Dec. 14, 1943. F. W. MANNING 2,336,743

METHOD AND APPARATUS FOR SPINNING UNWOVEN FABRICS

Filed Oct. 13, 1941 3 Sheets-Sheet 1

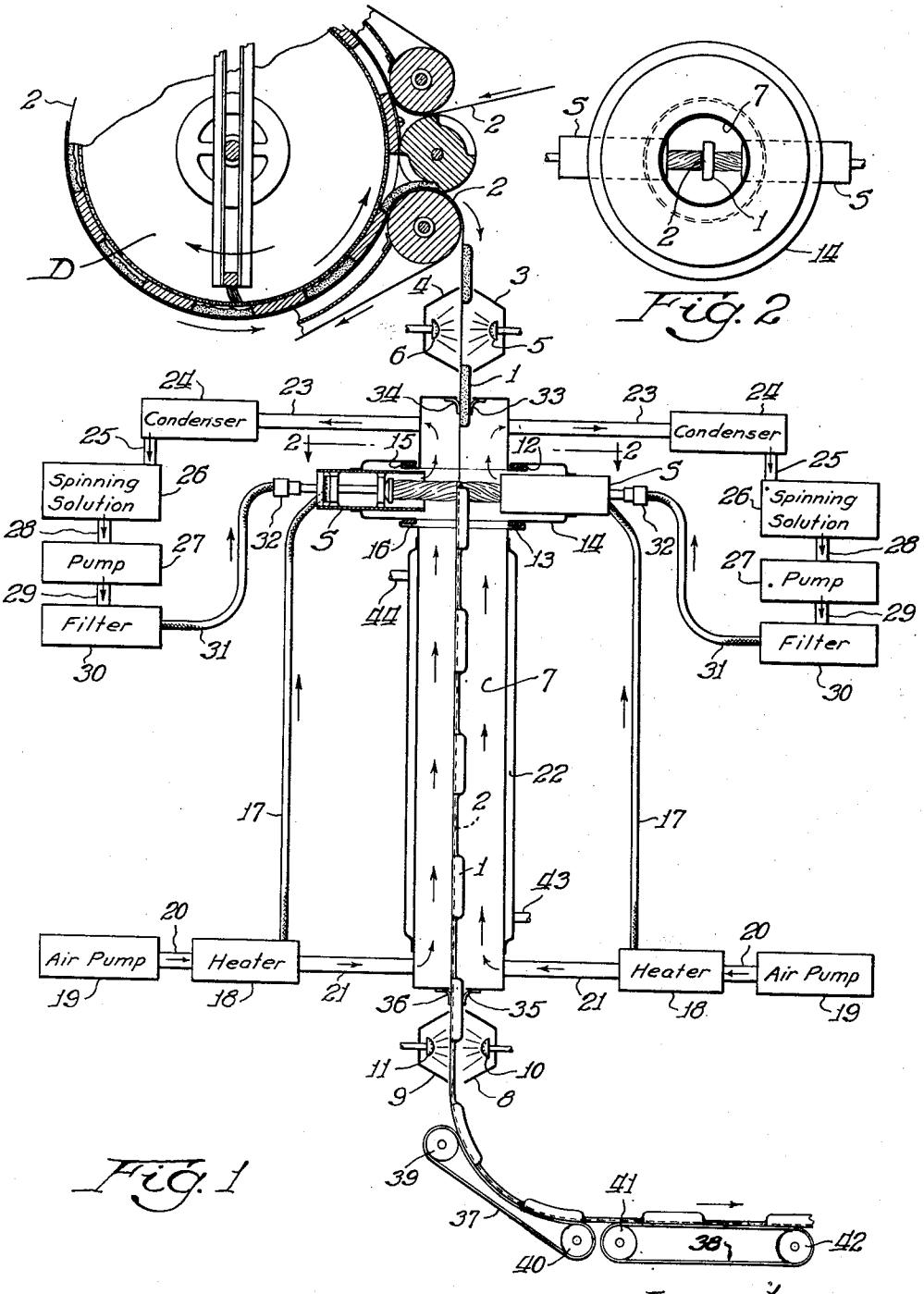

Fig. 1

Fig. 2

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METHOD AND APPARATUS FOR SPINNING UNWOVEN FABRICS

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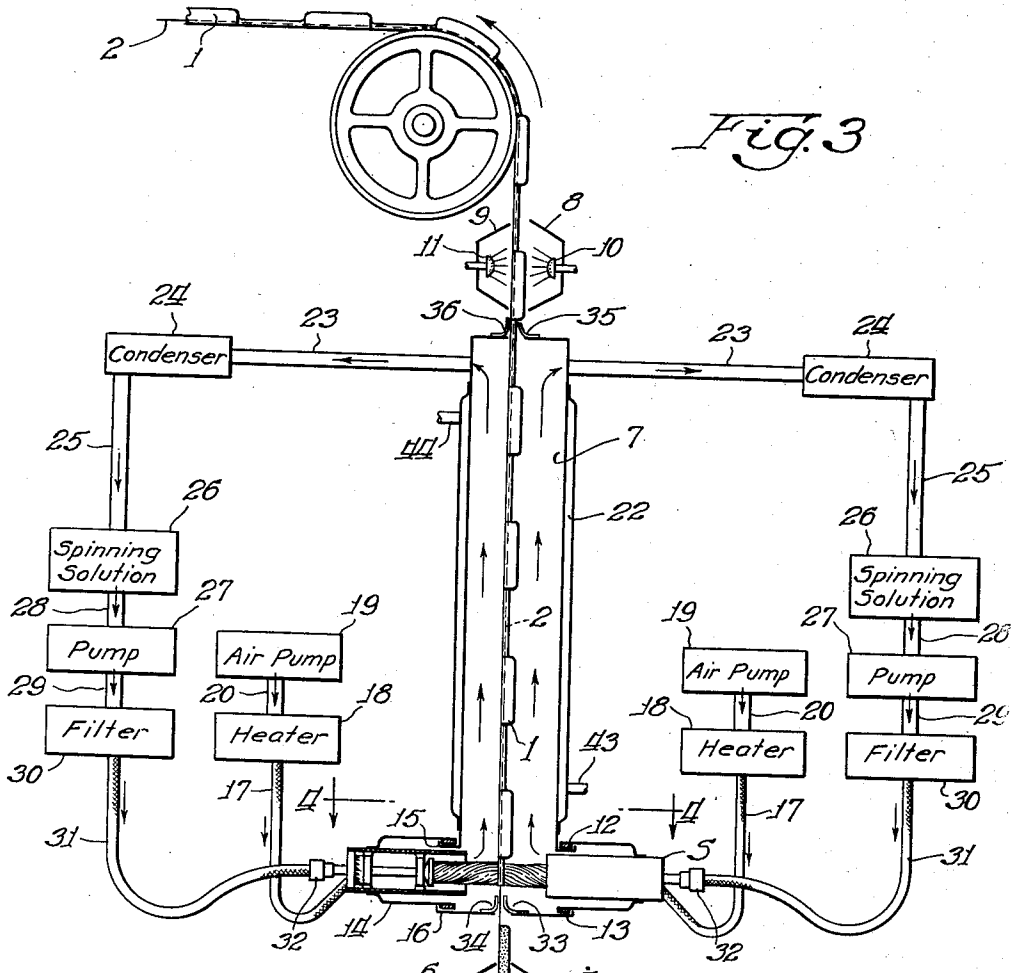

Fig. 3

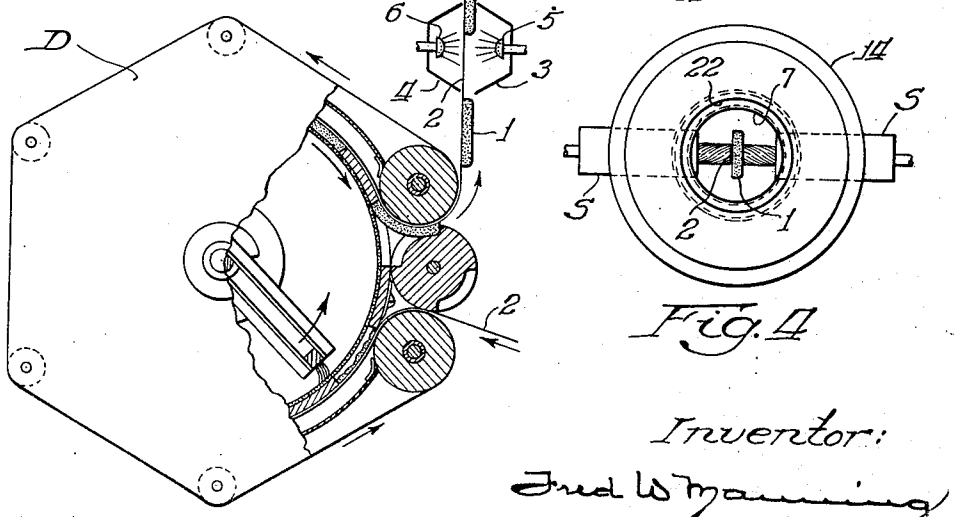

Fig. 4

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METHOD AND APPARATUS FOR SPINNING UNWOVEN FABRICS

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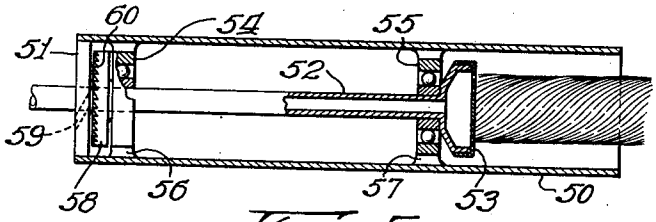

Fig. 5

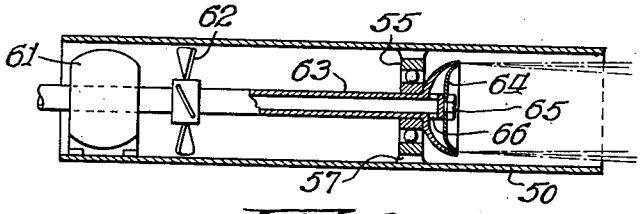

Fig. 8

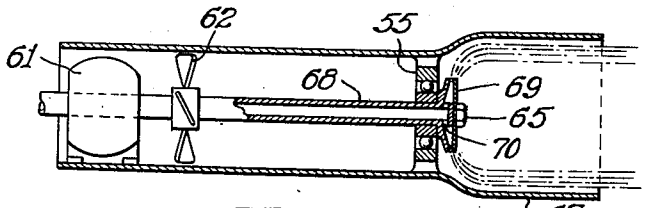

Fig. 9

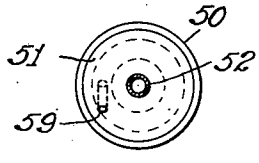

Fig. 6

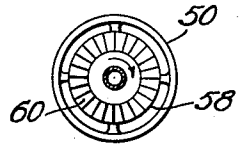

Fig. 7

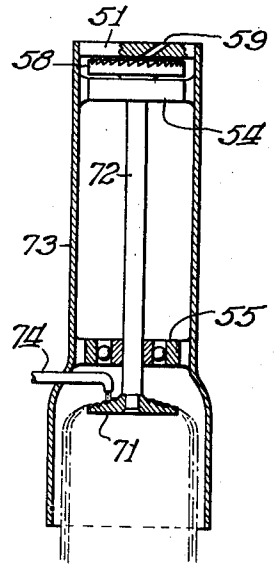

Fig. 11

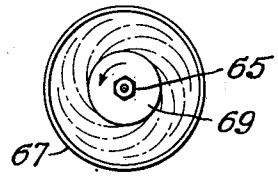

Fig. 10

Inventor:
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Patented Dec. 14, 1943

2,336,743

UNITED STATES PATENT OFFICE

2,336,743

METHOD AND APPARATUS FOR SPINNING UNWOVEN FABRICS

Fred W. Manning, Palo Alto, Calif.

Application October 13, 1941, Serial No. 414,809

15 Claims. (Cl. 18—8)

My invention relates to the manufacture of unwoven fabrics, and more particularly to the spinning of filamentous coatings over articles for their protection, conveyance, reinforcement, exhibition, and like purposes. This application is a continuation-in-part of my copending application, "Extensible fabrics," Serial No. 398,984, filed June 20, 1941.

The object of my invention is to provide a method and apparatus for spinning a coating or covering directly over the article to be enclosed, or otherwise treated, in order to avoid such operations as the fabrication of a plurality of filaments or fibres into threads or yarns, the weaving of threads into fabrics, the cutting and forming of fabrics for enclosures, etc.

In the art of sericulture it is well known that the silk glands of the silkworm consist of two sacs running along the sides of the body having a common extrusion outlet, or spinneret, on the underlip of the head of the larva, and as the larva approaches maturity these sacs become gorged with a clear viscous fluid which it proceeds to spin into an oval filamentous structure around itself by ejecting the spinning fluid from both glands simultaneously in a continuous reelable thread of perhaps 1,000 yards in length while moving its head around in regular order for several days. It should be noted that the thread so ejected consists of filaments seriposited from two separate glands, which during extrusion come into contact with a resinous substance called "sericin" exuded from two other glands. The sericin is supposed to serve the double purpose of helping the fine viscous threads through the spinneret and causing the filaments to adhere when brought into contact with the atmosphere so that the inner layers of the cocoons become so closely and densely agglutinated as to constitute a parchment-like mass. This adherence of a filament to the inside of the cocoon, in conjunction with a movement of the head of the larva relatively greater than the extrusion speed of the filament, enables the worm to give stretch and strength to the latter. After the cocoons have been treated in various ways to facilitate the removal of their filaments the latter are unwound from a number of cocoons simultaneously, twisted together to form a thread, the thread reeled and woven into a fabric, and the woven fabric cut and conformed for various covering purposes. Similarly, in the utilization of synthetic materials, it has been the practice to extrude the spinning dope through spinnerets to form individual filaments, coagulate the extruded filaments by spinning baths or solvent recovery chambers, twist and stretch the filaments during the curing process to form a thread or yarn, reel the spun threads for weaving, weave the reeled threads into a fabric, and cut and fit the fabric for various covering purposes.

As distinguished from such prior practice, I propose to follow more closely the habits of the silkworm by spinning a fabric, covering, or coating, directly and in close proximity to the spinneret, and thereby accomplish with a simple device the results that heretofore have required a number of complicated machines. In accordance with my invention, the spinning material is extruded through orifices in the spinneret, which may be slits, circular, or of other cross-section; the configuration may be such as to make the filaments, bristles, ribbons, or sheet, of any desired shape and size, the filamentous coating may be made water repellent, fire resistant, impervious to moisture, or of any desired porosity, and to adhere to the surface of the contained article, or to become physically homogeneous therewith, or simply to become an enclosure for the article; and the filaments may be spun in parallel lines that may intersect uniformly, or in irregular lines that intersect promiscuously and progressively about the article to be enclosed until the desired coating results. In all such structures, I prefer the spinning of the extruded filaments to be accomplished by the rapid whirling of the filaments within a controlled area while subject to the influence of an elastic fluid for directing the movements of the whorls, stretching, congealing, and depositing the filaments, in which case, the filaments will be treated in a dispersed or disrupted condition and not the continuous unbroken state so necessary in present practice. The deposition and induration of the spun filaments will cause the structure to conform to the shape of the object to be coated or enclosed; and any desired adherence of the two may be accomplished by the congealing of the filaments, or by use of a solution in which the solvent is common to both filaments and object to be coated, or by the application of an adhesive solution in which the solvent is not applicable to either. As an example: Acetone is a solvent for certain cellulosic fibres and may also be used as a solvent for a copolymer of vinyl chloride and vinyl acetate in a spinning solution, and such a solution may be used to autogenously weld the spun filaments to a pad of fibres to hold the latter together in the manufacture of surgical dressings; water is not a solvent for either filaments

or fibres, but it may be used as a solvent for sodium silicate in a spray solution to cause the filaments to adhere to the fibres. In any case, the object to be coated, or/and the deposited filaments, may be treated with a wetting agent, such as sodium sulfonate of dioctyl succinate, commonly sold as "Aerosol O T," to aid the bonding action. Of course, the silkworm builds its cocoon from the inside. I usually reverse this procedure by building the filamentous coating upon or about the object from the outside, but the very limited space required for my spinning operation is commensurate with that required by the silkworm; and speed of induration, stretching, and application of the filaments, is obtained by the rapid whirling of the filaments in a substantially separated condition in a suitable gaseous medium moving in a controlled path, in conjunction with a relative movement of spinneret and/or filaments and object being coated, until a sufficient filamentous structure or membrane on the object results. If the whirling speed is great compared with the extrusion velocity of the filaments the stretch will be correspondingly great, and may be increased by a rapid relative movement of the spinneret and object being coated to extend the whorls and filaments as they are deposited.

Any suitable material, such as a latex composition, cellulosic or petroleum derivative, polymeric amide, protein-base material, copolymer of vinyl chloride and vinyl acetate, etc., may be modified by other materials, such as pigments, resins, plasticizers, volatile solvents, etc., to form a viscous spinning fluid, providing such solution will produce a filamentous structure of the required characteristics as to strength, elasticity, heat-sensitivity, coagulant point, etc.; or a mineral, mineral derivative, and other organic and inorganic substances, such as glass, argillaceous limestone, polymeric amide, etc., may be spun separately or together from a molten state with or without the aid of solvents, plasticizers, etc., to produce a filamentous structure. Induration of the filaments and bonding agents may be accomplished by various means, such as vulcanization for latex compositions, evaporation for solutions containing a cellulosic derivative in a volatile solvent, a cooling agent for molten thermoplastics, absorption of oxygen for air-drying petroleum derivatives, hot air for heat reactive phenol-formaldehyde and glycerol-phthalic anhydride resins, contact with chemicals in a gaseous state for certain viscose materials, etc.; and any suitable elastic fluid, such as air, hydrogen, nitrogen, carbon dioxide, etc., may be used for heating, cooling, evaporating, directing the movements of the filaments, and other spinning and curing operations.

The invention is exemplified in the following description, and a preferred arrangement is illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a part vertical section of the spinning and curing chambers with the auxiliary equipment shown diagrammatically, and in which the indurating gases in the curing chamber pass countercurrently to the movement of the fabric.

Figure 2 is a cross-section of the curing chamber taken on line 2—2 of Figure 1.

Figure 3 is a part vertical section of the spinning and curing chambers with the auxiliary equipment shown diagrammatically, and in which the indurating gases in the curing chamber pass concurrently to the movement of the fabric.

Figure 4 is a cross-section of the curing chamber taken on line 4—4 of Figure 3.

Figure 5 is a vertical section of a spinning chamber having a rotative spinneret driven by a fluid motor.

Figure 6 is the motor end view of the spinning cylinders shown in Figures 5 and 11.

Figure 7 is the motor end view of the spinning cylinders shown in Figures 5 and 11 with the cylinder head removed.

Figure 8 is a vertical section of a spinning chamber having a rotative spinneret driven by an electric motor.

Figure 9 is a vertical section of a spinning chamber having a centrifugal spinneret driven by an electric motor.

Figure 10 is an end view of Figure 9 showing the movement of the spiralling filaments resulting from centrifugal spinning.

Figure 11 is a vertical section of a spinning chamber showing another type of centrifugal spinneret, driven by a fluid motor.

Referring to the drawings more specifically by reference characters:

Figure 1 shows the discharge of fibre fluff sanitary pads 1 from the deposition chamber D, described in my copending application, entitled "Extensible fabrics," Serial No. 398,984. These pads are connected together by attenuated ends, string, or tape 2, which may be pervious and moistened with an adhesive to cause the fibres to adhere thereto, and move as a continuous sheet through: enclosures 3 and 4, where they may be treated to wetting agents, deodorizers, adhesive materials, or other treating agents, from spray nozzles 5 and 6, respectively; curing chamber 7, where the deposited filaments become indurated; and enclosures 8 and 9, where the coated pads also may be treated by wetting agents, water repellents, adhesive materials, or other treating agents, from spray nozzles 10 and 11, respectively. Rings 12 and 13 of the spinning manifold 14, rotate in the circular tracks 15 and 16, respectively, of the curing chamber, and positioned radially in the spinning manifold are one or more spinning chambers S. The flexible hose 17, which permits rotative movement of the spinning manifold, conveys air from the heater 18 to the spinning chamber through which it passes concurrently with the movement of the filaments to accomplish their spinning, deposition, and partial induration; and the heater is supplied by air from pump 19 through the pipe line 20. The same means is used to supply heated air through pipe line 21 to the curing chamber where it may be further heated by steam jacket 22 during which it treats the deposited filaments in a movement counter to that of the pads. A portion of the volatile solvent of the spinning solution is therefore removed in the spinning chamber by a concurrent movement of the air during the spinning operation, and the balance is removed from the deposited filaments by a counter-current movement of the air in the curing chamber, after which the two volumes of solvent laden air unite to be exhausted through pipe line 23 to the condenser 24. The condensate is discharged through pipe 25 to the spinning solution supply tank 26, which is connected to the pump 27 by means of pipe 28. The solution is then conveyed to the spinning chamber under pressure and in a filtered condition by means of: pipe 29, filter 30, flexible pipe 31 which allows for swing of the spinning manifold, and turning joint 32. Flexible strips 33 and 34, and 35 and

36, at the inlet and outlet of the curing chamber, respectively, prevent loss of solvent vapor and ingress of air. Conveyor belts 37 and 38, passing over pulleys 39 and 40, and 41 and 42, respectively, convey the coated pads away for cutting and wrapping purposes. Inlet 43 and outlet 44 permit circulation of steam through the heating jacket of the curing chamber.

Figure 3 shows an arrangement in which the spinning manifold is placed at the bottom of the curing chamber and the spinning fluid is used to treat and complete the induration of the deposited filaments in a concurrent movement, both treating gases and pads moving in an upward direction.

Figures 2 and 4 show an arrangement for two opposed spinning chambers S, in a rotatable spinning manifold. The latter may be built to take any required number of chambers, which will usually be positioned radially and spaced uniformly. The number used will determine the extent to which the manifold must swing to cause the filaments to overlap during deposition before the swinging action should be reversed. The swing back and forth may be accomplished by hand, but preferably is actuated by the well known automatic rotative reversing equipment.

Figure 5 shows a spinning chamber consisting of cylinder 50, cylinder head 51, spinning tube 52, spinneret plate 53, ball bearings 54 and 55, rib supports 56 and 57, respectively, for the ball bearings, and a fluid impeller 58 fastened to the spinning tube. Air from one or more ports 59 engage the buckets 60, causing the tube to spin, and escapes at the periphery of the impeller through the openings between the rib supports, and finally through the annular space between the spinneret and cylinder. The pump pressure of the spinning solution and the rapid rotative movement of the spinneret cause each extruded filament to move forward in a helicoid, thereby stretching the filaments; and in this forward helical movement the helices are extended, and the filaments supported, surrounded, conveyed, and given an additional stretch by the discharge of the annular column of air, which is also given a rotative movement in the same direction by the rapid turning of the spinneret. The end views of the spinning chamber with and without the cylinder head are shown in Figures 6 and 7, respectively.

Figure 8 shows an arrangement in which an electric motor 61, which may be placed internally or externally of the spinning chamber, is substituted for the fluid motor of Figure 5. A fan 62, attached to the spinning tube 63, supplies the air pressure required for supporting, surrounding, conveying, and stretching the whirling filaments. In this arrangement a flexible spinneret plate 64 is fastened to the spinning tube by lock nut 65, and the spinning fluid escapes from the tube through openings 66 into the centrifugal bowl of the tube. Extrusion force, resulting from pump differential pressure and/or centrifugal action causes the spinneret plate to give sufficiently to allow an annular film to be extruded, and this film immediately disperses into filaments as a result of pump pressure and/or centrifugal force and/or movements of the elastic conveying fluid.

Figure 9 shows a centrifugal spinneret arrangement in which a cylinder 67 encloses a spinning tube 68 and a spinneret plate 69. Openings 70 permit the spinning dope to escape from the tube into the centrifugal bowl from which it is spun through openings in the bowl's periphery, or by deflecting the spinneret plate; and the spinning fluid is dispersed into filaments as the result of the spinning forces mentioned in connection with the design shown in Figure 8. The rotation of the spinneret results in each extruded filament stretching into an ever widening spiral that bends forward until its movement is directed towards the object to be coated as a result of the annular rush of air from the blower.

Figure 10 shows the end of the cylinder in Figure 9, indicating the spiral spinning of the filaments as the result of centrifugal action.

Figure 11 shows a vertical spinning chamber in which a serrated spinneret plate 71 is fastened to a rod 72, which is driven by a fluid motor enclosed within the smaller end of the spinning cylinder 73. In this construction the spinning dope is discharged from the pipe 74 onto the serrated plate, and upon overflowing the last serration is thrown off centrifugally and the spiralling filaments carried forward by the annular rush of air from the fluid motor exhaust.

It will be obvious from the foregoing description that both the extrusion of the filaments through the spinneret, and the stretching of the extruded filaments, are spinning operations; and that whirling of the filaments in a controlled path may be used to greatly speed up the spinning, curing, and application of the filaments, and also simplify the apparatus required for such a purpose. The whirling may be accomplished spirally by means of centrifugal force, and the spiralling filaments then carried forward for deposition purposes by an elastic fluid moving in a controlled path; or the whirling may be accomplished helically by extruding the filaments axially under pressure through a revolving spinneret and conveying the filaments forward by an elastic fluid moving in a controlled path; or axially extruded filaments may be carried forward directly without whirling by an elastic fluid moving in a controlled path. If the filaments are extruded and spun by centrifugal force, each one will form a spiral in which the filament will stretch as the spiral increases in diameter, and the conveying fluid will cause the spirals to bend forward and stretch before deposition can take place; if the filaments are extruded axially through a rotating spinneret, each filament will still be whirled in a spiral in proportion to the centrifugal force exerted and then advanced to form a helicoid, and the coils of the helix stretched toward the object to be coated in proportion to the velocity of the conveying fluid until the rotative force of the spinneret is lost, and the filaments will be deposited with less disruption than in the former case; if the filaments are extruded axially and carried forward directly without whirling they will be stretched in proportion to the velocity of the conveying fluid, and the disruption of the filaments during conveyance and deposition may be very little; and, of course, the spinning of a filamentous coating may be accomplished without whirling of the filaments, and without the aid of an elastic fluid, and without disruption of the filaments, by a rapid movement of the object being coated whose surface speed ordinarily would be greater than the extrusion velocity of the filaments. However, whether the filaments are spun spirally, helically, or in a straight line, they must travel relatively, and preferably be deposited progressively, over the object to be coated; and during deposition of the filaments the conveying fluid

may pass through the object being coated, or it may be diverted without such passage, or its force may be neutralized. The spinning may therefore be accomplished by an extrusion force, movement of a conveying fluid, or a relative movement between the filaments or spinneret and the object to be coated, but preferably is the result of the cooperative movements of all three; an elastic fluid may be used for spinning, conveying, indurating, and depositing purposes; and the induration of the filaments may be accomplished during spinning, or after deposition, but preferably takes place during both periods for the purposes of speeding up the curing process, to facilitate the conforming of the filaments to the shape of the object to be covered, and sometimes to obtain adherence between the filaments and object coated.

Throughout the specification and appended claims, it will be understood: "to disrupt a spinning material" means, to extrude, or break up, or otherwise divide, the spinning material into filaments, and this may be accomplished from a solvent, molten, or other state; a "spinneret" is any device that may be used, to extrude, or break up, or otherwise divide, the spinning material into filaments; "spinning" means, to form by extension of a spinning material; "integral" means, all of one piece; and "retaining wall" includes, sheets, pads, and all other articles that may be coated or enclosed by a filamentous structure, or upon which a filamentous structure may be supported or deposited.

I claim as my invention:

1. The method of spinning an unwoven fabric comprising: disrupting a plastic spinning material into a plurality of filaments; and conveying the said filaments by force of a fluid stream moving in a controlled path in such manner as to cause the filaments while they are still sufficiently plastic to adhere to one another, to intersect and unite into an integral pervious web.

2. The method of spinning an unwoven fabric comprising: disrupting a plastic spinning material into a plurality of filaments; conveying the said filaments by force of an elastic fluid moving in a controlled path; and depositing the said filaments while sufficiently plastic to adhere to one another, upon a retaining wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web.

3. The method of spinning an unwoven fabric comprising: disrupting a plastic spinning material into a plurality of filaments; conveying the said filaments by force of a fluid stream moving in a controlled path; and depositing the said filaments while sufficiently plastic to adhere to one another, progressively upon a retaining wall by relative movement of the said stream over the wall, and in such a manner as to cause the filaments to intersect and unite into an integral pervious web.

4. The method of spinning an unwoven fabric comprising: heating a plastic spinning material to a molten state; disrupting the molten material into a plurality of filaments; and depositing the said filaments while sufficiently plastic to adhere to one another, upon a retaining wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web.

5. The method of spinning an unwoven fabric comprising: heating a plastic spinning material to a molten state; disrupting the molten material into a plurality of filaments and dispersing the filaments by action of centrifugal force; and depositing the dispersed filaments while sufficiently plastic to adhere to one another, upon a retaining wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web.

6. The method of spinning an unwoven fabric comprising: disrupting a plastic spinning material into a plurality of plastic filaments; stretching the plastic filaments by moving them at a greater speed than that at which the filaments are formed; and depositing the extended filaments while sufficiently plastic to adhere to one another, upon a retaining wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web of substantial strength.

7. The method of spinning an unwoven fabric comprising: disrupting a plastic spinning material into a plurality of plastic filaments by the action of centrifugal force; stretching the plastic filaments by moving them in whorls by force of an elastic fluid at a greater speed than that at which the filaments are formed; and depositing the extended filaments while sufficiently plastic to adhere to one another, upon a retaining wall in such a manner as to cause the filaments to intersect promiscuously and unite into an integral pervious web of substantial strength.

8. The method of spinning an unwoven fabric comprising: disrupting a plastic spinning material into a plurality of filaments; conveying and dispersing the said filaments by force of a fluid stream moving in a controlled path; depositing the said filaments while sufficiently plastic to adhere to one another, upon a retaining wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web.

9. The method of spinning an unwoven fabric comprising: forming a plastic spinning solution of a fibre producing material and a solvent; disrupting the said solution into a plurality of filaments; disrupting and dispersing the said filaments by force of a fluid stream moving in a controlled path; depositing the said filaments while sufficiently plastic to adhere to one another, upon a retaining wall in such a manner as to cause the filaments to intersect promiscuously and unite into an integral pervious web.

10. In a spinning apparatus, the combination of: a spinneret; a curing chamber to which the said spinneret is connected; means for moving a retaining wall into the said chamber; means for passing a plastic spinning material through the said spinneret to disrupt the material into a plurality of filaments; and means for conveying the said filaments while sufficiently plastic to adhere to one another, from the said spinneret to the said wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web on the wall.

11. In a spinning apparatus, the combination of: a spinneret; a curing chamber to which the said spinneret is connected; means for moving a retaining wall into the said chamber; means for passing a plastic spinning material through the said spinneret to disrupt the material into a plurality of filaments; means for conveying the said filaments while sufficiently plastic to adhere to one another, from the said spinneret to the said wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web on the wall; and means for passing a treating fluid through the said chamber in

a counter direction to the movement of the said wall to indurate the said web.

12. In a spinning apparatus, the combination of: a spinneret; a curing chamber to which the said spinneret is connected; means for moving a retaining wall into the said chamber; means for passing a plastic spinning material through the said spinneret to disrupt the material into a plurality of filaments; means for conveying the said filaments while sufficiently plastic to adhere to one another, from the said spinneret to the said wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web on the wall; and means for moving the said spinneret and said wall relatively during the said deposition whereby the filaments are extended and strengthened and the said web is progressively formed.

13. In a spinning apparatus, the combination of: a spinneret; a curing chamber to which the said spinneret is connected; means for moving a retaining wall through the said chamber; means for passing a plastic spinning material through the said spinneret to disrupt the material into a plurality of filaments; and means for conveying the said filaments while sufficiently plastic to adhere to one another, from the said spinneret to the said wall simultaneously with the movement of the wall through the said chamber in such a manner as to cause the filaments to intersect and unite progressively into an integral pervious web on the wall.

14. In a spinning apparatus, the combination of: a spinneret; a curing chamber to which the said spinneret is connected; means for moving a retaining wall through the said chamber; means for passing a plastic spinning material through the said spinneret to disrupt the material into a plurality of filaments; and means for conveying the said filaments while sufficiently plastic to adhere to one another, from the said spinneret to the said wall at a greater speed than that at which the filaments are formed in such a manner as to cause the extended filaments to intersect and unite into an integral pervious web of substantial strength on the wall.

15. In a spinning apparatus, the combination of: a spinneret; a curing chamber to which the said spinneret is connected; means for moving a retaining wall into the said chamber; means for passing a plastic spinning material through the said spinneret to disrupt the material into a plurality of filaments at a given speed; means for applying a fluid stream to the said filaments to disperse and propel the filaments in the direction of their travel at a greater than the said given speed whereby the filaments are extended; and means for depositing the extended filaments on the said wall while sufficiently plastic to adhere to one another, in such a manner as to cause the filaments to intersect and unite into an integral pervious web of substantial strength on the wall.

FRED W. MANNING.

Disclaimer

2,336,743.—*Fred W. Manning*, Palo Alto, Calif. METHOD AND APPARATUS FOR SPINNING UNWOVEN FABRICS. Patent dated Dec. 14, 1943. Disclaimer filed Nov. 20, 1947, by the inventor.

Hereby enters this disclaimer to claim 4 in said specification.

[*Official Gazette December 16, 1947.*]