Jan. 23, 1962 F. G. MAILLARD 3,017,918

APPARATUS FOR MANUFACTURING NON-WOVEN TEXTILE ARTICLES

Filed July 28, 1958 3 Sheets-Sheet 1

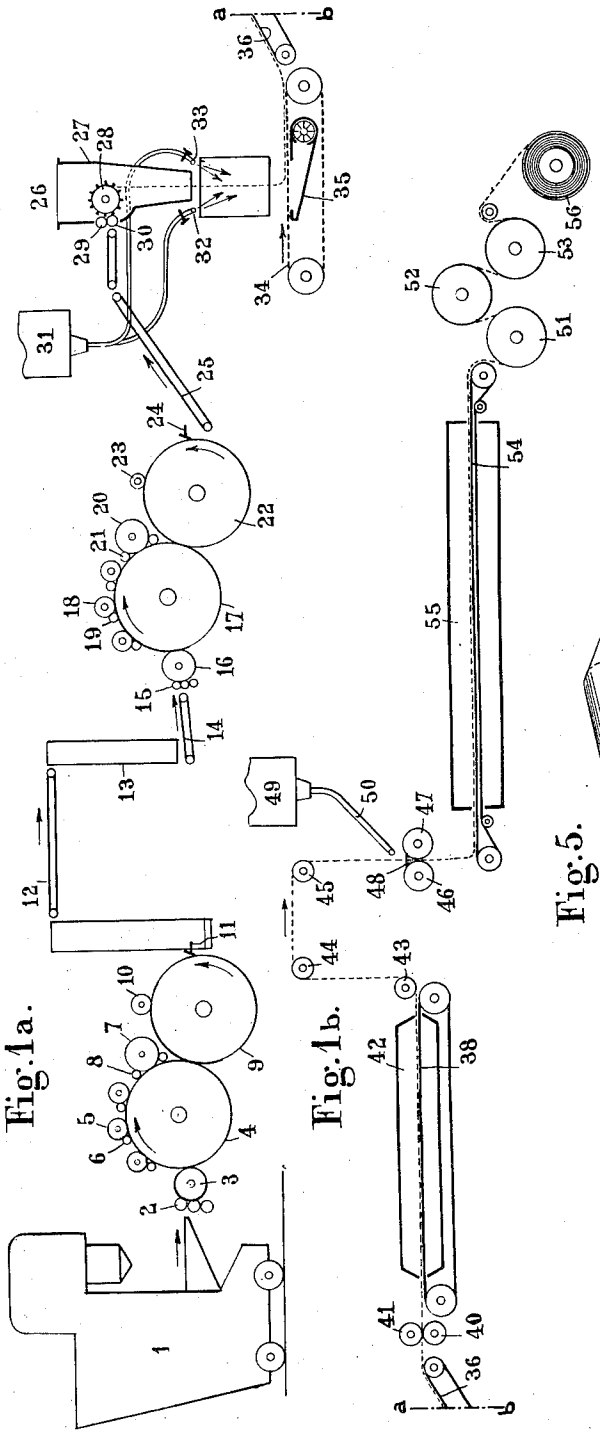

Fig.1a.

Fig.1b.

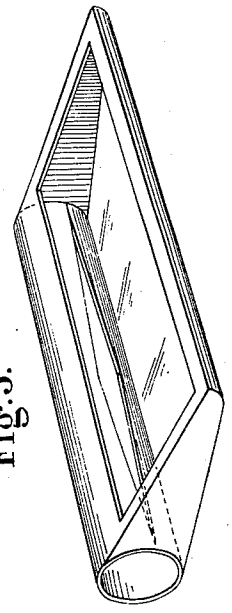

Fig.5.

APPARATUS FOR MANUFACTURING NON-WOVEN TEXTILE ARTICLES

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Fig. 2.

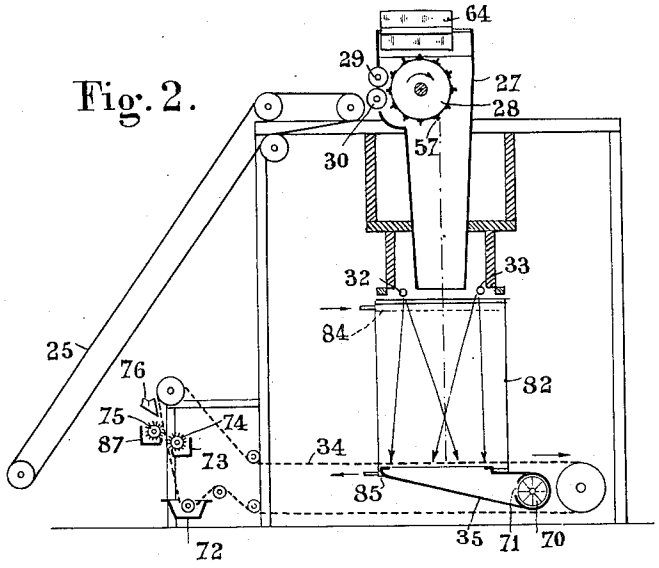


Fig. 8.

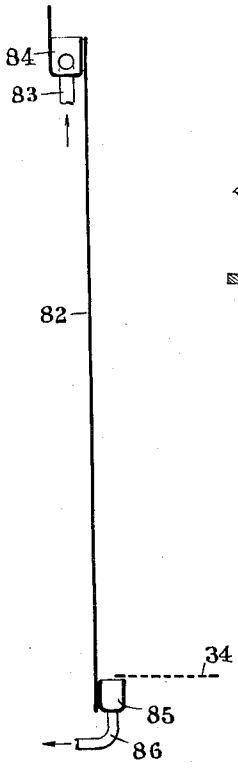


Fig. 3.

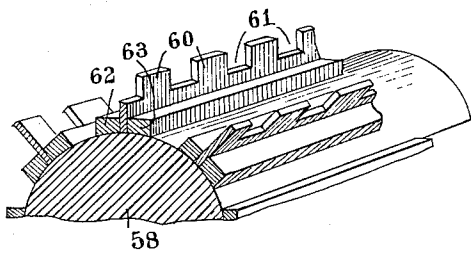
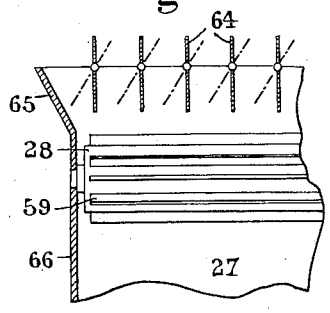


Fig. 4.



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APPARATUS FOR MANUFACTURING NON-WOVEN TEXTILE ARTICLES

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Fig. 6.

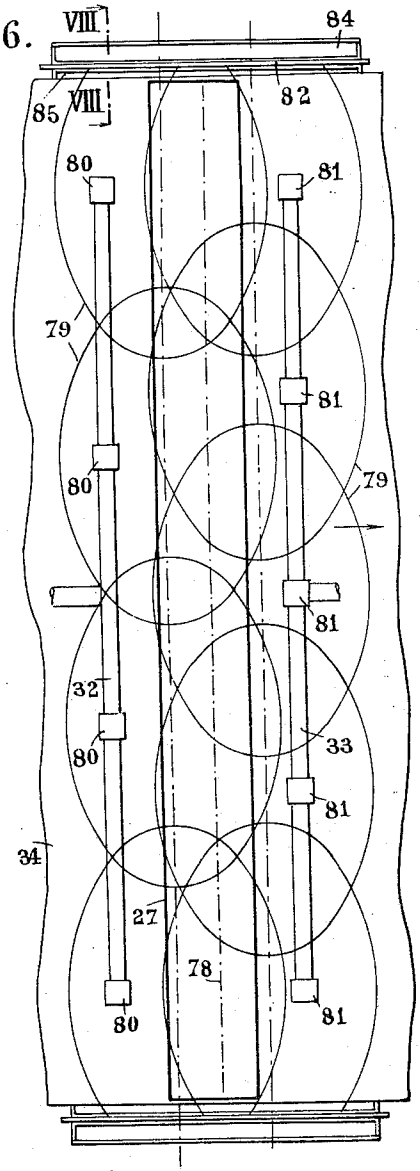
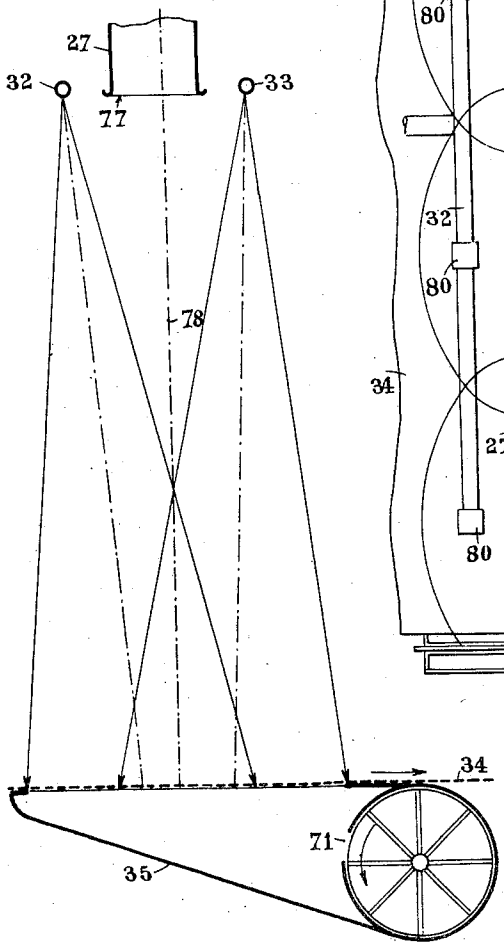


Fig. 7.



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APPARATUS FOR MANUFACTURING NON-WOVEN TEXTILE ARTICLES

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5 Claims. (Cl. 156—370)

The present invention relates to the manufacture of non-woven textile articles, that is, products obtained from non-felting fibres, without any spinning, weaving or knitting operation.

It is already known that these non-woven textile articles display, as end products, an appearance and properties similar to those of conventional fabrics.

It is obvious that the spinning and weaving or knitting operations, which are compulsory in conventional processes, constitute an extremely heavy cost factor both as to the equipment or "machine" capital investment and as to the manpower cost.

The suppression of these operations in the manufacture of non-woven products constitutes such an improvement that the future of these products may be considered as illimited.

Various methods of manufacturing non-woven textile articles have already been proposed. Now this invention relates to the manufacture of these articles by agglomerating conventional textile fibres by means of a chemical binder.

This method is adapted but not exclusively for the use of an ordinary textile equipment in the form of a conventional set of machines consisting for example of a single card, of two cards, or three cards, as in current practice, the assembly leading to the delivery of a veil or sheet of textile fibres which is called "card veil."

This method is characterized in that it comprises three successive well-defined phases.

1ST PHASE

During the first phase a quite normal veil or sheet is delivered by the output end of a carding machine, this veil or sheet having the width of the carding machine and being subsequently broken and reduced into many separate elements resembling snow flakes.

To this end, the sheet may be led by a belt conveyor into a cutting chamber in which a cylinder carrying a great number of teeth rotates at high speed; feed cylinders may be used for delivering the sheet as close as possible to the cutting cylinder, the air current produced at the same time by the rotation of the cutting cylinder carrying along the textile material downwards.

2ND PHASE

During the second phase a liquid chemical binder is sprayed in sufficient quantity on the flake-forming fibres just formed, as they fall, and this binder is thus fixed on the various fibres before they fall onto the underlying belt conveyor.

To this end the fibres just issuing from the cutting chamber and falling freely in the form of flakes may be collected on a perforated movable conveyor belt a pneumatic suction being produced therethrough to attract these cut fibres.

This liquid binder spraying may be effected by using two distributing lines each provided with a plurality of spray guns, one line being located before the zone in which the flakes fall and the other after this zone, the two jets issuing from these distributors crossing each other so that each free falling fibre will be safely impregnated with the liquid binder.

As the underlying fibre-collecting endless belt operates at a variable speed as the card veil or sheet is delivered under constant weight conditions, it is very easy, by varying the conveyor speed, to obtain a regular, uniform sheet having the desired thickness and wherein each fibre or flake receives the desired and suitable quantity of binder.

3RD PHASE

During this third phase the fibres are fixed to one another by mechanical pressure obtained for example from presser or winding cylinders.

To obtain this result, the sheet formed during the second phase may be caused to travel while being supported by a conveyor beneath a source of moderate heat imparting to it a first degree of compactness or consistency.

Another degree of compactness or consistency may be given to the sheet by pressure rollers or winding-drying cylinders as conventional in the paper-making industry.

These various members provide a pressure sufficient to fix all the fibres to one another and constitute a uniform homogeneous felt-like assembly in which all the fibres are dispersed in all directions, this dispersion resulting from the fact that the flakes are allowed to fall freely during the second phase of the process.

After having received an adequate pressure from one or the other of said cylinder types, the material thus formed is dried, that is, the moisture or water contained in the sprayed binder is eliminated in a drying oven and/or between drying cylinders.

The treatment is completed by curing the dehydrated binder in the same oven and/or drying cylinders, or in similar devices disposed after these means.

COMPLEMENTARY POSSIBILITIES

The pressure and heat obtaining during the third phase, that is, during the passage of the material through the pressure and/or drying cylinders, and during the optional passage through a complementary oven, impart the desired cohesion to the non-woven textile product.

This textile product may of course be subjected to complementary treatments or processes; thus, the product may be subsequently treated by impregnation or soaking (this being extremely easy since the product was given its strength and cohesion during the third phase of the process) and thus impart thereto all the requisite complementary properties, such as non-rumpling characteristics, water-proofness, imperviousness, fire-proofing, etc.

The non-textile article thus obtained may also be fluted or crimped.

If desired, a dyeing or printing process may be applied to this product.

Of course, these various operations may be combined with one another, if desired.

PROPERTIES OF BINDER

The binder consists preferably of a water emulsion or dispersion; it may be selected from the group of natural rubber latex, or from the group of synthetic rubbers. It may also consist of plastisol, that is, a mixture of plastics in the liquid state without any presence of water.

It is preferable to use acrylonitrile butadiene emulsions because they are less liable to attacks from solvents than natural rubbers, this being important in the manufacture of textile products for garments.

ADVANTAGES OF THE METHOD

The method offers notably the following advantages:

(1) The fibres are impregnated with the binder when

their fineness is maximum, and therefore their homogeneity is maximum.

(2) The binder is a liquid having a high concentration of active substances: in the case of plastisols the concentration of active substances is 100 percent.

In the case of emulsion or dispersion the binder may be concentrated to 50% of active substance without difficulty.

The proportion of water to the fibre is thus reduced to a minimum.

For example, a non-woven textile article containing in the finished state a proportion of 30% of binder in the dry state is obtained with this method by using a binder having a 30% water content with respect to the fibre content, if the binder is used as an emulsion or dispersion, and no water content if it is used in the form of plastisol.

Hitherto known process required the use of a binder with an excess of water of about 200% with respect to the weight of fibres treated, in view of impregnating a binder which, in the finished or dry condition represents only 30% of the weight of fibre, just to cite an example comparable with the example of the preceding paragraph.

As this water must be subsequently eliminated by the application of heat it will be readily understood that given equal heat sources the process of this invention will afford a considerable higher yield with respect to hitherto known methods.

The installation for carrying out this process comprises a first series of machines or devices adapted to effect primary steps, giving a crude, unfinished article to be subsequently subjected to a complementary treatment consistent with the future use of the product, and another series of machines or devices for carrying out secondary steps consisting of said complementary treatment and more particularly of an impregnation, followed by a drying operation and a curing operation, to impart to the product resulting from the first operation the properties necessary for its subsequent use.

To carry out said primary steps, the installation comprises a series of carding machines adapted to form the veil of fibres, a veil-cutting machine projecting the fibres downwards onto an endless conveyor belt on which the sheet is formed, means being associated with said endless conveyor belt for producing a suction therethrough whereby the sheet formed thereon becomes somewhat compact and can be transported, spraying devices for projecting the binder onto the fibres and notably, for carrying out this method, spraying machines adapted to spray the binder on the fibres as they fall from said cutting machine to said endless conveyor belt, a heated calender adapted to reduce the thickness of the sheet while imparting a first strength to the product, and finally a continuous oven to complete the drying of the end product.

All these machines or devices may be of conventional design, except the cutting machine and the spraying machines which are specially designed in view of producing an article perfectly uniform throughout its length, and the endless conveyor belts designed for a reliable operation and provided with means permitting the recovery of any excess binder.

The secondary operations are carried out in the following machines or devices also mounted in series: a so-called "fulling" machine in which the article issuing from the primary operations is impregnated, three heating cylinders and a continuous oven for curing the elastomers and thermosetting substances present in the binder.

In order to afford a clearer understanding of this invention and of the manner in which the same may be carried out in the practice, reference will now be made to the accompanying drawings forming part of this specification and illustrating diagrammatically by way of example a typical form of embodiment of an installation for carrying out the method of this invention. In the drawings:

FIGURES 1*a* and 1*b*, when joined by their ends *a*, *b*, show diagrammatically the portions for carrying out the primary and secondary operations in the installation, respectively.

FIGURE 2 is a diagrammatic view showing the cutting and spraying machines.

FIGURE 3 is a fragmentary view showing on a larger scale and in perspective the beater of the installation.

FIGURE 4 is a fragmentary section showing the arrangement of the air-deflecting blades.

FIGURE 5 is a perspective view showing the suction box.

FIGURES 6 and 7 are a plan view and an elevational view respectively showing the arrangement of the spray guns and binder jets; and

FIGURE 8 is a fragmentary view, in vertical section, taken upon the line VIII—VIII of FIG. 6.

The installation illustrated in the drawings comprises an automatic loading machine **1**, three delivery rollers **2**, a feed roller **3**, a main cylinder or drum **4**, with a number of workers **5** and feeders **6** co-acting therewith, a fly **7** with its cleaning roller **8**, and a porcupine **9** with its cleaning roller **10** and doffing knife **11**; the endless conveyor belt **12** collects the veil formed at the outlet of the doffing knife **11** and leads same to a crossing device **13** directing the fibres at right angles to their initial path; then, the fibres are fed to a finishing card comprising substantially the same component elements as the breaker card described hereinabove, with the only difference that the card filletting, instead of being rigid or semi-rigid as in the breaking card, is relatively flexible in the finishing card; in fact, after the conveyor belt **14**, FIG. 1*a* shows clearly the delivery rollers **15**, a feed roller **16**, a main cylinder **17** with a suitable number of workers **18** and feeders **19** co-acting therewith, a fly **20** with its cleaning roller **21** and a porcupine **22** with its cleaning roller **23** and doffing knife **24**.

An endless conveyor belt **25** collects the veil issuing from the finishing card and delivers same to the cutting machine **26** comprising, within a hopper **27**, a beater **28** adapted to break up the fibres delivered between two small cylinders **29**, **30**.

The binder container in a reservoir **31** is fed to two parallel binder distributing lines **32**, **33** provided with spray guns for impregnating the fibres as they fall in the lower portion of hopper **27** onto the collecting conveyor belt **34**, a suction box **35** being arranged beneath this belt **34**, as shown; then, the veil of fibres is led from the suction belt **34** to other conveyor belts **36**, **37**, **38** by which they are caused to travel through a pair of heated presser rollers **40**, **41** and also through a tunnel-type oven **42** in which the drying operation is completed.

The unfinished crude product thus obtained is then fed to a bridge-forming overhead roller assembly **43**, **44**, **45** from which it is directed downward to a pressing device consisting of a pair of parallel, close-spaced rollers **46**, **47** having their axes disposed on a common horizontal plane, these rollers being constantly fed with an adequate quantity of treatment product **48** stored in a reservoir **49** and fed through a pipe line **50**; the thus impregnated veil is conveyed by the endless belt **54** through the continuous oven **55** and finally over three heating rollers **51**, **52** and **53** to cure the elastomers and thermosetting materials contained in the binder; finally, the product is wound up on the take-up roller **56**; as the rollers **51**, **52**, **53** and oven **55** have complementary functions, their order may be inverted, if desired.

As shown more particularly in FIG. 2, the feed rollers **29**, **30** have a relatively small diameter so that the blades **57** of beater **28** may be positioned as close as possible to the fibre clamping line corresponding to the nearest or contact generatrices of the two feed rollers **29**, **30**; as the fibre clamping action must be efficient throughout the length of the rollers, these are solid to avoid any flexure.

The beater illustrated on a larger scale in FIG. 3 consists of a cylindrical core **58** of Bakelite or any other

material having equivalent properties; spaced on its periphery are twelve blades 59 consisting of strips of rubber, plastic or metal secured on the core 58 by a pair of wooden lathes 62, 63 disposed on either side thereof; these blades have alternating teeth 60 and notches 61 of same dimensions formed therein, the teeth 60 of one blade being staggered relative to those of the next blade so that the passage of any pair of successive blades will sweep completely the generatrix of the veil.

With the provision of these teeth the veil is broken with greater strength, and the fibres are exhausted more sharply to reduce the veil into elementary fibres.

The velocity of rotation of the beater is adjustable for example within the range of 500 to 1,400 r.p.m., the cutting speed being proportional to the velocity of rotation; thus, with a velocity of rotation of 1,000 r.p.m. and a linear spead of 82 ft./mn. there is one blade stroke every 5/64" of veil feed, and if the beater were driven at 1,400 r.p.m. there would be one blade stroke only every .584" of veil feed.

The beater rotates in the direction shown by the arrow in FIG. 2 so that in addition to its fibre-cutting function it may also act as a fan and create a downward air stream adapted to carry along through the hopper casing 27 an air flow entering the top portion of this casing.

In order to provide a uniform suction throughout the width of the beater, deflecting blades 64 are provided at the upper end of the casing 27 to direct the air stream in a homogeneous manner; these blades are adapted to be set in different inclinations according to their respective position; thus, their inclination may vary from 0 to 60 degrees to the vertical and is symmetrical relative to the mean longitudinal plane of the machine, the central blade being vertical and the two outermost blades inclined up to 60 degrees.

The upper portion 65 of the side walls 66 of casing 27 is inclined outwardly by an angle for example of the order of 45 degrees to permit the ingress of a stream of air adapted to counteract any tendency of the fibres forming the marginal portion of the veil to be urged upwards by the backward air flow that would take place if this upper portion 65 of the side walls 66 were vertical.

During their downward travel through the hopper constituting the lower portion of the aforesaid casing 27, the fibres are subjected to three forces co-acting to maintain their fall in a regular and substantially rectilinear path: the air stirred by the beater 28 and forced downwards, gravity, and the vacuum created by the suction box 35 underlying the receiving belt 34.

The side walls 66 of this hopper 27 are vertical and its rear side 68 and front side 69 are slightly convergent.

The walls of the hopper provide a seamless and perfectly smooth or glazed inner surface, as the least unevenness would retain the fibres during their downward travel and cause them to roll and form a snow-ball that would accumulate the fibres along the margins of the veil and impair its homogeneousness.

The suction conveyor belt 34 is of the wide-mesh type to ensure an efficient suction; it may consist of stainless steel to resist the attacks of the chemical constituents of the binder; the suction proper is produced by a fan 70 and in order to ensure an even distribution of the vacuum throughout the suction surface, the air suction may be effected through a lozenge-shaped slot 71 as shown in FIG. 5.

The fibres are regularly distributed all over the surface of the receiving or collector endless belt 34 due to the fact that the beater rejects on the one hand the fibres regularly throughout its width, and, due to the provision of the adjustable blades 64 and also to the inclined upper edges 65 of the upper portion of hopper 27, causes on the other hand a uniform ventilation at all points, inasmuch as the suction box 35 itself creates a suction of same character throughout the width of the band; moreover, the regularity is completed automatically, if need be, in that the vacuum is less pronounced where the first fibres were deposited on the conveyor belt 34, so that the following fibres are led to occupy the free places where the suction is more intense.

As the receiving conveyor belt 34 tends to become soiled due to the presence of the core in a concentrated form, on the one hand, and to the fact that the fibres tend to form sticky agglomerates likely to clog the belt perforations, on the other hand, it is necessary to clean this belt continuously.

To this end the conveyor belt is caused to travel through a vat 72 containing water, and subsequently through another vat 73 provided with a brush 74 cleaning its lower face, and finally through a vat 87 provided with a brush 75 cleaning its upper face; the belt thus cleaned but moist moves past a perforated pipe 76 providing an air suction through the endless belt to remove any trace of water therefrom, whereafter the cleaned and dried belt may continue its travel to receive fresh fibres.

The binder impregnating the fibres falling from the beater 28 onto the collector or receiving endless belt 34 is sprayed by means of adequate guns in mist form on the fibres in suspension and also on the fibres already resting on the endless belt.

The position of the spray guns must be adjusted with respect to the lower portion 77 of hopper 27, to the receiving belt 34 and also to the fibres themselves as they fall along a substantially transverse plane 78.

The spray guns project the resin in the form of frusto-elliptic jets of which the bases 79 on the plane of the conveyor belt 34 are shown diagrammatically in FIG. 6.

Very good results have been obtained by providing, as shown in the same figure, four spray guns 80 in the rear ramp 32 and five spray guns 81 in the front ramp 33, the position of the outermost guns being so selected that the bases 79 of their frusto-elliptic jets distribute a sufficient quantity of binder up to the marginal portions of the veil, the other spray guns being subsequently distributed in equal number in the two ramps.

As clearly shown in FIGS. 6 and 7 the distribution of the liquid binder thus sprayed by the guns 80, 81 is adjustable with respect to the base 77 of hopper 27 as well as to the conveyor belt 34, and adequate means (not shown) are preferably provided for adjusting their inclination to direct their jet axis as required.

Moreover, between the lower portion 77 of hopper 27 and the conveyor belt 34 two lateral walls 82 are provided for guiding the fibres laterally during their fall; these walls are so arranged, as shown in FIG. 8, that a continuous stream of water will flow permanently on their inner face; to this end, the water fed continuously through pipe line 83 to the trough 84 fills the latter and the excess flows over its inner edge as well as over the upper edge of wall 82, and subsequently down the inner face of this wall, so as to be finally collected at the lower portion of this wall by another trough 85 located just beneath the side edge of the suction conveyor 34, the water being finally discharged through a drain pipe 86.

As illustrated in FIG. 6, a certain percentage of resin projected by the endmost spray guns 80, 81 would have formed on the walls 82 a sticky film catching the marginal fibres so that these fibres would then form "snowballs" most likely to prove detrimental to the regularity of the marginal portions of the sheet through a width of the order of four inches according to practical tests; the water stream thus created along the walls 82 carries along the fine droplets of resin and the few marginal fibres tending to diverge from their path, so that particularly clean and regular selvedges or marginal portions are obtained in the article.

Various binder compositions may be used according to the desired physical and chemical characteristics of the

end product; a few chemical compositions are given hereafter by way of example.

Composition No. 1

Substance:	Parts by weight—solid
Acrylonitrile butadiene emulsion	100
Colloidal zinc oxide	9
Non-ionic stabilizer	1.2
Non-ionic alkyl phenoxyl ethylene ethanol	0.8
Formol melamine emulsion	8.4
Condensation product of thermosetting resin	0.5
Silicone emulsion	0.1

This resin yields end products having a very good resistance to the attack of solvents and to rumpling; for this reason there is a thermosetting resin in the composition.

Composition No. 2

Substance:	Parts by weight—solid
Acrylonitrile butadiene emulsion	100
Colloidal zinc oxide	8
Non-ionic stabilizer	9
Silicone emulsion	0.1

This resin composition is suitable for yielding flexible, elastic products having however a questionable resistance to solvents; on this ground, there is no thermosetting resin but only a synthetic latex of acrylonitrile butadiene.

In this case butadiene polymers, butadiene copolymers, polychloprene derivatives or natural latex may be used as a mother binder and as a substitute for the acrylonitrile butadiene.

Composition No. 3

Substance:	Parts by weight—solid
Polyvinyl chloride emulsion	100
Non-ionic stabilizer	7
Dioctyl phthalate	45
Silicone emulsion	0.1

This composition is suitable for yielding stiffer products than those obtained with composition No. 2 (for example as required for supporting slabs).

The vinyl chloride emulsion may be replaced by a vinyl acetate emulsion; as plasticizers, butyl-, nonyl- or decyl phthalates or sebacates may be used; their percentage may vary from 10 to 100% of the weight of the dry polymers according to the mechanical characteristics to be found in the end product.

Composition No. 4

Substance:	Parts by weight—solid
Polyvinyl alcohol emulsion	100

The product thus treated is subsequently printed by using a specially engraved cylinder so as to produce a resin deposit, colored or not, having for example the following formula:

	Parts by weight—solid
Acrylonitrile butadiene emulsion	100
Stabilizer	8
Colloidal zinc oxide	9.50
Sodium alginate emulsion (acting as thickening agent)	2
Silicone emulsion	0.1

The product is then passed through a water bath heated to 90° C. and the product thus obtained is bound by points and has the drape and "flowing" characteristics of woven textiles.

It will be readily understood that the various resins suggested hereinabove are given by way of example only and should not be construed as limiting the purpose of this invention; thus, many modifications may be brought to the form of embodiment of these compositions as well as to the installation described hereinabove and illustrated in the attached drawings without departing from the spirit and scope of the invention as set forth in the appended claims. Thus, stabilizers, thickening agents, gellifiers, opaque-making agents and thermosetting resins may be added as required.

What I claim is:

1. An installation for manufacturing non-woven textile articles which comprises a card adapted to form a veil of textile fibres, a veil cutting machine adapted to project the fibres and cause them to fall freely in a substantially vertical plane extending transversely to the plane of said veil, a movable endless conveyor belt adapted to receive said fibres on its top surface to form a sheet carried along in a longitudinal direction, and two sets of spraying apparatus disposed in rows parallel to said veil, said sheet and the aforesaid transverse plane of free-falling fibres, on either side of said transverse plane, and adapted to spray a binding agent onto said free-falling fibres, the jets issuing from said spraying apparatus of said two sets of apparatus crossing each other on said transverse plane.

2. An installation as set forth in claim 1, wherein said veil cutting machine for projecting the fibres and cause them subsequently to drop freely in a substantially vertical plane extending transversely to the plane of said veil comprises two feed cylinders of relatively reduced dimensions, a beater cylinder provided with blades adapted to break said fibres in close proximity of the line along which the fibres are seized by said feed cylinders, said blades carrying along said fibres firstly upwards, and a casing surrounding at least the input side of said feed cylinders, said casing being formed, at its upper portion, with an aperture above the level of said feed cylinders and beater cylinder, shutters for regulating the delivery of air through said aperture into said casing, and a downward extension of said casing which has the form of a hopper having its lower outlet aperture overlying said endless conveyor belt, and wherein said two sets of spraying apparatus are located in the vicinity of the lower end of said hopper with their nozzles projecting the binding agent downwardly onto the fibres.

3. An installation according to claim 2, wherein two vertical walls defining the width of the stream of textile fibres falling from said hopper-forming extension onto said endless conveyor belt are disposed between the lower portion of said extension and said endless conveyor, means being also provided for causing a thin jet of water to flow continuously along the inner face of said walls.

4. An installation as set forth in claim 1, wherein a suction vat is provided beneath said endless conveyor belt.

5. An installation as set forth in claim 1, comprising means for continuously cleaning said endless conveyor belt during the operation of the installation.

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