Oct. 4, 1949. C. S. FRANCIS, JR 2,483,406

PROCESS AND APPARATUS FOR PRODUCING FIBROUS MATERIALS

Original Filed Nov. 20, 1943

Fig. 1.

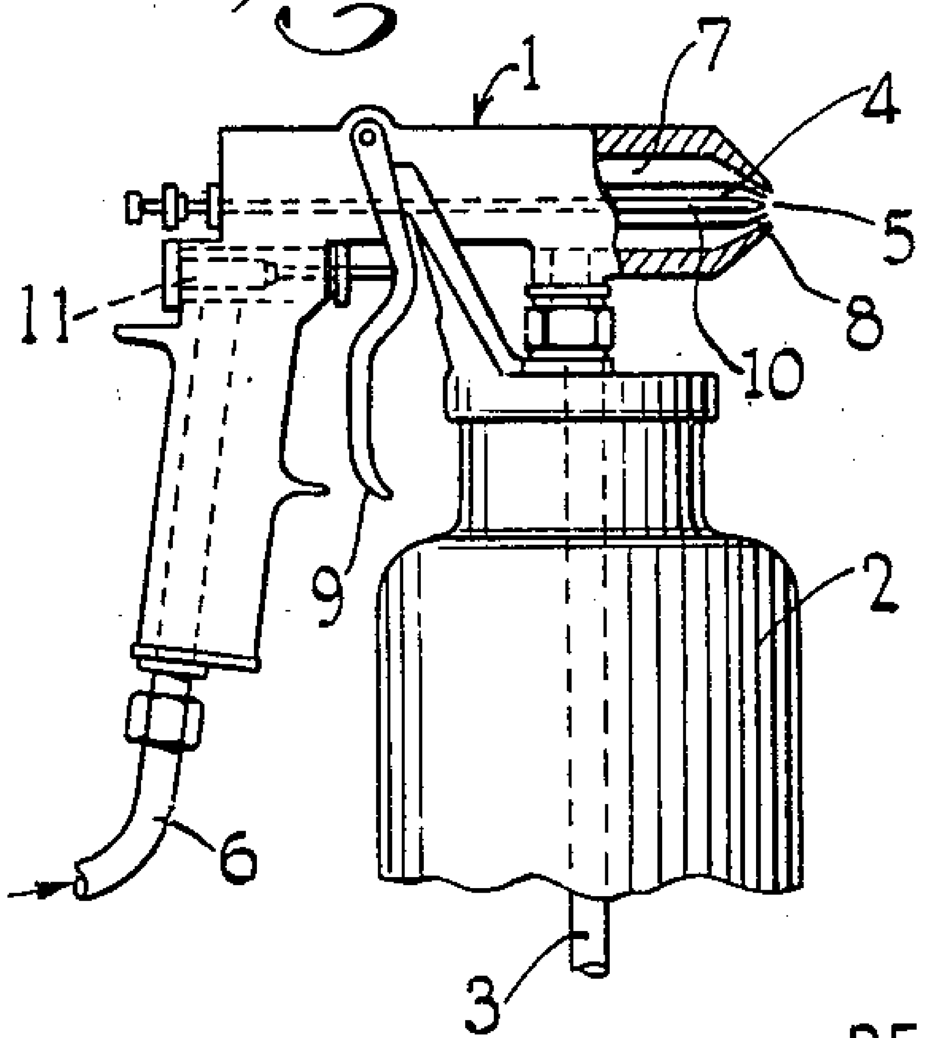

Fig. 2.

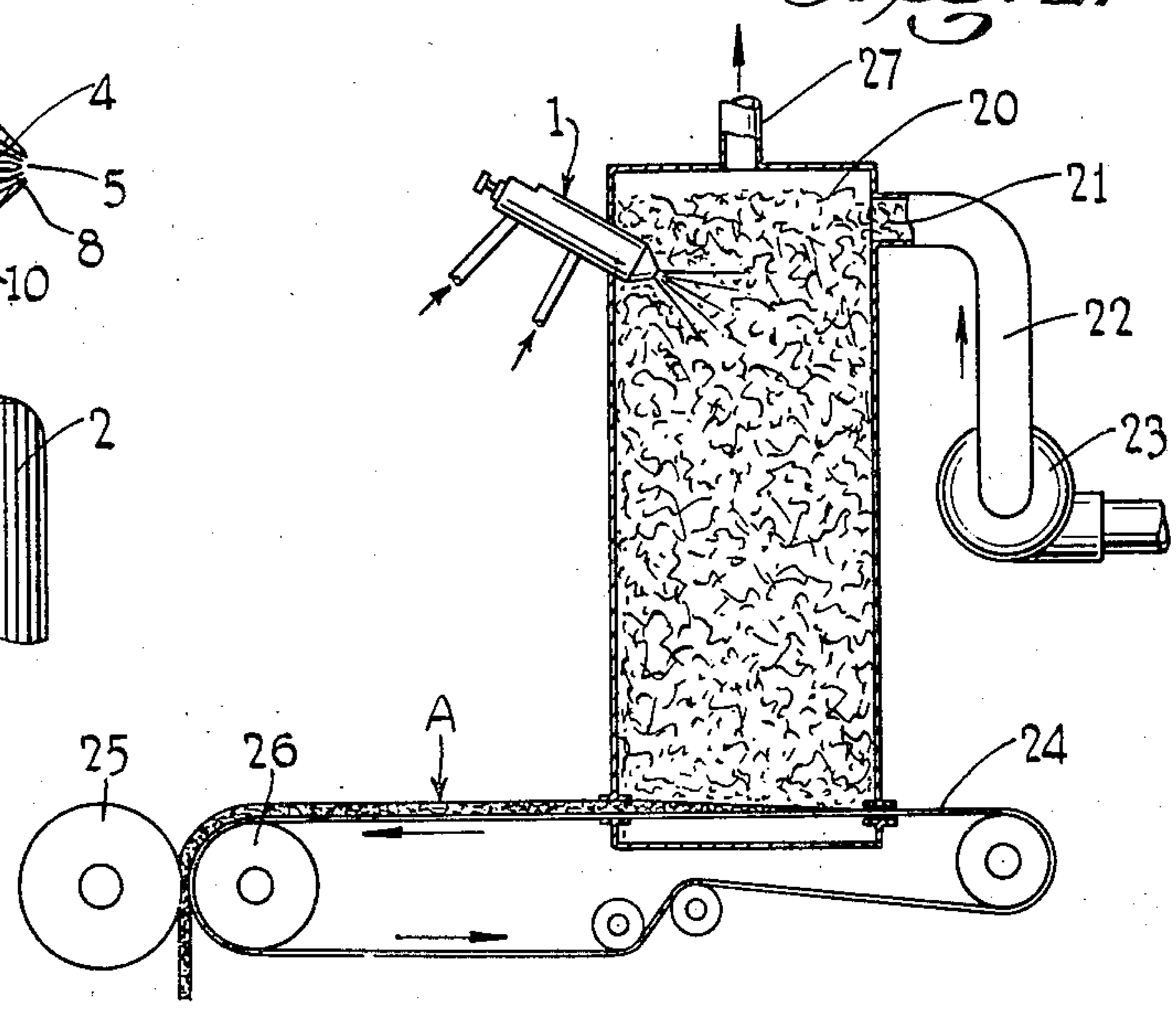

Fig. 3.

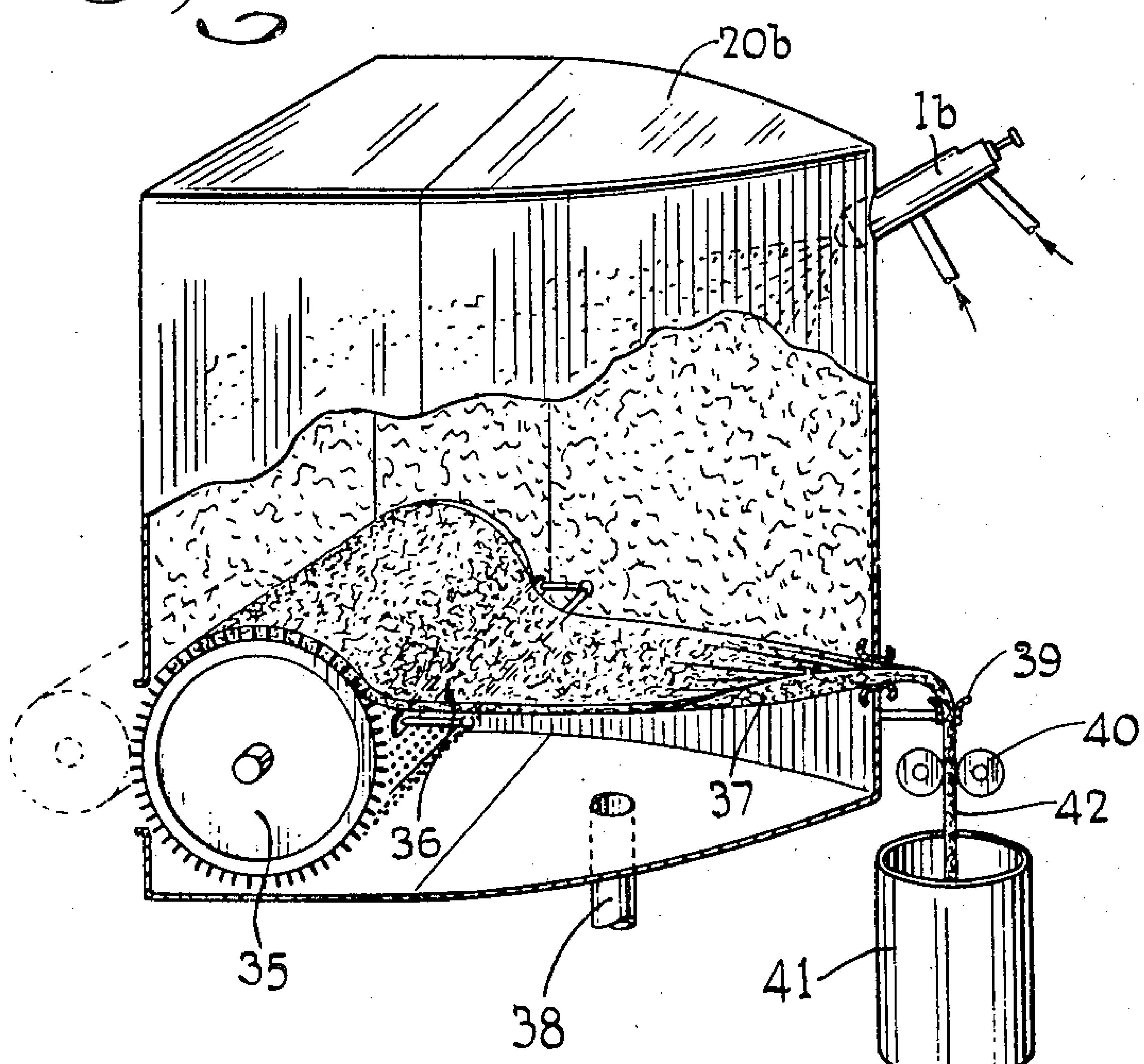

Fig. 5.

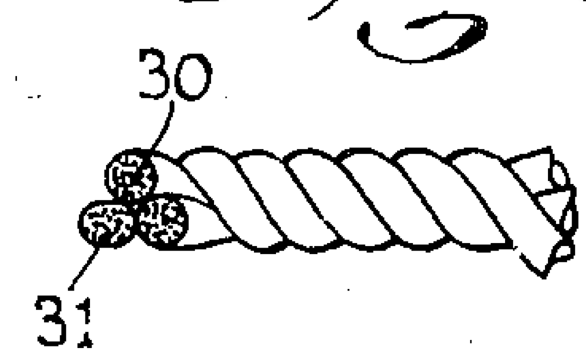

Fig. 4.

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PROCESS AND APPARATUS FOR PRODUCING FIBROUS MATERIALS

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Original application November 20, 1943, Serial No. 511,024. Divided and this application December 16, 1947, Serial No. 792,020

11 Claims. (Cl. 154—29)

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The present invention relates, in general, to methods and apparatus for producing fibrous products, such as textiles containing fibres which can be rendered adhesive to bind fibres in the product together. The fibrous products may, if desired, contain non-adhesive fibres in addition to the potentially adhesive fibres. The invention also relates to processes designed to enhance the quality, utility, structure, and properties of such products without detrimentally affecting the flexibility, porosity, or other desirable characteristics inherent in the products.

The present application is a division of application Serial No. 511,024, filed November 20, 1943, which application was a continuation-in-part of application Serial No. 381,292, filed March 1, 1941 (now Patent No. 2,357,392) and of application Serial No. 405,102, filed August 1, 1941.

The present invention also relates generally to the production of textiles of the types disclosed and claimed in U. S. Patents Nos. 2,252,999 and 2,253,000, which textiles are formed from at least two types of fibres, one of which can be rendered adhesive to bind fibres in the product. Potentially adhesive fibres heretofore manufactured and sold are formed by extrusion through spinnerettes such as are used in the manufacture of rayon. Such extrusion processes are limited to the use of certain plastic compositions having proper filtering characteristics, requisite solubility, viscosity, wet and dry tensile strength, and other characteristics necessary for spinning the materials into continuous filaments. Moreover, the filaments thus produced must fall within a narrow range as to denier and must be cut to staple lengths within a narrow range imposed by their use on conventional textile and felting equipment, that is, the cut staple fibres must be capable of being carded, drafted, spun, and felted on standard equipment used for making textiles and felts. Moreover, it is not practical, in many cases, to incorporate plasticizers, hardening agents, and the like in the plastic composition before extrusion since such additions change the spinning properties and the products so produced can seldom be sold as regular textile fibres, thus decreasing the market and increasing the cost of such specially formulated fibres. Accordingly, the combination of the above-mentioned factors limits the artificial fibres available to a few kinds of thermoplastic materials, to a narrow range of fibre lengths and deniers, to certain kinds of plasticizers and puts the thermoplastic fibres so produced in a high price range.

Therefore, it is a general object to provide processes for the production of fibrous products in which fibres in the product are bound together as a result of the activation of potential adhesive fibres in the product.

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It is a further object of the invention to provide processes by which improved fibrous products of the type just mentioned can be produced without limitation as to the nature of the material from which the potentially adhesive fibres can be made, or of the plasticizers which may be incorporated in such fibres.

It is a further object of the invention to provide processes for the production of fibrous products of the type described without limitation as to length or denier of the potentially adhesive fibres.

It is another object of the invention to provide processes by which improved textiles comprising at least two types of fibres, one of which is adapted to be rendered adhesive for binding fibres together in the product can be readily produced.

Other objects of the invention, including the provision of novel apparatus in which the aforesaid processes can be conducted, will in part be obvious and will in part appear hereinafter.

According to the process claimed in my copending application Serial No. 381,292 (now Patent No. 2,357,392) fibrous products are made by associating discontinuous potentially adhesive organic plastic fibres, concurrently with their formation, with non-adhesive fibres, more particularly by dispersing into a gas, a potentially adhesive fibre-forming material to form fibres, associating the potentially adhesive fibres concurrently with their formation with another type of fibre, fabricating said mixture of fibres into a fibrous structure, such as a textile, and thereafter activating the potentially adhesive fibres to bind fibres in the product. In contrast to prior extrusion methods, the potentially adhesive material in that process is formed into fibres by dispersing it, as by spraying a plastic or molten mass of the material or a solution of the material in a suitable solvent into a gaseous atmosphere, under such conditions that a multiplicity of filamentary structures are produced as described in detail hereinafter.

The fibrous products and fibrous structures produced comprise a multiplicity of potentially adhesive fibres associated with a multiplicity of non-adhesive fibres, the fibres being preferably commingled in an unarrayed manner, the potentially adhesive fibres varying in diameter and length and contacting the other fibres at substantially more points than an equal weight of the fibre-forming material when spun as continuous filaments and then cut into staple fibres. It is to be understood that the articles of the present invention may be made in a number of ways and are not limited to products produced by the processes of my copending application Serial No. 381,292, filed March 1, 1941.

In the following specification and in the claims, the term "fibre" or "fibres" when used in reference to the potentially adhesive material is intended to include any fibril and discontinuous fibres, whether independent from one another or adhered at spaced points to form a felted product or reticulated structure. The expression "fibrous product" includes rolls, mats, bats, and other interfelted products, and the term "fibrous structure" includes textile products such as fabrics, felts, and paper as well as rovings, yarns, threads, and cords formed from said mixture of fibres.

Among the textiles which may be produced are yarn, single or plied, threads, and cords of all kinds which may be used as warp or as filler (weft) in making fabrics, or in association with other yarns of like or unlike character, in weaving, knitting, netting, lacing, and other textile constructions, and when doubled or twisted with other yarns, for the preparation of threads and cords of all kinds.

The term "adhesive" includes sticky, cementitious, agglutinous, or tacky conditions. The term "non-adhesive fibres" includes those fibres which, although they may be rendered adhesive by some treatment, are not rendered adhesive under the conditions used to activate the potentially adhesive fibres associated therewith.

For a more complete understanding of the invention, reference should be had to the accompanying drawing, in which:

Fig. 1 is a side elevation, partly in section, of one embodiment of suitable means for forming the potentially adhesive fibres of the invention;

Fig. 2 is a side elevation, partly in section, of one embodiment of means for carrying out the invention in the fabrication of flat felts and papers;

Fig. 3 is a side view, partly in section, of a suitable means for commingling fibres in the fabrication of one embodiment of the fibrous product of the invention;

Fig. 4 is an enlarged perspective view of one of the potentially adhesive fibres used in the fibrous products of the invention; and

Fig. 5 is an enlarged view in cross-section of a layer of the commingled fibres in one embodiment of the product.

Among the non-adhesive fibres which may be employed are natural fibres such, for example, as wood fibres, cotton, flax, jute, kapok, wool, hair, and silk; and synthetic fibres, such, for example as cellulosic fibres, such as cellulose hydrate, cellulose derivatives, as cellulose esters, mixed cellulose esters, cellulose ethers, mixed cellulose ester-ethers, mixed cellulose ethers, cellulose hydroxy-alkyl ethers, cellulose carboxy-alkyl ethers, cellulose ether-xanthates, cellulose xantho-fatty acids, cellulose thiourethanes; natural and synthetic rubber and derivatives thereof; fibres made of alginic acid, gelatine, casein; and mineral fibres such, for example, as spun glass, asbestos, mineral wool, and the like; and fibres made of natural and synthetic resins which are not rendered tacky when the potentially adhesive resin fibres are rendered tacky; also fibres and filaments made by slitting, cutting or shredding non-fibrous films, such as cellophane.

For producing the potentially adhesive fibres, there may be employed any potentially adhesive fibre-forming substance in a flowable condition, i. e. in a plastic or molten state or solution, such, for example, as a cellulose derivative, a natural resin or rubber, either singly or in compatible admixtures. Among the cellulose derivatives which are suitable are, for example, cellulose esters, cellulose ethers, mixed cellulose ester-ethers, mixed cellulose esters, mixed cellulose ethers, and mixtures of cellulose derivatives, all of which should be of the type which is soluble in volatile organic solvents.

Various natural resins may be employed since such substances may be formed into fibres by spraying although they are unsuitable for extrusion into filaments. Suitable natural resins are, for example, shellac, dammar, copal, and the like. Any of the synthetic resins which are soluble in organic solvents may be employed, such, for example, as polymers of single organic compounds, such as cumarone, indene hydrocarbons, chloroprene, vinyl chloride, vinyl acetate, styrene, esters of acrylic acid, also thermoplastic resins formed by condensation of two or more substances, such, for example, as sebacic acid and glycerol, sulphur olefine resins, resins formed from dicarboxylic acids and diamines (nylon type), also thermosetting resins in the thermoplastic state, such, for example, as phenol aldehyde resins, urea aldehyde resins, melamine aldehyde resins, sulfonamide aldehyde resins, alkyd resins, drying oil-modified alkyd resins, also synthetic rubber or synthetic elastomers herein included in the term resins, such, for example, as polymerized butadiene, polymerized olefine polysulfides, polymerized isobutylene, also resins formed by copolymerization of two or more compounds, such, for example, as copolymers of vinyl halides and vinyl acetate, copolymers of vinyl halides and an ester of acrylic acid, copolymers of a vinylidene chloride and vinyl acetate (Saran), the polymer of a vinyl compound and styrene, copolymers of polyvinyl alcohol and a halide, copolymers of acrylonitrile and butadiene, copolymers of butadiene and isobutylene, also resins derived from rubber, for example, a chlorinated rubber of the type of "Parlon," the reaction product of a hydrogen chloride and rubber, e. g. "Pliolite," and cyclized rubber derivatives formed by treating rubber in the presence of stannic chloride, e. g. "Plioform"; also fibres made from rubber latex, crepe rubber, gutta percha, balata, and the like.

Further, the potentially adhesive fibres may be formed from mixtures of the cellulose derivatives with resins or rubber, such, for example, as a mixture of cellulose nitrate and an acrylic acid resin, or a mixture of benzyl cellulose and a vinyl resin, or a mixture of ethyl cellulose and shellac. The invention is particularly well adapted for forming the potentially adhesive fibres from compositions of cellulose derivatives, resins, rubbers, and their mixtures, which compositions are not adapted for forming fibres by extrusion through artificial silk spinnerettes, since such factors as filtering characteristics, solution viscosity and fibre tenacity are not critical in the present fibre-forming process.

In making up the fibre-forming solution, the fibre-forming material may be dissolved in a suitable organic solvent which will volatilize rapidly at moderately elevated temperatures.

Suitable solvent mixtures may be selected by those skilled in the art having regard for the nature of the fibre-forming substance. As an alternative to dissolving the substance in a suitable solvent, the fibre-forming material may be heated until plastic or molten and the plastic or molten mass dispersed into fibres as hereinafter described.

The proportion of the fibre-forming substance to the solvent will depend, inter alia, upon the nature of the fibre-forming material, the type of dispersing device employed and the type of fibres desired to be produced. In general solution concentrations of from 5% to 50% will be suitable for most fibre-forming substances and conditions.

To the fibre-forming material or solution thereof, there may be added suitable plasticizers, hardening agents for the resins, latent activating agents, dyes, pigments, mothproofing agents, fireproofing agents, water-proofing agents, and the like. In particular, it may be desirable to add to the material or solution suitable substances for lowering the thermal softening point of the fibres produced, such, for example, as plasticizers, soft resins, and the like. Among suitable plasticizers for this purpose are dibutyl tartrate, ethyl phthallyl ethyl glycolate, while suitable soft resins are polyvinyl acetate, ester gum, cumarone resin, and the lower polymer of alkyd resins.

Generally speaking, the fibre-forming process of the invention comprises dispersing the fibre-forming material while in flowable condition, that is, in solution or plastic or molten condition, into a gaseous atmosphere under sufficient pressure to form a multiplicity of fibres. When a solution is employed, the dispersion is preferably into a gaseous atmosphere which is heated sufficiently to evaporate the solvent rapidly. In this embodiment, the organic solvent may be wasted or recovered in a suitable manner as by scrubbing or absorption. When a molten mass is dispersed, the atmosphere is preferably cooled so as to cause a rapid congealing or solidification of the fibre-forming material.

To carry out the fibre-forming process, there may be used any suitable means for converting the flowable substance or composition into fibrous form and the invention is not to be limited to the particular means hereinafter described.

In the now preferred embodiment of the invention, the fibre-forming composition is dispersed into a heated gaseous atmosphere by means of a spray gun or atomizer comprising, in combination, means to supply the fluid composition under pressure to an orifice, means to supply one or more streams of air or gas at a point adjacent the fluid orifice so as to disperse and disrupt the stream of fluid issuing from the orifice.

There is shown in Fig. 1 a conventional type of spray gun, hereinafter designated generally by the reference character 1, and comprising essentially a container 2 adapted to hold the fibre-forming composition from which it is forced by air pressure through the supply line 3 to the chamber 4 from which the composition is discharged through the orifice 5. The air is supplied through the line 6 to the air chamber 7 which surrounds the chamber 5 and terminates in a plurality of orifices 8 positioned adjacent the orifice 5. The trigger or handle 9 is adapted to operate the pin valve 10 which opens the orifice 5 and the air valve 11 which opens the air line 6. As the stream of fibre-forming composition is discharged from the orifice 5, it is disrupted by the force of the tangential streams of air discharged through the orifices 8. The size, shape, and character of fibre produced by this spraying operation is a function, inter alia, of the viscosity of the solution, the pressure under which the solution and air are discharged, the angle with which the air streams contact the fluid stream, but these factors and their control are well known to those skilled in the art and can be adjusted to produce various types of fibres without transcending the scope of the invention. When the fibre-forming material is plastic or molten, the material suitably heated to render it flowable is caused to flow into contact with an air stream which disperses the material into fibres, or is forced under pressure through an orifice into fibres and means may be provided to maintain the material flowable to the point of dispersion.

In another embodiment, the non-adhesive fibres or the potentially adhesive fibres may be formed by electrical dispersion in a gaseous atmosphere. For example, a stream of the fibre-forming material is caused to flow into an electrically charged field, whereupon the stream is dispersed into a multiplicity of fibres which are attracted in the direction of an oppositely charged element, and the fibres so produced may be collected on the belt 24 of Fig. 2.

The fibres produced may be independent and separable from one another or they may adhere to each other at spaced points to form a more or less fibre web or reticulated structure depending upon whether the fibre is inherently tacky or is still tacky due to its temperature or to the presence of residual solvent when the fibre contacts a fibre of like character.

Fig. 4 is a perspective view of a representative fibre formed by spraying. It should be noted that the ends 28 of the sprayed fibre are tapered in contrast to the square cut ends of extruded staple fibres. Also, the sprayed fibre is characterized by having an unequal thickness or denier throughout its length although the variations from the average thickness are not sufficiently great to prevent its effective use in the fibrous structures of the invention. While the fibre shown may be considered a representative average fibre, in the mass of fibres sprayed under given conditions there will be a substantial variation in the length of the individual fibres and in the thickness and denier which is another physical feature which differentiates the fibres from staple fibres cut from continuous filaments.

It is to be understood that when the formation of the above-described fibres takes place in the presence of non-adhesive fibres, that the potentially adhesive fibres may adhere to such other fibres, as well as to themselves if the solvent is not completely removed from the fibre at the points of mixing and depositing. Accordingly, it is possible in the present invention to form, mix, and substantially adhere or combine the fibres together in immediate sequence, that is, concurrently and continuously, merely by regulating the rate of evaporation of the organic solvent, the time elapsing between the formation of the potentially adhesive fibres and the point of contact with the other fibres.

It should be noted that since the fibres are not carded but are deposited from a gaseous dispersion, they are intermingled in an unarrayed manner which gives a product having uniform strength in all directions.

If desired, the formation of the potentially adhesive fibres may be carried out in a chamber separate from but connected with the chamber in which these fibres are associated, as by mixing, with the non-adhesive fibres. Thus, a single fibre-forming means may serve to supply fibres for a plurality of different mixing chambers. However, the expression "concurrently with their formation" as used therein includes forming and associating in immediate sequence without permitting the potentially adhesive fibres to settle before association.

The above-described fibre-forming processes may be employed for producing the non-adhesive fibres as well as the potentially adhesive fibres.

The expressions "non-adhesive" and "potentially adhesive" as used in the specification and claims are relative terms which depend upon the particular activating treatment selected; as used in Example VII hereof, the term "non-adhesive" designates that fibre type which remains non-adhesive under the treatment which renders the other type adhesive.

The ratio of potentially adhesive fibre to other fibre may be varied over a wide range depending on the purpose for which the fibrous product is intended. In general, to preserve the inherent flexibility, porosity, and texture of the product, a minor proportion of the potentially adhesive fibres is employed and preferably from 3% to 20% by weight. In the production of certain products, for example, if felts and textiles having reduced porosity or impermeability are desired, the potentially adhesive fibre present may constitute a major proportion for example, up to 65% of the total fibres.

Referring to Fig. 2, fibre mixtures suitable for the manufacture of textile structures of the type of felts and paper may be produced by dispersing a fibre-forming composition by means of the spray gun 1 into a heated gaseous atmosphere contained in the chamber 20 into which is simultaneously blown non-adhesive felt or paper-making fibres 21 through conduit 22 by means of a blower 23. The mixture of fibres falls downwardly in the chamber and comes to rest on the surface of an endless belt 24 made of porous or perforated flexible material such as textile, metal, leather, or the like, which is positioned in a horizontal plane at the base of the chamber 20. The bat of mixed fibres is carried on the belt from the chamber and through pinch rolls 25 and 26 which compress the bat and enable it to be removed from the belt for activating or finishing operations to be hereinafter described. If the potentially adhesive fibres produced by spraying are thermoplastic, the rolls 25 and 26 may be heated sufficiently to activate the thermoplastic fibres, the fibres becoming deactivated when the felt passes from the rolls and becomes cool. The solvent evaporated from the fibre-forming composition may be withdrawn from the chamber 20 through exhaust pipe 27 and wasted or recovered in a known manner. When using potentially adhesive fibres which are activatable by means of an organic solvent, such solvent can be sprayed on the fibre bat as it is carried on the belt, as at point A, so that the fibres are in an adhesive condition when passing through the pressure rolls 25 and 26. In the manufacture of paper felts, the belt 24 may be considered as comprising the wire screen of the paper-making machine. Thus, the fibre-forming, mixing, and felting steps in making the felts and papers are carried out concurrently and continuously, in immediate sequence, that is, in a simple and economical manner.

In the apparatus shown in Fig. 2, the non-adhesive fibres may be produced from a solution of, or a plastic or molten fibre-forming material by use of a second spray gun positioned in the chamber 20 in place of the conduit 22. In this manner, novel fibrous products are capable of being produced entirely of a mixture of dispersed artificial fibres, one type of which is potentially adhesive and the other is non-adhesive.

In the manufacture of textiles, the forming and mixing of the potentially adhesive fibres with the textile fibres can be effected at any point prior to the completion of the spinning of the yarn, but in the preferred embodiment, the forming and mixing of the fibres takes place during or immediately after carding of the textile fibres. Referring to Fig. 3, the roll 35 represents the last or delivery roll on a conventional cotton carding machine, from which the doffer blade 36 strips the thin layer of fibres to form continuously the gauzelike web 37 of cotton fibres. There is built around the last roll 35 and the web 37 a fibre-forming and mixing chamber 20b, the web 37 being positioned adjacent the base of the chamber and a spray gun 1b being positioned at the top of the chamber. The fibres formed by the spray gun fall downward in the chamber 20b, being aided by a down draft created by the withdrawal of the solvent through the pipe 38 in the base of the chamber. The potentially adhesive fibres are thus deposited on the thin web 37 of cotton fibres and are gathered between the folds of this web as it passes out of the chamber and through the usual funnel 39 and is delivered by the rolls 40 into the sliver can 41. During the subsequent drafting, and spinning of the card sliver 42, the potentially adhesive fibres become sufficiently admixed with the textile fibres to achieve the objects of the invention when the textile is simultaneously activated, compacted, and otherwise finished. The potentially adhesive fibres may differ in length and diameter compared to the textile fibres. Moreover, since the potentially adhesive material is actually in fibrous form it does not sift out of the sliver or roving during drafting, spinning, doubling, weaving or other textile operation prior to activation. The forming of the potentially adhesive fibres is effected concurrently and continuously with the mixing of such fibres with the non-adhesive textile fibres.

The sliver or roving formed from the mixture of potentially adhesive fibres and non-adhesive textile fibres is then formed into a singles yarn by drafting and spinning in the usual manner, and, if desired, such singles yarns may be doubled with each other or with other yarns to form a plied yarn or cord 30 as shown in Fig. 5. Referring to Fig. 5, one or all of the singles yarns 31 may contain the potentially adhesive fibres. Before or after spinning and before or after doubling, the potentially adhesive fibres may be rendered adhesive to bind fibres in the product. Depending upon the percentage of the potentially adhesive fibres, the method of activation, and the disposition of the potentially adhesive fibres in the yarn, the yarn twist in the singles yarn may be stabilized and likewise one may stabilize the structure of the plied yarn or cord as a result of the activation. Owing to the fact that the potentially adhesive fibres formed by spraying may be finer than fibres heretofore produced by extrusion, it is possible to have a larger number of potentially adhesive fibres and, therefore, more points of contact using such sprayed fibres than would be possible with an equal weight of the same material when extruded in the form of continuous filaments and cut into staple fibres.

Apparatus similar to that shown in Fig. 3 may be employed in the manufacture of felts, in which case the web, after having had the potentially adhesive fibre deposited thereon, is not drawn into the funnel 39 but is withdrawn in web form and a bat formed therefrom in a desired manner.

The invention contemplates activating the potentially adhesive fibres and the activation may be in predetermined areas or uniformly throughout the product depending upon the effect desired; also, the textile may be subjected to two or more activating treatments either in sequence or separated by other treatments and textile operations. Among the methods which may be used for activation are the following, taken singly or together in appropriate combinations:

1. When the potentially adhesive fibres are thermoplastic, they may be activated by heat, for example, by the use of dry hot air, contact with heated surfaces, or steam.

2. By applying to the fibrous mixture a solvent or swelling agent or mixtures thereof with diluents, under such conditions of concentration and temperature so as to render the potentially adhesive fibres tacky. For example, fibres of organic cellulose derivatives, such as cellulose esters may be rendered adhesive by solvents, such as acetone, ethyl acetate, butyl acetate, and the like.

3. When the fibres are tacky at the time of activation, they can be activated by pressure alone.

4. A latent activating agent may be combined with the potentially adhesive fibres and/or with the non-adhesive fibres. Such agent may be rendered active by a subsequent treatment, such as chemical agents, heat, or irradiation, thus producing a simultaneous activation of the potentially adhesive fibres. For example, fibres may be impregnated with a liquid which, at room temperature, is a non-solvent therefor but which, at a higher or lower temperature, is a solvent sufficiently active to render the potentially adhesive fibres adhesive.

A plasticizer may be applied to the fibres and/or to the product before activation. The plasticizer may function to increase the flexibility of the fibres and, when employed with thermoplastic fibres, the plasticizer may serve, in addition, to lower the thermal softening point. The plasticized thermoplastic fibres can be rendered adhesive by heating to a temperature below that at which the non-thermoplastic textile fibres associated therewith would be detrimentally affected by such heating. The plasticizer may be allowed to remain in the product or it may be removed by suitable means such as washing and extraction, thus again elevating the thermal softening point of the thermoplastic material and preventing reactivation upon ironing.

While the fibres are in an adhesive condition, the fibres are preferably subjected to a compacting treatment to promote adhesion of the associated fibres at their points of contact and the term "compacting" includes pressing, squeezing and tension. For example, mechanically applied pressure may be exerted on the activated material during and/or after activation, and/or during calendering, embossing, printing, drying, and other operations involving the use of rollers. Compacting may be accomplished by twisting or stretching the yarns, threads, or cords with or without application of additional external pressure. For example, an activated yarn may be wound under tension upon a spool or core. A fabric may be passed between pressure rolls to compress the mixed fibres or may be subjected to tension in one or both dimensions.

After activation, the fibrous material is treated to deactivate the adhesive, that is, to render the adhesive non-tacky so as to fix the new relationship of the fibres. The nature and extent of the deactivation treatment will depend, inter alia, upon the nature and extent of the activating treatment and upon the proportion and kind of potentially adhesive fibres used. If activation has been accomplished by heat, deactivation may be accomplished by heating to a higher temperature as with thermosetting resins, or by cooling; and if activation is by means of a solvent, deactivation may involve extraction of the solvent as by washing, evaporation, decomposition; if activation has been accomplished by pressing, deactivation follows upon release of the pressure. The removal of the activating agent depends upon whether its presence in the product is desirable or objectionable.

The activating, compacting, and deactivating treatments herein described may be carried out independently of, or simultaneously with, various treatments common to the fabrication, finishing, and sizing of textile fabrics and materials.

Further, the products of the invention may at any time be embossed, calendered, molded, or otherwise shaped, in whole or in part, to deform the surface while the adhesive fibres are still tacky and then subsequently deactivated to set them with a desired form or surface condition to produce effects such as grain, lustre, smoothness, or designs, by suitable means, used hot or cold, and with or without the aid of agents which soften, swell or plasticize the material acted upon.

The fibrous products may be colored before, during, or after activation, compaction, and/or deactivation, by dyeing or printing, for example, with inks containing pigments or dyestuffs which are resistant to such treatments. If desired, the activating agent or the deactivating agent may be added to the dyebath or the printing ink.

The properties of the finished product depend upon various factors, such as the nature and proportion of potentially adhesive fibres; the extent of the activation thereof; the adhesive condition of the fibres during compacting; and the nature of the deactivation. The extent of activation, compacting, and deactivation may be varied considerably, depending upon the relative proportions of the types of fibres, the properties of the potentially adhesive fibre, and the effect desired in the product. The potentially adhesive fibres may be rendered superficially tacky; or made adhesive without losing their fibrous form; or rendered sufficiently fluid to spread under pressure to form a film in which the other fibres are embedded. If the potentially adhesive fibres are rendered only slightly tacky, the frictional resistance between fibres will be increased and the strength improved. If the potentially adhesive fibres are rendered substantially adhesive, they will cohere to each other and adhere to the other fibres to fix the position thereof to give a product having increased tensile strength and lower stretch and shrinkage, and if a film is formed the product may be given a glassy smooth surface.

By way of illustrating but not by way of limiting the invention, there will be given the following specific examples:

Example I

To manufacture a textile yarn or a thread by the present process, staple rayon fibres are carded, using the apparatus shown in Fig. 3. There is produced potentially adhesive fibres by spraying through the spray gun **1b** a solution of 40 parts of vinyl acetate in 60 parts of acetone under a pressure of 40 pounds per square inch, the spray being so regulated that the proportion of the fibres in the sliver will be about 85 per cent. rayon and 15 per cent. vinyl acetate fibres; the sliver thus produced is drafted and spun and then twisted into a yarn in a known manner. After the twisting, the yarn is preheated to a temperature of about 250° F. sufficiently long to render the vinyl acetate fibres adhesive and while they are in such an adhesive condition, the yarn is passed through a heated metal eye to compress the fibres while simultaneously the yarn is placed under tension to bring the fibres into more intimate contact with each other, whereupon the tacky vinyl acetate fibres adhere to the other fibres at their points of crossing. Upon cooling to deactivate, the product will be found to have a higher tensile strength, a decreased tendency to untwist, a decreased shrinkage upon washing, and less nap than a yarn made in the same manner but composed entirely of rayon staple fibre.

Example II

The yarn produced according to Example I is, prior to activation, woven into a textile fabric and the fabric is then passed between pressure rolls heated to 250° F. or heated to this temperature while under tension to activate the vinyl acetate fibres. The fabric shows an improved tensile strength, both wet and dry, a decreased shrinkage, and a decreased slippage of the yarns one upon the other.

Example III

In the manufacture of a flat textile felt, there may be used an apparatus shown in Fig. 2 in which cotton fibres are blown in simultaneously with the spraying through the spray gun **10** a solution comprising 30 parts cellulose acetate, 3 parts triphenyl phosphate, 30 parts acetone, and 37 parts ethyl acetate. The conditions are so adjusted that the solvent is not completely eliminated by the time the fibres are mixed together and deposited on the belt **24**. The proportion by weight of cellulose acetate fibres to cotton fibres should be about 10 to 100. The layer of fibres is then carried on the belt through the rollers **25** and **26** which are maintained at a temperature of 285° F. whereupon the cellulose acetate fibres in the felt are rendered adhesive and bind the other fibres. If necessary, the felt so produced may be subjected to a drying action in a heated chamber to eliminate the residual solvent. The felt will show substantial resistance to abrasion, a relatively strong binding of the fibres, and a sufficient compactness for the product to be useful as a shoe interlining.

Example IV

The process of Example III is carried out but substituting, for the solution therein used, a solution of 25 parts of polymerized isobutylene ("Vistanex") dissolved in 75 parts by weight of toluene, and the inherently tacky fibres so produced are activated by pressure alone.

Example V

The process of Example III is carried out by substituting, for the solution used therein, a rubber latex composition containing a rubber accelerator which causes vulcanization at room temperature, and the rubber fibres so produced may be activated in the product by pressure alone. Upon standing, the rubber fibres are gradually vulcanized so that they become non-tacky and incapable of further activation.

Example VI

The process of Example III is carried out but the conduit **22a** through which the natural fibres are introduced, is replaced by a second spray gun through which a solution of 40 parts of cellulose acetate dissolved in 60 parts of acetone is dispersed to produce the non-adhesive fibres, and through the spray gun **1a** a solution of 40 parts of polyvinyl acetate in 60 parts of acetone is dispersed to form potentially adhesive fibres, the rate of dispersion of the two solutions being so correlated that the fibrous mixture produced comprises 10% of the polyvinyl acetate fibres and 90% of the non-adhesive cellulose acetate fibres. Upon subjecting the fibre mixture to a temperature of 225° F., only the vinyl acetate fibres are rendered adhesive and the cellulose acetate fibres remain unactivated.

Example VII

The process of Example VI is repeated but the fibre mixture is treated with carbon tetrachloride which activates the polyvinyl acetate fibres only and pressure without heat is then applied. Upon evaporation of the carbon tetrachloride, the adhesive fibres are deactivated.

It is apparent that the present products have many advantages over prior products. For instance, by forming the potentially adhesive fibres concurrently with the mixing, the steps of prespinning and carding such fibres are eliminated with all their attendant difficulties. Since the present products contain fibres of smaller diameter than those obtainable by extrusion through rayon spinnerettes, more points of contact are produced upon the activation than are produced from an equal weight of potentially adhesive fibres formed by such extrusion. Thus, a greater effect is obtainable with an equal weight of fibres or the same effect can be obtained with a lesser weight of potentially adhesive fibres. The present invention enables one to employ cheaper fibre-forming materials and also materials not physically adapted for forming filaments by rayon spinning methods and permits the incorporation in the fibre-forming composition of a wider variety of additional ingredients, in particular, a wider variety of plasticizers. Furthermore, this invention permits the use of inherently tacky fibres and fibres which become inactivatable with time, and which, by reason of such characteristics, could not be formed, shipped or manipulated in conventional textile or felting operations. Since the potentially adhesive material is in fibrous form, there is no loss of material during the fabrication of the fibrous structures as would be the case if such adhesive material were employed in the form of particles or powder. In the manufacture of textiles, the present invention simplifies the fibre mixing step since no carding of the fibre mixture is necessary. Further, the potentially adhesive fibres do not have to be of the same length or denier as the textile fibres. In the manufacture of felts, the present invention permits the direct manufacture of such products with the elimination of fulling, pouncing, wetting, drying, and other costly operations. The present invention enables improved felts to be made from various natural or synthetic fibres and filaments which are smooth-surfaced and/or relatively straight and which consequently do not felt readily.

Since certain changes in carrying out the above process, and certain modifications in the article which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. The method of making a composite fabric comprising: disrupting a plastic spinning material into a gaseous atmosphere to produce a plurality of discontinuous filaments; depositing the said filaments in a promiscuously intersected condition to form a primary web; depositing natural fibres in a discrete condition to form a secondary web, one of the said webs being deposited in a superposed relation to the other said web; and subjecting the said webs to heat and pressure whereby the said natural fibres are bonded together by the said plastic filaments.

2. The method of making a composite fabric comprising: depositing natural fibres in a discrete condition to form a primary web; disrupting a plastic spinning material into a gaseous atmosphere to produce a plurality of discontinuous filaments; depositing the said filaments in a plastic and promiscuously intersected condition upon the said primary web to form an integral secondary web thereover; and indurating the said plastic filaments to bond the said secondary web to the said primary web.

3. The method of making a composite fabric comprising: disrupting a plastic spinning material into a gaseous atmosphere to produce a plurality of discontinuous filaments; depositing said disrupted filaments while said disrupted fibres are sufficiently plastic to adhere to one another upon a web of fibres in such a manner as to cause the said disrupted filaments to intersect and unite to form an integral pervious web and to adhere to the web of fibres.

4. In an apparatus for producing composite fabrics, the combination of: a device for disrupting a spinning material into a plurality of filaments in a gaseous atmosphere; an endless travelling wall; a housing enclosing the said device and at least a portion of the said wall; and means for depositing a web of fibrous material and an integral plastic web of the said disrupted filaments in superposed relation on the said wall.

5. In an apparatus for producing composite fabrics, the combination of: a device for disrupting a spinning material into a plurality of filaments in a gaseous atmosphere; an endless travelling wall; a housing enclosing the said device and at least a portion of the said wall; means for depositing a web of fibrous material on the said wall; and means for depositing the said disrupted filaments in an integral plastic web over the said web of fibrous material.

6. An apparatus comprising a device for disrupting a plastic material into a plurality of filaments in a gaseous atmosphere; a chamber to which said device is connected; means for passing a plastic material through said device to disrupt the material into a plurality of relatively short filaments; means for moving a retaining wall into the said chamber; and means for depositing a web of said disrupted, relatively short filaments on said wall.

7. An apparatus comprising a device for disrupting a plastic material into a plurality of filaments in a gaseous atmosphere; a chamber to which said device is connected; means for passing a plastic material through said device to disrupt the material into a plurality of relatively short filaments, means for moving a retaining wall into the said chamber; and means for depositing said relatively short filaments while sufficiently plastic to adhere to one another upon said wall in such a manner as to cause the filaments to intersect and unite into an integral pervious web.

8. An apparatus comprising a device for disrupting a plastic material into a plurality of filaments in a gaseous atmosphere; a chamber to which said device is connected; means for passing a plastic material through said device to disrupt the material into a plurality of relatively short filaments; means for moving a retaining wall through said chamber; and means for depositing a web of said relatively short filaments upon said wall simultaneously with the movement of the wall through said chamber.

9. An apparatus comprising means for disrupting a plastic material into a plurality of filaments in a gaseous atmosphere; a chamber to which said device is connected; means for passing a plastic material through said device to disrupt the material into a plurality of relatively short filaments; means for moving a retaining wall through said chamber; and means for depositing said relatively short filaments while sufficiently plastic to adhere to one another upon said wall simultaneously with the movement of the wall through the said chamber in such a manner as to cause the filament to intersect and unite progressively into an integral pervious web on the wall.

10. In an apparatus for producing composite fabrics, the combination of a device for disrupting a spinning material into a plurality of filaments in a gaseous atmosphere; a travelling wall; a housing enclosing the said device and at least a portion of the said wall; and means for depositing a web of fibrous material and a web of the said disrupted filaments in superimposed relation on the said wall.

11. The method of making a composite fabric comprising: disrupting a plastic spinning material into a gaseous atmosphere to produce a plurality of discontinuous filaments; depositing said disrupted filaments in a promiscuously intersected condition upon a fibrous material to form a web of said disrupted filaments superposed on said fibrous material; and subjecting said product to heat whereby the plastic filaments are bonded to the said fibrous material.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,219,346	Thomas et al.	Oct. 29, 1940