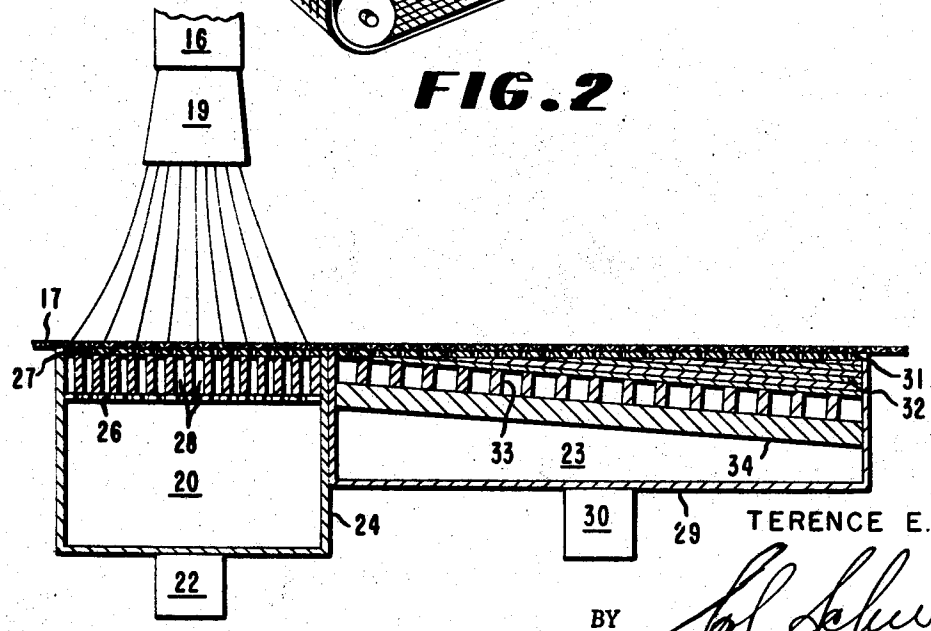



FIG. 2




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# APPARATUS FOR MAKING A NONWOVEN WEB

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This invention relates to an apparatus for depositing fibrous materials being transported in a moving fluid medium, such as air, onto a moving receiver as a nonwoven web, and in particular to an apparatus wherein the fibrous materials, after deposition, are firmly held to the receiver so that they do not shift their position under the influence of air currents.

In the adaptation of the recently developed process for the preparation of continuous-filament webs, described in British Patent 932,482, to economical commercial production of wide nonwoven webs, it is necessary, in order to obtain the desired productivity, to use a plurality of spinnerets or other filament-producing devices and collect the outputs from these spinnerets as a nonwoven web of the desired width. The spinnerets may be located across the width of the web to be produced, and positioned so that the filaments, after having been molecularly oriented by drawing and electrostatically charged, can be forwarded toward the laydown zone and deposited in overlapping ribbons to form the nonwoven web.

The electrostatic charge is applied to the filaments to cause them to separate when the tension on them is released and thus permit the collection of uniform, nonblotchy nonwoven webs. Jet devices, which use a high-velocity stream of air flowing cocurrently with the filaments through the device, are preferred for forwarding the electrostatically charged filaments because the tension which the jet devices apply to the filaments is rapidly released as the filaments exit from the jet device and therefore the filaments are free to separate due to the applied electrostatic charge. When multiple jet devices are used, however, the air streams exiting from the jet devices and the electrostatic charge on the filaments cause interference between the filaments exiting from adjacent jet devices and prevents them from being combined uniformly into a non-directional web on the web-laydown receiver. It has been found that this interference between adjacent jet devices can be overcome by withdrawal of at least 5 times the amount of air supplied to the jet devices through the foraminous receiver into a suction or plenum chamber located below the web-laydown zone.

The withdrawal of this large quantity of air, however, increases the air movement across the web and this causes the filaments to blow up, and the nonwoven web to curl, overlap and become non-uniform in the region where the freshly-deposited web leaves the suction area at the downstream side of the suction chamber.

In the instant method the aforementioned difficulties are overcome. The air stream exiting from the jet device and containing the bundle is directed toward a stationary depositing zone over the moving foraminous web-laydown receiver while suction is applied to the underside of the receiver in the area beneath the depositing zone. Substantially all the air of the stream exiting from the jet passes through the foraminous receiver while the filaments contained in the stream are retained on the receiver. As the filaments, now in the form of a deposited web, are carried downstream from the area of deposition by the moving receiver, suction is applied to the underside of the receiver in a second area that is contiguous to the first area beneath the depositing zone. The suction



applied is greatest in the region immediately adjacent the suction area under the depositing zone and diminishes or decreases in intensity in the downstream direction. Thus a decreasing air flow gradient exits across the receiver from the region contiguous to the suction area under the depositing zone to the downstream region of said second suction area. The air flow is reduced to zero where the web leaves the second suction area.

The apparatus of this invention eliminates this shifting of the filaments after laydown and makes possible the high-speed deposition of filaments onto a moving foraminous receiver as a uniform nonwoven web. The apparatus comprises, in combination with a primary suction chamber located below a web-laydown receiver for initially attracting and holding filaments to the receiver, a secondary suction chamber located below the web-laydown receiver and contiguous with the downstream side of the primary suction chamber, the secondary suction chamber comprising means for providing a decreasing air flow gradient from the side of the secondary suction chamber contiguous to the primary suction chamber to the downstream side where the web leaves the suction zone of the secondary suction chamber.

The invention will be further understood by reference to the drawings in which

FIGURE 1 is an isometric view showing in part an apparatus for producing a wide nonwoven web and outlining the placement of the primary and secondary suction chambers; and

FIGURE 2 is an enlarged cross-sectional view taken along line **2**—**2** of FIGURE 1 showing preferred embodiments of primary and secondary suction chambers.

The essential parts of an apparatus suitable for producing wide, continuous-filament nonwoven webs are shown in FIGURE 1. For clarity only one filament-spinning position including the means for electrostatically charging and drawing the filaments and only three filament-forwarding jet devices are shown. The additional positions and jet devices are identical to those shown and are provided in the number required to produce the desired width of nonwoven web by overlapping the adjacent ribbons of nonwoven web laid down on the moving receiver. In FIGURE 1, filaments **10** are extruded from spinneret **11** and combined into a bundle on snub bar **12**. Snub bar **12** may be cylindrical as shown or may have a convex or concave surface to cause divergence or convergence of the filament bundle, respectively. Alternatively, a comb device may be used in place of the snub bar **12** to regulate the width of the filament bundle and maintain it in the desired alignment with the draw rolls and jet device downstream therefrom. The filaments are then electrostatically charged by means of corona-discharge devices comprising target bars **13** and charge heads **14**. The filament bundle is passed into light contact with slowly rotating target bars **13** which are posittioned adjacent charge heads **14** which have needle electrodes. A corona discharge is generated by applying a high electric potential to the electrodes and grounding the target bars.

The charged filaments pass over draw rolls **15** and then into stationary slot jets **16** which strip the filaments from the last draw roll and forward them toward the web-laydown receiver **17**. The slot jets are provided with air through inlets **18**. The jet devices are equipped with diffuser sections **19** to spread the filament bundles and provide elongated areas of deposition which are readily blended by overlapping about 67% into a wide, uniform nonwoven web.

The filaments are collected on moving foraminous receiver **17** above the primary suction chamber **20** as web **21**. Air is withdrawn through the receiver into the suc-

tion chamber and then through exhaust duct **22** which is attached to a suction-blower system not shown. The air withdrawn through the receiver into the primary suction chamber serves to overcome the aerodynamic and electrostatic interference between laterally-adjacent jet devices. In order to utilize electrostatic attraction as well as aerodynamic forces to attract and hold the charged filaments to the receiver, the receiver may be a grounded metal screen or alternatively, if a fabric belt is used, the surfaces of the primary and secondary suction chambers which contact the belt are grounded and a grounded metal plate is positioned below the belt in the region downstream from the secondary suction chamber.

The secondary suction chamber **23** is positioned adjacent to the downstream side **24** of primary suction chamber **20** and is provided with means, not shown in FIGURE 1, to provide a decreasing air-flow gradient in the direction of arrow **25**. The air withdrawn through the receiver into the secondary suction chamber is controlled and graduated in such a way that the effect holding the filaments to the receiver decreases gradually from a high level at the primary suction chamber to lower levels over the secondary suction chamber, and to virtually zero as the nonwoven web leaves the suction zone of the secondary suction chamber. This gradient is essential and satisfactory results cannot be obtained merely by applying a high vacuum to both suction chambers. Ordinarily the air velocity differential in going from suction to no suction, i.e. the point where the web leaves the secondary suction zone should not exceed 50 ft./min. In going from first suction zone to the secondary suction zone the air velocity differential should preferably not exceed about 150 ft./min. The stepwise reduction in air velocity should preferably not exceed about 30 ft./min. per three inches of receiver width.

In FIGURE 2, the primary suction chamber **20** holds the filaments to the receiver from the time they touch until they are clear of the stream of air exiting from the jet devices. Virtually all of the air from the jet devices enters the primary suction chamber. In a preferred embodiment of the primary suction chamber, the chamber comprises an orifice plate **26**, a perforated cover plate **27**, and a multiplicity of independent fluid-distribution cells **28** forming a honeycomb structure between the orifice plate and cover plate. The cells are open at both ends, the lower end being in contact with the orifice plate and positioned over a single hole in the orifice plate, and the upper end being in contact with the cover plate. The cover plate may have an open area below each jet device conforming with and slightly larger than the pattern of the jet air striking the laydown receiver above the primary suction chamber. These open areas may consist of perforated portions in an otherwise solid cover plate or may be present in a mask plate positioned over the perforated cover plate.

The embodiment of secondary suction chamber shown in FIGURE 2 consists of an outer shell **29** which is solid except for exhaust duct **30**, which is attached to an auxiliary suction-blower system not shown, and the top surface. The top consists of three elements plus a support frame. A uniformly perforated or foraminous plate **31**, which is relatively open to air flow, is located directly below and in contact with web-laydown receiver **17**. Below plate **31** is mask **32** made of layers of a woven or nonwoven fabric, with increasing numbers of layers toward the exit edge of the secondary suction chamber, thereby providing a gradient of increasing resistance to airflow. Of course, a single layer of increasing thickness would be equally suitable. Below mask **32** is a grating **33** which supports mask **32** and offers little restriction to air flow. A series of beams **34**, which have no significant effect on the air flow, support the grating above the bottom of the secondary suction chamber. Since plate **31** is normally a light-weight material which is supported only by mask **32** in the region between the side walls of the suction chamber, it is desirable to have beams **34** adjustable so that the plate can be maintained in a level position across its entire width.

While the above-described embodiment of the secondary suction chamber is preferred because of excellent performance, simplicity and low cost, other methods for obtaining a gradient of resistance to air flow can also be used. For example, the open area in the perforated plate **31** may be gradually decreased by decreasing the number and/or size of the perforations in the direction of travel of the receiver. Alternatively, a honeycomb structure of the type described above in the primary suction chamber may be used, with the holes in orifice plate being decreased in size in the direction of travel of the receiver.

Separate primary and secondary suction chambers with separate suction-blower systems are preferred because they provide great versatility to the laydown operation and precise control over the air-flows. These factors are of considerable importance because the preparation of various types of non-woven products can require the use of different process conditions in the spinning and subsequent treatments of the filaments. These different process conditions may require different velocities of jet air. For each jet air velocity, there are optimum levels of air withdrawal for both the primary and secondary suction chambers and these optimum levels can be readily obtained with separate chambers. If, however, only a single type of nonwoven web is to be produced, it is possible to use a single suction chamber with two portions corresponding to and functioning in accord with the above-described primary and secondary suction chambers, and with both of these portions being connected to the same suction-blower system. It is intended that this type of suction chamber come within the scope of the present invention.

What is claimed is:

**1.** Apparatus comprising a movable foraminous web-laydown receiver on which to form a nonwoven web, a plurality of means for discharging a stream of air containing a plurality of filaments onto one face of said receiver, a primary suction-chamber located at the opposite face of said receiver and opposite the said discharging means, for withdrawing air that is directed at the web-laydown receiver by said discharge means and that passes through said web-laydown receiver, and a secondary suction-box located below the web-laydown receiver and contiguous with the downstream side of the primary suction-chamber, the secondary suction-chamber having means for successively increasing resistance to flow from the side of the secondary suction-chamber contiguous to the primary suction-chamber to the downstream side where the web leaves the suction zone of the secondary suction chamber.

**2.** The apparatus of claim **1** wherein the means providing an increasing resistance to air flow comprises layers of fabric increasing in number toward the exit edge of the secondary suction chamber.

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