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METHOD OF MAKING A PARALLEL FIBERWEB

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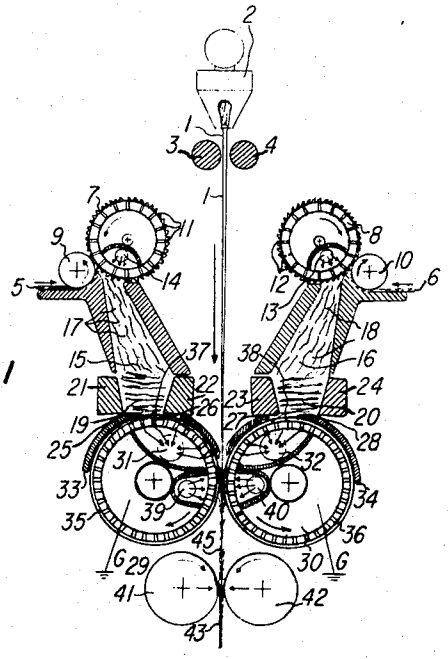


FIG. 1

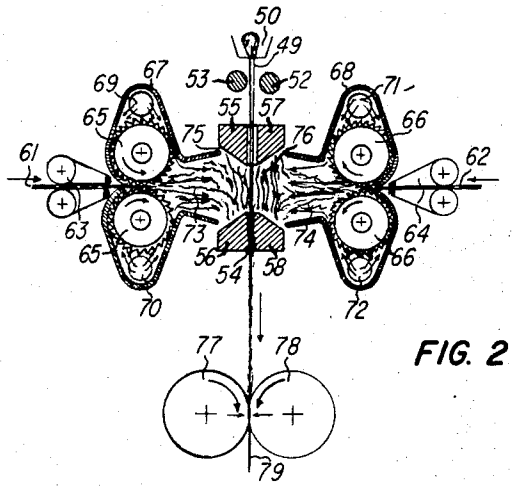


FIG. 2

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METHOD OF MAKING A PARALLEL FIBERWEB

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ABSTRACT OF THE DISCLOSURE

A method and apparatus for causing staple fibers to pass through an electrostatic field and thereby assume an orientation parallel to each other and then causing the fibers to adhere to an adhesive substrate to form a sliver.

This invention relates to a novel method of parallelizing staple fibers by passing them in a sufficiently strong and progressively intensifying electrostatic field.

More particularly the invention relates to a new method of producing fiberwebs and slivers with substantially parallel arranged fibers, the parallelization whereof is achieved by electrostatic means.

As is well known, it is often very important in textile industry to provide slivers or webs with substantially parallel aligned fibers, in view of their further processing into yarns and other textile fabrics. Up to now, the parallelization of staple fibers has been carried out by means of the conventional mechanical carding which constitutes one of the main drawbacks towards an automatic high speed operation.

Mechanical carding, of course, is a relatively slow and rather complex procedure and ever since it has been introduced, numerous attempts have been made to develop an improved universal card which would be able to process at satisfactory speeds any type of staple fibers, independently of their length, surface characteristics and other properties. These attempts have, however, failed and carding, together with the associated garnetting and drawing operations, has remained one of the most complex steps in the fiber to yarn processing.

It is the main object of the instant invention to eliminate entirely the carding operation and to achieve the desired parallel alignment of the staple fibers through the use of electrostatic means.

Another object of the invention is to provide an electrostatic method and means of fiber parallelization that will be adaptable to substantially any type of staple fibers irrespective of the variations in their physical and chemical properties.

Other objects and advantages of the invention will be apparent from the following more detailed description.

The essence of the invention resides in passing the mass of disintegrated and at random arranged staple fibers through a sufficiently strong and progressively intensifying electrostatic field; thereby the individual fibers are electrostatically charged and aligned substantially parallel to each other so that when they leave the electrostatic field, they form a mat of parallel arranged staple fibers which may be transformed in a simple manner into slivers or fiberwebs suitable for further processing into yarns.

The progressively intensifying electrostatic field may be created by means of suitable electrodes having adjustable and converging active faces, the field of highest intensity being, of course, produced between the portions of said faces which are closest to each other.

The electrostatic force between the electrodes should be such as to properly charge the staple fibers and to force them to align in a parallel fashion while they move

through the intensifying electrostatic field. A suitable range has been found to be between 15 and 300 kv., however, it is not limitative since any man of the art will readily establish the most convenient electrostatic force for his particular needs and type of fibers employed.

The converging electrodes are usually laterally movable so that the gap therebetween may be adjusted in relation of the mean length of the fibers and generally so that the narrowest distance between the electrodes approximately corresponds to said mean length.

It should also be mentioned that before the staple fibers are introduced into the electrostatic field between the pair of converging electrodes, they are subjected to thorough cleaning and opening operations (as in the case of conventional processes) and the thus obtained loose fiber mass is condensed into a substantially even fibermat of at random arranged staple fibers, e.g. picker lap of cotton fibers.

This fibermat is then subjected to the action of one or two licker-in rolls of known type, operating at a sufficiently high speed to separate the individual staple fibers and to propel them by centrifugal forces and, if necessary, with the help of an air flow, into an outlet duct leading toward the electrostatic field.

Upon leaving the electrostatic field in parallel condition, the staple fibers are collected on a suitable collecting device which leads them away for further processing into a sliver or fiberweb. The collecting device may consist of a revolving drum positioned just below the electrodes and having about the same width as that of said electrodes and of the licker-in roll or rolls.

The parallel arranged and electrostatically charged fibers are collected on the periphery of this drum which is grounded to remove the charge and are transported through rotation of said drum to a place where they are pressed or combined with other similarly aligned fibers from another drum of the same type to form a loosely bound fiberweb suitable for transformation by any appropriate condensing means into a sliver.

Instead of forming a loose fiberweb, the properly aligned fibers may be deposited from the drum onto a side surface or on both side surfaces of a tacky thermoplastic substrate consisting of a suitable extrudable resin (for instance of the polyamide or polyolefin type) and being in the form of an extruded film or linear curtain of thermoplastic monofilaments. In this way, a fiberweb wi'l be obtained, which will have a thermoplastic core or backing and a surface of parallel arranged staple fibers of desired type; such fiberweb if necessary, can be transformed into yarn for example in the manner already described in applicants' United States application No. 283,389 of May 27, 1963, now Patent 3,347,727 and No. 416,983 of Dec. 9, 1964, now Patent 3,319,469.

The collecting drum is usually perforated by numerous sma'l orifices and may have a regular peripheral surface or one provided with many circumferential narrow parallel grooves with the orifices being at the bottom of said grooves. Inside the drum, there are usually mounted stationary suction and blowing devices, the first being adapted to draw the parallel aligned staple fibers from the electromagnetic field and onto the peripheral surface of said drum and the second to project these fibers away from the drum after, say, ¼ revolution of the latter, to form a sliver or web.

The orifices provided on the collecting drum are, of course, such as to enable an easy operation of the suction and blowing devices without permitting the fibers to pass therethrough.

The circumferential parallel grooves, whenever provided, are such that the fibers will lie therein while being collected on the drum; in this fashion, the parallel align-

ment of said fibers is maintained with greater ease while they are transported on the rotating drum and then projected therefrom.

For efficiency sake, it is preferable to use the above described combinations two by two so that each collecting drum is positioned at the side and in close proximity of another. This enables simultaneous doffing of the parallel arranged fibers from both drums towards each other to form one continuous fiberweb which may then be passed through condensing rolls and trumpet and thereby transformed into a continuous sliver with substantially parallel fibers; the sliver may then be collected in a conventional sliver collecting pot and further processed as desired.

If doffing the parallel arranged fibers onto a film or filament curtain of a tacky thermoplastic substrate to form a fiberweb is desired, said film or filament curtain is passed between the two collecting drums from which the staple fibers are transferred onto the tacky substrate.

The transfer of the staple fibers onto the tacky thermoplastic film or filament curtain, without distortion of their substantial parallel arrangement, can be achieved in several ways.

For example, the thermoplastic substrate, right after its extrusion, may be passed through a strong electrostatic field, sufficient to adequately charge the extruded material. This can be done by passing the substrate between suitable electrodes, e.g. of the corona discharge type. The electrostatically charged substrate, when passing between the collecting drums, without actually coming in physical contact therewith, attracts the zero potential staple fibers (the drums being grounded) parallel arranged on the surface of said drums.

The electrostatic charge of the substrate must also be strong enough to have the attracted staple fibers cling to said substrate in substantially parallel condition until the obtained combination passes through a pair of preferably chilled pressure rolls where it is laminated and consolidated to form the desired fiberweb.

The transfer of the staple fibers from the drums onto the tacky surface of the thermoplastic substrate may also be achieved aerodynamically by blowing a sufficiently strong air current from within the perforated drums, in the direction where the substrate passes at the closest proximity of said drums.

If desired, both the electrostatic and the aerodynamic methods of transferring staple fibers from the drums onto the surface of the substrate can be used simultaneously.

According to another embodiment of the invention, it is possible to deposit the staple fibers, right after their parallel alignment, directly onto the tacky surface of an extrudate without passing by any mechanical collecting device, such as the perforated drums. In such a case, the extrudate itself serves as collecting means for the parallel arranged staple fibers.

This embodiment is characterized in that two progressively intensifying electrostatic fields are provided side by side and a tacky and properly oriented film or filament curtain of thermoplastic material is passed therebetween.

The staple fibers, properly separated by licker-in devices, are, as before, introduced into the electrostatic field and are parallel aligned therein while moving towards the portions of said field having highest intensity and which are closest to the extrudate. The so aligned staple fibers are then transferred directly onto the surfaces of said extrudate, for example, with the help of an air flow, and the obtained combination is the laminated and consolidated by a pair of chilled pressure rolls to form a fiberweb having a middle layer of thermoplastic material and outer layers of parallel arranged staple fibers. Such fiberweb may then be slit into narrow tapes and processed into yarn, preferably using an apparatus such as that described and claimed in applicants' United States application No. 338,684 of Jan. 20, 1964.

The invention will now be further described with reference to the appended drawings in which:

FIG. 1 represents a vertical side view, in section, of one embodiment of the apparatus for performing the method according to the present invention; and

FIG. 2 illustrates a side view, also in section, of another embodiment of the apparatus for carrying out an alternative method according to the instant invention.

As shown in FIG. 1, fibermats **5** and **6** are first led, with the help of rollers **9** and **10**, towards the licker-in rolls **7** and **8** which break up these fibermats into individual fibers **17, 18.** The peripheral surface of the licker-in rolls **7** and **8** is perforated by a plurality of orifices **11, 12** and said rolls are provided therewithin with stationary blowing devices **13** and **14** which help to project the individual fibers **17, 18** into and through venturi shaped channels **15** and **16** towards progressively intensifying electrostatic fields **19** and **20.** The latter are suitably created by means of electrodes **21, 22** and **23, 24** having converging active faces, the highest intensity field lines being, of course, produced where the gaps between said electrodes are smallest, namely between points **25, 26** and **27, 28** respectively. These gaps can be suitably adjusted to approximately the average length of the fibers processed by shifting the electrodes towards or away from one another. Such electrostatic fields of proper intensity, as it has been established by the applicants, align the individual fibers lengthwise and substantially parallel to one another while the fibers are passing therethrough.

Upon leaving the electrostatic field, the properly aligned fibers are deposited on the surface of rotatable collecting drums **29** and **30** provided, if necessary, with suitable protective shields **33** and **34.** These drums are grounded as shown by G so that they will not be charged by the charge containing staple fibers collected thereon and the latter themselves will thus lose their charge and become of zero potential.

The collecting drums **29, 30** are suitaby perforated by a multiplicity of orifices **35, 36** respectively and are internally provided with stationary suction devices **31, 32** which suck the parallel arranged staple fibers through openings **37** and **38** and collect them on the periphery of the revolving drums **29, 30.**

As illustrated in the embodiment according to FIG. 1, the drums **29** and **30** are positioned side by side and in close proximity from one another; they may even contact each other if this is found desirable.

In the case it is intended to form slivers from the obtained parallel arranged staple fibers, the latter, upon travelling on said rotating drums for about ¼ revolution, will be projected towards each other by means of blowing devices **39** and **40** and will form a loose fiberweb **45** which, after compression between press rolls **41** and **42**, is guided through a conventional condensing trumpet and thereby transformed into a sliver suitable to be further processed into yarn.

On the other hand, if it is desired to form a fiberweb having a middle layer of thermoplastic material superimposed with parallel arranged staple fibers on both sides, thereof, this may be achieved by extruding a film or filament curtain **1** of such thermoplastic material from an extruder head **2** positioned directly above the gap between the two collecting drums **29** and **30.** This film or filament curtain extrudate **1** is permitted to pass in said gap and to be picked up by the press rolls **41** and **42** which are driven at a substantially higher velocity than the rate of extrusion, in order to provide said extrudate with proper longitudinal orientation. Also, while the extrudate **1** is passing between the rollers **29** and **30**, and is still in tacky condition, it is superimposed with parallel aligned staple fibers which are blown thereon from the perforated collecting drums **29** and **30** by blowing devices **39** and **40** positioned within said drums.

Instead of using these blowing devices **39** and **40**, or in addition thereto, the extrudate **1** may be passed between two electrodes **3** and **4** and thereby acquire a proper electrostatic charge. In such a case, the staple fibers which have zero potential, because the drums **29** and **30** are grounded, will be attracted towards the extrudate. The holding forces due to electrostatic charging and/or tackiness of the extruded fiber or filament curtain **1** will be sufficient to maintain the parallel arranged staple fibers properly superimposed on the extrudate until the formed combination is laminated and consolidated by preferably chilled press rolls **41** and **42** to form the desired fiberweb **43**. The latter may then be slit into narrow tapes which can be transformed into yarns by twisting means preferably imparting a heat set twist to said tapes.

Another embodiment of the invention is shown in FIG. 2. Here, a thermoplastic substrate **49**, in the form of a film or filament curtain, is extruded from the extruder head **50** and then passed through channel **54** between two progressively intensifying electrostatic fields **75** and **76**, created by electrodes **55**, **56** and **57**, **58** respectively. As before, each pair of electrodes consists of electrodes with suitably converging active faces which can be moved towards or away from each other depending on the average length of the fibers processed.

Simultaneously, fibermats **61** and **62** are fed by feeding devices **63** and **64** into licker-in means **65** and **66** provided at the side of the electrostatic fields **75** and **76** respectively. These licker-in means are mounted in casings **67** and **68** which also have therein air blowing devices **69**, **70** and **71**, **72**.

The fibermats **61** and **62** are disintegrated by the licker-in devices **65** and **66** into individual fibers **73**, **74** which are carried with the help of the air blown by the blowing devices **69**, **70** and **71**, **72** towards and through the progressively intensifying electrostatic fields **75** and **76** where the fibers are aligned parallel by the electrostatic force. The so aligned staple fibers are then deposited onto both sides of the tacky extrudate **49** and are thereafter consolidated and laminated with said extrudate by passage through chilled press rolls **77** and **78**, to form the finished fiberweb **79**.

Pressure rolls **77** and **78** will usually be driven at a higher speed than the rate of extrusion of said extrudate **49** in order to achieve proper longitudinal orientation of the extrudate molecules; also, if desired, the obtained fiberwebs **79** can be slit into a plurality of narrow ribbons which may then be transformed into yarn.

In order to provide better attraction of the parallel arranged fibers towards the extrudate **49**, the latter may be charged by means of electrodes **52** and **53** with a proper electrostatic charge of opposite polarity to that of said fibers. In this manner, the fibers will be more easily attracted towards and held onto the surfaces of the extrudate **49** until they are finally laminated and consolidated by rolls **77** and **78**.

It should, of course be understood that the invention is not limited to the specifically described and illustrated embodiments, but that many modifications evident to those skilled in the art can be made without departing from the spirit of the invention and the scope of the appended claims.

What we claim is:

1. A method of parallelizing staple fibers to form fiberwebs of substantially parallel arranged staple fibers comprising forwarding said fibers to and through a progressively intensifying electrostatic field which increase with the distance travelled by the fibers and which is sufficiently strong to parallelize said fibers in the direction perpendicular to that of the fiber movement and contacting said fibers lengthwise with a tacky substrate while in said parallel arrangement and while said substrate is moving in a plane substantially parallel to the fiber orientation.

2. A method as claimed in claim **1**, in which said progressively intensifying electrostatic field is created in a gap between two electrodes having converging active faces and activated so as to produce the staple parallelizing field.

3. A method as claimed in claim **2**, in which said electrodes are shiftable towards and away from each other so as to adjust the gap therebetween to the at least average size of the staple fibers processed.

4. A method as claimed in claim **2**, in which the electrostatic field is in the range produced by a potential difference between the two electrodes of about 15 to 300 kv.

5. A method as claimed in claim **1**, in which prior to entering said electrostatic field the fibers are subjected to cleaning and fiber separation.

6. A method of producing a fiberweb with substantially parellel arranged staple fibers comprising: subjecting a fibermat of at random arranged staple fibers to the action of licker-in means to distintegrate it into individual fibers; introducing said individual fibers into a gap between two electrodes havng converging active faces; activating said electrodes so as to produce in said gap a progressively intensifying electrostatic field which increases with the distance travelled by the fibers; allowing said fibers to align parallel to each other and perpendicular to the fiber movement in the said gap while propelling them therethrough; collecting the so aligned fibers on collecting means without distortion of their orientation with respect to said electrostatic field; combining said collected fibers with other similarly obtained and collected parallel aligned staple fibers to form a fiberweb of loosely held together and substantially parallel fibers.

7. A method as claimed in claim **6**, in which said collecting means are grounded so that they will not be charged by the fibers collected thereon.

8. A method as claimed in claim **6**, in which the closest distance between the two converging electrodes is adjusted to correspond to the average length of the staple fibers processed.

9. In a method of producing a fiberweb having a layer of thermoplastic material with longitudinally oriented molecules, in the form of a film or a filament curtain, combined with a layer of substantially parallel aligned staple fibers on at least one side of said film or filament curtain, which method comprises: extruding a film or a filament curtain of thermoplastic material; stretching said film or filament curtain in the longitudinal direction to effect orientation of the molecules of said thermoplastic material; simultaneously, on at least one side of said film or filament curtain, subjecting a fibermat of at random arranged staple fibers to the action of licker-in means to disintegrate it into individual fibers; parallelizing said staple fibers parallel to each other and to said film or filament curtain; applying the so parallelized fibers onto a surface of the extruded and still tacky film or filament curtain without distorting their orientation with respect to said electrostatic field; and laminating and consolidating said fibers with said film or filament curtain to form the desired fiberweb; the improvement comprising parallelizing said staple fibers by forwarding the disintegrated individual fibers into and through a gap between two electrodes having converging active faces, activating said electrodes so as to produce in said gap a progressively intensifying electrostatic field increasing with the distance travelled by the fibers and allowing said fibers to align parallel to each other and perpendicular to the fiber movement while they are being propelled through said gap.

10. A method as claimed in claim **9**, in which the fibers are introduced into the gap between the electrodes, propelled therethrough and transferred onto the surface of the film or filament curtain with the help of an air current.

11. A method as claimed in claim **9**, in which the fibers are introduced into the gap between the electrodes, propelled therethrough and transferred onto the surface of the film or filament curtain on both sides of the latter.

12. A method as claimed in claim 9, in which, prior to its contact with the fibers, the film or filament curtain is imparted with an electrostatic charge of opposite polarity to that of said fibers in order to cause their attraction.

13. A method as claimed in claim 9, in which the gap between the electrodes is adjusted to the average size of the fibers.

14. A method as claimed in claim 9, in which the fibers are consolidated and laminated with the film or filament curtain by passage through a pair of chilled pressure rolls.

15. A method as claimed in claim 9, in which the fibers are transferred onto the surface of the film or filament curtain by fiber collecting and delivering means.

16. A method as claimed in claim 15, in which said fiber collecting and delivering means consist of a rotatable, perforated and electrically grounded drum having stationary suction and blowing devices therewithin, the suction device being mounted for collecting the fibers on the drum by suction and the blowing device to deliver them onto the surface of the film or filament curtain without distorting the parallel alignment of said fibers.

17. A method as claimed in claim 16, in which, prior to its contact with the fibers, the film or filament curtain is charged with an electrostatic potential of predetermined intensity sufficient to cause the attraction of the fibers towards said film or filament curtain.

18. Apparatus for parallelizing staple fibers comprising two electrodes positioned one beside the other with their active faces facing each other, said faces converging toward each other and forming a gap therebetween, means for shifting said electrodes laterally toward and away from each other to adjust the size of said gap, fiber propelling means for forwarding the staple fibers to be parallelized to and through the gap between the electrodes, and means for activating said electrodes so as to create in the gap between said faces a progressively intensifying electrostatic field which increases with the distance travelled by the fibers and which is sufficiently strong to parallelize the staple fibers in the direction perpendicular to that of the fiber movement and means for forming the obtained parallel aligned staple fibers into a sliver or fiberweb without disturbing their orientation with respect to said electrostatic field.

19. Apparatus according to claim 18, in which the fiber propelling means for forwarding the staple fibers to and through the gap between the electrodes comprises air channels arranged transversely to the converging electrodes.

20. Apparatus for forming slivers or fiberwebs with substantially parallel arranged staple fibers comprising:

(a) licker-in means;

(b) means for forwarding a fibermat of at random arranged staple fibers toward and through said licker-in means, whereby it is disintegrated into individual fibers which are then propelled through air channels;

(c) two electrodes positioned one beside the other and transversely to said air channels, with their active faces facing each other, said faces converging toward each other and forming a gap therebetween;

(d) means for forwarding the disintegrated individual fibers by means of said air channels into and through said gap between the electrodes;

(e) means for moving said electrodes laterally toward and away from each other to adjust the size of said gap;

(f) means for activating said electrodes to create in the gap between said faces a progressively intensifying electrostatic field which increases with the distance travelled by the fibers and which is sufficiently strong to parallelize the staple fibers in the direction perpendicular to the fiber movement; and

(g) means for forming the obtained parallel aligned staple fibers into a sliver or a fiberweb with respect to said electrostatic field.

21. In combination, two apparatuses as claimed in claim 20, positioned side by side and further provided with means for combining the parallel aligned fibers from both said apparatuses to form the desired sliver or fiberweb.

22. Combination as claimed in claim 21, in which said means for combining the parallel aligned fibers comprise a pair of rotatable, perforated and electrically grounded drums positioned side by side and close to the gaps between the electrodes where the electrostatic field is the strongest; each of said drums being provided therewithin with stationary suction and blowing devices, the first mounted for collecting the parallel aligned fibers on the drum by suction and the second for blowing them towards each other to form a loosely held together fibermat with parallel aligned fibers.

23. Combination as claimed in claim 21, in which said means for combining the parallel aligned fibers comprise a pair of rotatable, perforated and electrically grounded drums positioned side by side with a small space being left therebetween, said drums also being positioned close to the gaps between the electrodes where the electrostatic field is the strongest; an extrusion device positioned above the space between said two drums and adapted to extrude a film or a filament curtain of thermoplastic material which will pass through said space between the drums; each of said drums being provided therewithin with stationary suction and blowing devices, the first mounted for collecting the parallel aligned fibers on the drum by suction and the second for blowing them onto a side of the passing film or filament curtain and parallel to said film or filament curtain which is still in tacky condition; and a pair of chilled pressure rolls provided below said space between the drums and adapted to rotate at a substantially higher speed than the rate of extrusion of the film or filament curtain, for laminating and consolidating the obtained film or filament curtain-fiber construction and simultaneously for providing a longitudinal molecular orientation of the thermoplastic material.

24. Combination as claimed in claim 21, in which said apparatuses are positioned side by side with a small channel therebetween and also comprising an extrusion device positioned above said channel and adapted to extrude a film or a filament curtain of thermoplastic material that will pass through said channel; aerodynamic means adapted to blow the fibers, which are aligned substantially parallel to each other and parallel to said film or filament curtain, onto each side of said film while said film is in a tacky condition and a pair of chilled pressure rolls below said channel adapted to rotate at substantially higher speed than the rate of extrusion of the film or filament curtain, for laminating and consolidating the obtained film or filament curtain-fiber construction and simultaneously for providing a longitudinal molecular orientation of the thermoplastic material.

25. Combination as claimed in claim 24, further comprising means for imparting to said film or filament curtain an electrostatic charge of opposite polarity to that of the fibers, at a point before it reaches the channel between the apparatuses, whereby a better attraction of the fibers towards the film or filament curtain is obtained.

26. Combination as claimed in claim 21, in which said means for combining the parallel aligned fibers comprise a pair of rotatable, perforated and electrically grounded drums positioned side by side with a small space being left therebetween, said drums also being positioned close to the gaps between the electrodes where the electrostatic field is the strongest; an extrusion device positioned above the space between said two drums and adapted to extrude a film or a filament curtain of thermoplastic material which will pass through said space between the drums; means adapted to impart an electrostatic charge to said material at a point before it reaches said space between the drums; each of said drums being provided therewithin with a stationary suction device for collecting the parallel aligned staple fibers on the drum by suction and the so

collected fibers will then be attracted onto a side of the film or filament curtain and parallel thereto through difference in potential; and a pair of chilled pressure rolls below said space between the drums adapted to rotate at a substantially higher speed than the rate of extrusion of the film or filament curtain, for laminating and consolidating the obtained film or filament curtain-fiber construction and simultaneously for providing a longitudinal molecular orientation of the thermoplastic material.

27. Combination as claimed in claim **26**, further comprising within each of said drums a blowing device mounted for blowing the parallel arranged fibers from the drum and onto the side surface of the thermoplastic film or filament curtain, still in tacky condition, in addition to their attraction through difference in potential.

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