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METHOD AND APPARATUS FOR FORMING FIBROUS MATERIAL

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Fig. 1

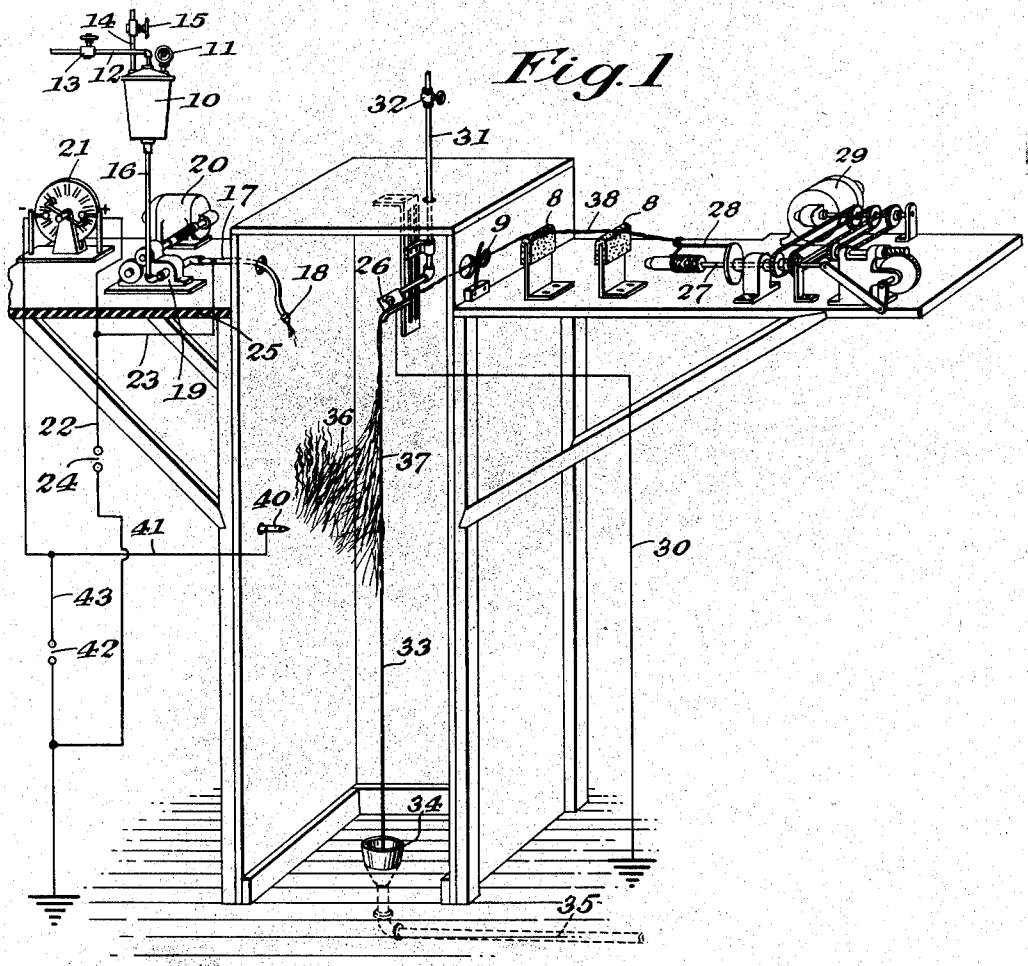
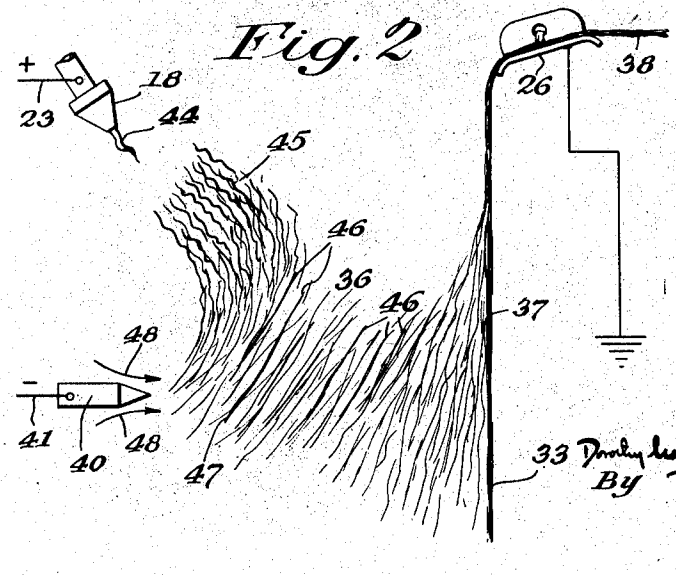


Fig. 2



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METHOD AND APPARATUS FOR FORMING FIBROUS MATERIAL

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Application November 13, 1939, Serial No. 304,082

10 Claims. (Cl. 18—8)

In a prior application, Serial No. 117,600, filed December 24, 1936, now Patent No. 2,265,742, are described a method and apparatus for producing a continuous length of fibrous material, for example, a roving, yarn, cord, or the like, from a succession of discontinuous artificial fibres by the electrostatic disruption into such fibres of a viscous liquid capable of rapid solidification, and the progressive withdrawal of the fibres, as they are formed, to a suitable collecting apparatus. As described in said application, the method includes electrifying the viscous liquid, for example, a solution of cellulose acetate in acetone, with an electrostatic charge while delivering the same from a nozzle in a continuous stream, thereby causing the stream to be disrupted and solidified into fibres in a region adjacent to but spaced from the point of delivery, collecting the fibres as they are formed on previously formed fibres in the form of a freely depending tail, and progressively withdrawing the tail, as it builds up, over a grounded support to form a sliver which may be led directly to a twisting and winding mechanism.

It has been found that the character, and particularly the evenness and strength, of the yarn or the like produced by the practice of the above method can be very greatly improved by subjecting the fibres, as they are formed and collected, to the effect of an electrified field of opposite polarity, and preferably substantially equal potential, to that of the disrupting charge. This is preferably done by means of a pointed electrode located beneath the nozzle and at the same side of the field or region of fibre formation, and directed or pointed toward the latter. As explained in the prior application above referred to, due to the electrostatic action, the material leaves the nozzle in the form of a tongue in a state of violent agitation or vibration which causes the resulting fibres to assume a more or less sinuous form and heterogeneous arrangement in the field of fibre formation. By reason, however, of the fact that the tail is supported in depending position, the fibres tend to move endwise and more or less upwardly into engagement therewith in orderly and generally parallel relatioinship. This is believed to be because each fibre, as it is formed, has its electrostatic charge concentrated at the ends, and the nearer of these ends tends to attach itself to the free end of the tail, leaving the remainder of the fibre free to be drawn in into parallel relationship with the other fibres. This action is assisted, and the resulting effect greatly augmented, by the action of the supplementary pointed electrode above referred to. With the latter arrangement, each fibre, in the field or region of its formation, is attracted at one end by the electrode and at the other by the tail, causing it to straighten out. The end of the fibre attracted by the electrode is prevented from approaching and adhering to the latter by the stream or current of electrified air which is projected from said electrode due to its pointed form. Consequently, as one end of the fibre is attracted toward and carried into engagement with the tail, the opposite end is attracted by the electrostatic field created by the electrode, so as to hold the fibre relatively straight, said fibre being, at the same time, caused or permitted by the air current to move toward the tail and to be drawn in into even and more truly parallel relation to the preceding fibres. In this way it has been found possible to produce a fine, even yarn of excellent quality and appearance having nearly three times the tensile strength and elasticity required by the minimum standards of leading manufacturers of textile material of this general character.

The invention will best be understood from the following description of the arrangement and operation of certain forms of apparatus embodying the same and by which it may be practiced, as illustrated in the accompanying drawing, the particular arrangements shown and the particular operations described having, however, been chosen for purposes of exemplification merely, as it will be obvious to those skilled in the art that the invention, as defined by the claims hereunto appended, may be otherwise embodied and practiced without departure from the spirit and scope thereof. It will also be understood that the theoretical statements herein contained as to the behavior of the materials, the effect of various factors involved, etc., are based on applicants' present knowledge of these matters, and are for the purpose of giving the fullest possible information now known to them, but without intention to limit themselves to the particular theories advanced.

In said drawing:

Fig. 1 is a diagrammatic perspective view, partly broken away, of an arrangement of apparatus embodying and suitable for practicing the invention.

Fig. 2 is an enlarged diagrammatic view illustrating the formation and collection of the fibres.

Except as hereinafter pointed out, the apparatus shown is similar to that described in prior application Serial No. 150,308, above referred to,

and includes a reservoir 10 (Fig. 1) for the viscous liquid material of which the fibres are to be formed, for example a solution of cellulose acetate in acetone. Means are preferably provided for applying a light pressure, indicated by a gauge 11, to the material in the reservoir, as, for example, a pipe 12 leading from a source of air under pressure and controlled by a valve 13. A supply pipe 14 controlled by a valve 15 may also be provided for replenishing the solution in the reservoir from time to time as may be required. Leading from the reservoir 10 is a standpipe 16 communicating with a conduit 17 leading to a delivery spout or nozzle 18 having an unobstructed discharge orifice of substantial size, for example a diameter of the order of ⅛ of an inch, or greatly in excess of that of the fibres to be formed. At a suitable point in the system, for example at the junction of the standpipe 16 and conduit 17, there is preferably interposed a metering pump 19 driven by a suitable motor 20. The metering pump may in some cases be omitted, particularly if sufficient pressure be provided to insure the flow of the liquid from the reservoir to the discharge spout, but it is preferred in order to insure an even flow of the material. 21 denotes an electrostatic machine or other suitable source of electric potential one pole, for example, the positive pole, of which is connected with the conduit 17 or other part of the discharge system as indicated at 23, whereby the liquid, prior to and at the instant of its discharge, is electrified with an electrostatic charge of single polarity. As a convenient means for controlling the potential of the charge, an adjustable spark gap 24 may be included in a ground connection 22 leading from the connection 23. The potential employed is susceptible of considerable variation in accordance with the length and fineness of the fibres desired. It should not be materially less than 5600 volts or materially greater than 13,000 volts, and is preferably of the order of from 7000 to 9000 volts. The electrified parts are all insulated from their support as indicated at 25.

Spaced horizontally from the discharge spout 18 is the collecting apparatus which, as shown, comprises a support 26 in the form of a short trough or guide, and a suitable winding and twisting apparatus which, as shown, comprises a spindle 27 and flyer 28 operated by an electric motor 29 through suitable power transmitting connections adapted to rotate the spindle and flyer at different speeds and reciprocate the spindle slowly in a longitudinal direction. The support 26 is preferably grounded as indicated at 30. Leading from a suitable source of cold water, or other liquid of the character above referred to, is a pipe 31 arranged to discharge said liquid upon the support 26 under the control of a valve 32, the liquid so discharged falling in a stream 33 into a receptacle 34 from which it is conducted to a suitable point of disposal through a conduit 35. Between the support 26 and spindle 27 may be suitably positioned guiding means 9 as well as wipers 8 for removing excess moisture.

With the apparatus arranged as above described, when the pump 19 and electrostatic machine 21 are started the material is discharged from the spout 18 in a highly electrified condition and is separated or disrupted into fine particles which are drawn out and solidified into discontinuous fibres in a region 36 adjacent to but spaced from the spout 18. A leader of cotton string is attached to the spindle 27 and passed over the guide 26 and allowed to hang down in the water stream to serve as a start for the fibres to build on. Said fibres are collected in or by contact with the wet string and the liquid 33 which flows through said region, whence they may be progressively withdrawn from said region and from said stream of liquid upwardly, or in a direction opposite to the direction of flow of said stream, over the support 26, so that the continued formation of fibres in said region and stream causes them to be built up on the tail 37 of fibres previously formed, resulting in the production of a continuous sliver or length 38 of fibrous material which is withdrawn over the support 26 and led to the twisting and winding apparatus where it is twisted into a yarn.

In accordance with the present invention there is provided, beneath the nozzle 18, a pointed electrode 40 located with its point disposed in the general direction of the region 36 of fibre formation, said electrode being connected, as indicated at 41, with the other pole, for example, the negative pole, of the electrostatic machine 21. The potential of the charge imposed upon the electrode 40 can be conveniently controlled by an adjustable spark gap 42 in a ground connection 43 leading from the connection 41. Preferably the electrostatic charges imposed upon the nozzle 18 and electrode 40, while of opposite polarity, are of substantially equal potential, although this is susceptible of variation.

Referring particularly to Fig. 2, due to the vibration of the tongue 44 of electrified liquid as it leaves the nozzle 18, the fibres initially formed are of sinuous form and more or less heterogeneous arrangement, as indicated at 45, but since their electrostatic charges are concentrated at their ends, the end of each fibre nearest the grounded tail 37 is attracted thereto, as indicated at 46, while the opposite end is attracted toward the electrode 40, as indicated at 47, so that the fibres straighten out and tend to arrange themselves more or less in parallelism. The ends 47, however, are prevented from engaging and adhering to the electrode by reason of the current of electrified air which is discharged from said electrode, due to its pointed form, as indicated by the arrows 48, which current prevents the fibre ends from reaching the electrode and, while still electrically attracting them in opposition to the attraction of the tail 37, causes them to be carried along by convection, in straight and relatively orderly arrangement toward the latter, so that, as the ends 46 approach and attach themselves to the tail, the remainder of the fibres will be drawn in in parallel relation, resulting in an even and altogether satisfactory sliver.

What is claimed is:

1. The art of forming a sliver of textile fibres, the method which comprises disrupting by an electrostatic charge a stream of liquid of a character adapted to form individual fibres when so disrupted, providing a ground including a sliver for attracting the disrupted fibres by electrostatic action, supporting the sliver so as to provide a depending tail thereon, subjecting said fibres as they are formed and in the region of said tail to the effect of an electrified current of air carrying a charge of opposite polarity to that of the disrupting charge and moving in a direction toward said sliver, whereby the fibres are caused to arrange themselves in substantially parallel relation and to attach themselves endwise to one another and to the sliver tail,

and progressively withdrawing the sliver at a speed to render the same continuous.

2. The art of forming a sliver of textile fibres, the method which comprises disrupting by an electrostatic charge a stream of liquid of a character adapted to form individual fibres when so disrupted, providing a ground including a sliver for attracting the disrupted fibres by electrostatic action, supporting the sliver so as to provide a depending tail thereon, subjecting said fibres as they are formed and in the region of said tail to the effect of an electrified current of air carrying a charge of opposite polarity to and of substantially equal potential to that of the disrupting charge and moving in a direction toward said sliver, whereby the fibres are caused to arrange themselves in substantially parallel relation and to attach themselves endwise to one another and to the sliver tail, and progressively withdrawing the sliver at a speed to render the same continuous.

3. The art of forming a sliver of textile fibres, the method which comprises disrupting by an electrostatic charge a stream of liquid of a character adapted to form individual fibres when so disrupted, providing a ground including a sliver wetted with a non-solvent electrically conductive liquid for attracting the disrupted fibres by electrostatic action, supporting the sliver so as to provide a depending tail thereon, subjecting said fibres as they are formed and in the region of said tail to the effect of an electrified current of air carrying a charge of opposite polarity to that of the disrupting charge and moving in a direction toward said sliver, whereby the fibres are caused to arrange themselves in substantially parallel relation and to attach themselves endwise to one another and to the sliver tail, continuously wetting the sliver with said electrically conductive liquid, and progressively withdrawing the sliver at a speed to render the same continuous.

4. The art of forming a sliver of textile fibres, the method which comprises disrupting by an electrostatic charge a stream of liquid of a characted adapted to form individual fibres when so disrupted, providing a ground including a sliver wetted with a non-solvent electrically conductive liquid for attracting the disrupted fibres by electrostatic action, supporting the sliver so as to provide a depending tail thereon, subjecting said fibres as they are formed and in the region of said tail to the effect of an electrified current of air carrying a charge of opposite polarity to that of the disrupting charge and moving in a direction toward said sliver, whereby the fibres are caused to arrange themselves in substantially parallel relation and to attach themselves endwise to one another and to the sliver tail, and progressively withdrawing the sliver from the field of fibre formation counter to the flow of said stream of electrically conducting liquid at a speed to render the sliver continuous.

5. An apparatus for forming a sliver of textile fibres comprising, in combination, means for disrupting a spinning liquid into discontinuous fibres in a field of fibre formation by the action of an electrostatic charge, means for subjecting said field to an electrostatic charge of opposite polarity to that of said first-named charge, a grounded support above said field adapted to support a sliver with a freely dependent tail, and means for progressively withdrawing a sliver of said fibres upwardly over said support as it is built up by the collection of successively formed fibres upon a tail of previously formed fibres depending from said support and sliver.

6. An apparatus for forming a sliver of textile fibres comprising, in combination, means for disrupting a spinning liquid into discontinuous fibres in a field of fibre formation by the action of an electrostatic charge, means for subjecting said field to an electrostatic charge of opposite polarity and substantially equal potential to that of said first-named charge, a grounded support above said field adapted to support a sliver with a freely dependent tail, and means for progressively withdrawing a sliver of said fibres upwardly over said support as it is built up by the collection of successively formed fibres upon a tail of previously formed fibres depending from said support and sliver.

7. An apparatus for forming a sliver of textile fibres comprising, in combination, means for disrupting a spinning liquid into discontinuous fibres in a field of fibre formation by the action of an electrostatic charge, a pointed electrode having an electrostatic charge of opposite polarity to that of said first-named charge adjacent said field and directed toward the latter, a grounded support above said field adapted to support a sliver with a freely dependent tail, and means for progressively withdrawing a sliver of said fibres upwardly over said support as it is built up by the collection of successively formed fibres upon a tail of previously formed fibres depending from said support and sliver.

8. An apparatus for forming artificial fibrous material from a spinning liquid capable of electrostatic disruption comprising, in combination, a nozzle, means for delivering the liquid from said nozzle in the form of an electrified stream, whereby said liquid, as it leaves said nozzle, is broken up and solidified into discontinuous fibres in a region adjacent to but spaced from said nozzle, a pointed electrode having an electrostatic charge of opposite polarity to that of said liquid located below said nozzle at the same side of said region and directed toward the latter, a support above said region adapted to support a sliver with a freely dependent tail, and means for progressively withdrawing the resulting material upwardly over said support in a continuous length as it is built up by the collection of successively formed fibres upon a tail of previously formed fibres depending from said support.

9. An apparatus for forming a sliver of textile fibres comprising, in combination, means for disrupting a spinning liquid into discontinuous fibres in a field of fibre formation by the action of an electrostatic charge, means for subjecting said field to an electrostatic charge of opposite polarity to that of said first-named charge, a grounded support, means for progressively withdrawing a sliver of said fibres over said support as it is built up by the collection of successively formed fibres upon a tail of previously formed fibres depending from said support and sliver, and means for progressively wetting said tail with a non-solvent, electrically conductive liquid.

10. An apparatus for forming artificial fibrous material from a spinning liquid capable of electrostatic disruption comprising, in combination, a nozzle, means for delivering the liquid from said nozzle in the form of an electrified stream, whereby said liquid, as it leaves said nozzle, is broken up and solidified into discontinuous fibres in a region adjacent to but spaced from said nozzle, a pointed electrode having an electrostatic charge of opposite polarity to that of said liquid located

below said nozzle at the same side of said region and directed toward the latter, a support above said region adapted to support a sliver with a freely dependent tail, means for progressively withdrawing the resulting material upwardly over said support in a continuous length as it is built up by the collection of successively formed fibres upon a tail of previously formed fibres depending from said support, and means for directing over said support and tail a falling stream of an electrically conductive liquid in which said fibres are insoluble.

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