Aug. 30, 1960 P. C. WATSON ET AL 2,950,752

APPARATUS AND METHOD FOR THE PRODUCTION OF RETICULATE WEBS

Filed Dec. 24, 1953 2 Sheets-Sheet 1

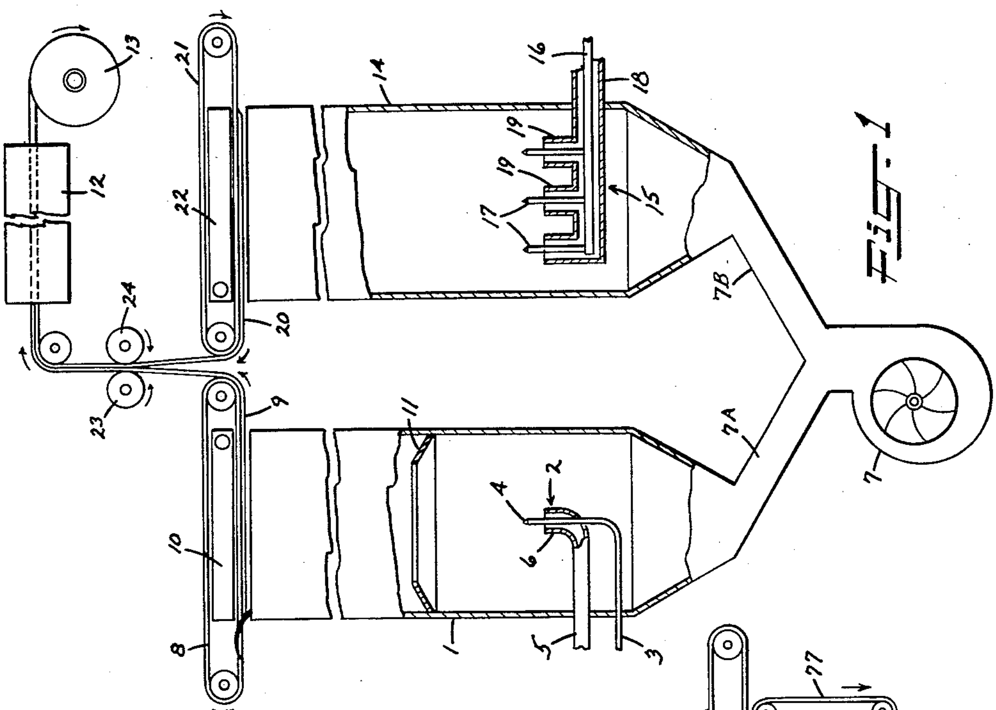

Fig. 1

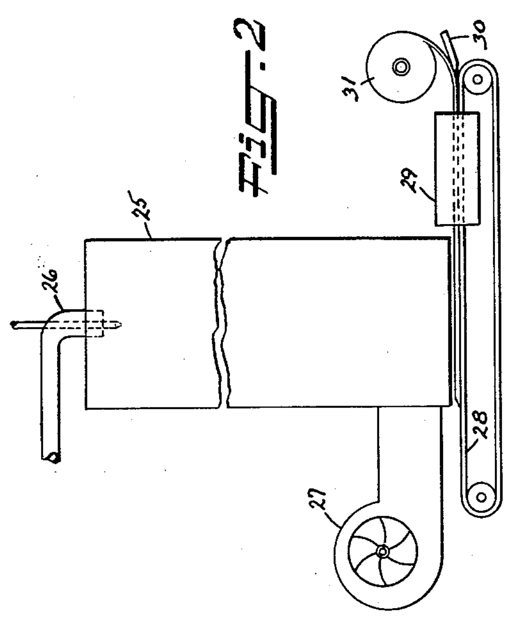

Fig. 2

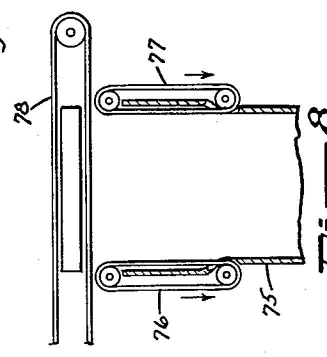

Fig. 8

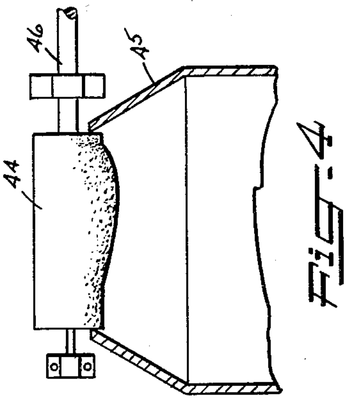

Fig. 4

APPARATUS AND METHOD FOR THE PRODUCTION OF RETICULATE WEBS

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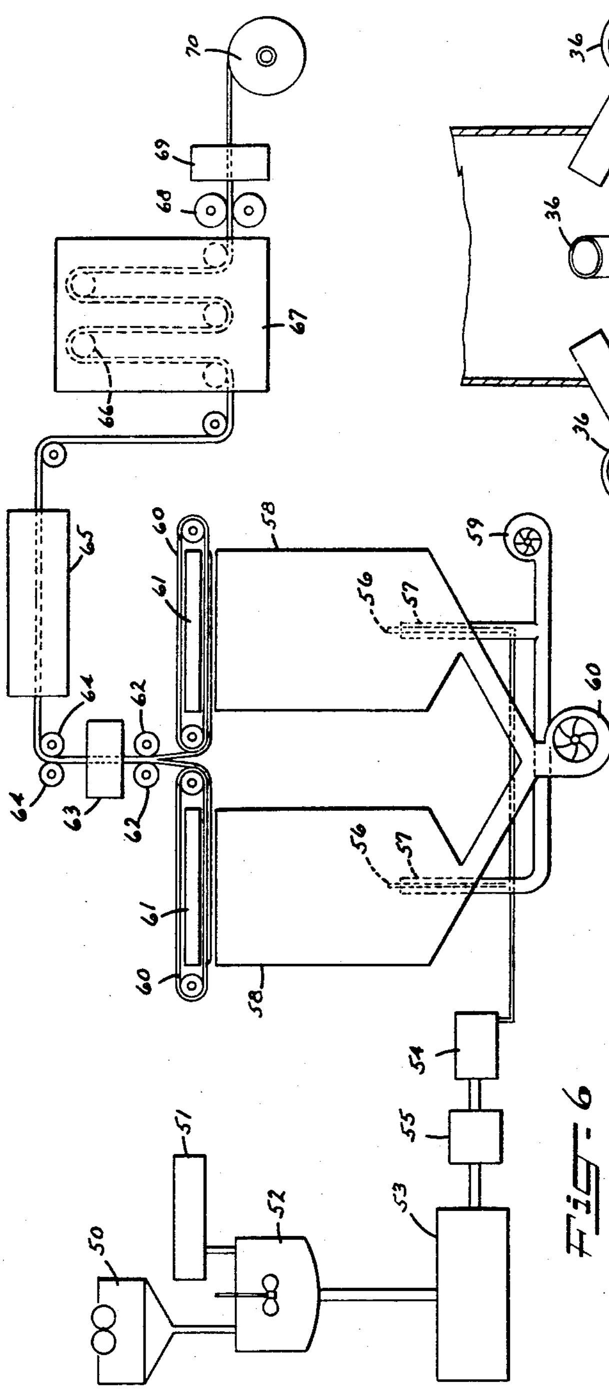

Fig. 6

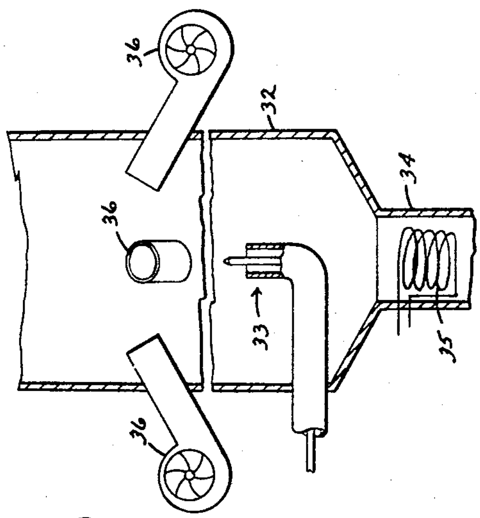

Fig. 3

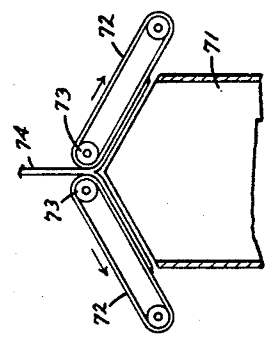

Fig. 7

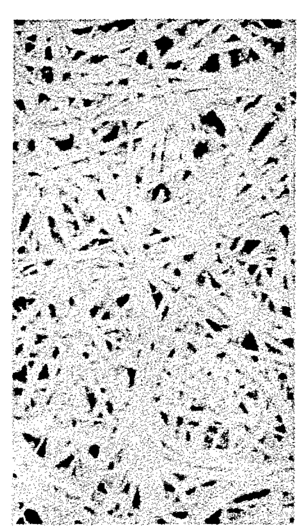

Fig. 5

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APPARATUS AND METHOD FOR THE PRODUCTION OF RETICULATE WEBS

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10 Claims. (Cl. 154—1)

This invention relates to fibrous bodies and more particularly to reticulated webs or structures formed of fibrous materials and to methods and apparatus for preparing such bodies or structures.

Fibrous bodies or structures of fiber-forming organic substances are generally formed from filaments prepared by either extruding the fiber-forming organic substance through an orifice or by spraying the organic substance by the use of spray guns and the like. Methods which involve the extrusion of the fiber-forming substance through orifices are limited to the use of certain substances which may be filtered and which possess certain other characteristics, including wet and dry tensile strengths, necessary for the spinning operations. The filaments produced by conventional extrusion methods are continuous filaments and the size or denier is limited by the extrusion characteristics of the substances or of the spinning solutions of the particular substance. In many instances, it is desirable to incorporate various solid materials, such as fillers, into the fibers or filaments. However, it is not practical to do so when the material is to be extruded through fine orifices and the amount of foreign material which may be incorporated in the fiber or filament is strictly limited. In the production of sheet material or padding from such filamentary materials, it is necessary to collect the filaments and cut them to staple lengths. The staple is subsequently processed on conventional textile and felting equipment to form a woven sheet or felted layer or mat. Where the filament is formed of a potentially adhesive substance and it is desired to produce a product, with or without non-adhesive fibers, wherein the fibers are bonded together at their points of contact, it is necessary to subject the sheet or mat, as formed, to an activating treatment whereby the potentially adhesive fibers become tacky or adhesive and are capable of bonding to other fibers at their points of contact and then deactivate the fibers.

As an alternative, fibres or filaments may be formed from a wide range of substances by the use of various types of spray guns. Because of the relatively large size of the spray gun orifices as compared to extrusion orifices such as those of a rayon type spinneret, for example, the limitations with respect to the characteristics of the spinning liquid are far less exacting than for the extrusion methods. Various materials such as fillers, hardening agents, plasticizing agents and the like may be incorporated in the spinning liquids. If it is desired to form a product of potentially adhesive fibers and non-adhesive fibers, the potentially adhesive fibers may be produced by spraying into an air stream containing air-borne non-adhesive fibers and collecting the mixed fibers, for example as shown in the patent to Carleton S. Francis, Jr. No. 2,357,392.

The general purpose of the present invention is to provide a method and apparatus for the preparation of reticulated fibrous webs or structures formed of discontinuous fibers in random distribution.

A further purpose of this invention is to provide a method for forming fibers and reticulated webs or structures from organic solutions of elastomeric materials.

Another object of this invention is to provide a method for the production of fibrous webs or structures formed of an elastomeric fiber-forming material and non-adhesive preformed fibers and/or discrete particles.

Another purpose of this invention is to provide apparatus for producing reticulated fibrous webs or structures formed of elastomeric materials with or without non-adhesive preformed fibers and/or discrete particles.

Another object of this invention is to provide a fluid-permeable, fibrous web or mat of elastomeric materials.

A further object of this invention is to provide a novel reticulated fluid-permeable, fibrous web or mat of an elastomeric fiber-forming material and non-adhesive preformed fibers and/or discrete particles.

Other objects and advantages of this invention will become apparent from the description and claims which follow.

In the drawings,

Figure 1 is a diagrammatical, elevational view, partly in section, of one form of apparatus for the practice of the method of this invention;

Figure 2 is a diagrammatical, elevational view, partly in section of another form of apparatus for the practice of the method of this invention;

Figure 3 is a diagrammatical, elevational view, partly in section, of a further form of apparatus for the production of the products of this invention;

Figure 4 is an elevational view, partly in section, of another form of collecting surface for the production of shaped bodies in accordance with this invention;

Figure 5 is a photograph, at an enlarged scale, of a reticulated product of this invention;

Figure 6 is a schematic diagram of a production unit for the manufacture of a laminated, reticulated product of this invention; and

Figures 7 and 8 are diagrammatical, elevational views, partly in section, illustrating further forms of collecting surfaces for the apparatus of this invention.

The present invention contemplates the production of relatively long, discontinuous, fine fibers of elastomeric materials by a spraying technique wherein the fiber-forming spraying liquid is extruded into and within a primary or high velocity stream of gas as an initial relatively large-diameter stream of plastic which is attenuated and broken transversely into a plurality of fibers or fibrils before landing on a collector. Unlike dry spinning, as performed in the rayon and synthetic fiber industries, in which a spinneret with multiple minute holes is used to produce a predetermined number of filaments each substantially of the same size as the holes and in which the continuous filaments are pulled continuously from the face of the spinneret to a moving collector, the fiber-forming process of the present invention utilizes a single relatively large extrusion orifice producing a single large-diameter plastic stream which is attenuated and broken transversely into a plurality of fibers, the number of which is always greater than one and the diameters of which fibers are small fractions of the orifice diameter, there being no continuous filament running between the orifice and the collector.

The velocity of the gas is appreciably higher than the velocity of extrusion of the spraying liquid and the direction of extrusion is coincident or concurrent with the direction of the gas flow. The high velocity stream of gas attenuates the sprayed liquid, breaks the attenuated plastic stream transversely and partially sets the elastomeric material due to the partial evaporation of solvent to form a plurality of fibers having diameters smaller than the orifice. A secondary or low velocity stream of gas is provided which has a velocity lower than that of the primary stream of gas but greater than that of extrusion of the fiber-forming liquid. The secondary stream of gas carries, supports or floats the attenuated fibers or fibrils and deposits the fibrils or allows the fibrils to deposit upon a suitable collecting surface.

The elastomeric material contemplated by our invention is rubber, both natural rubbers and synthetic rubbers or rubber substitutes. Such elastomeric materials or rubbers, both natural and synthetic, which are soluble in inexpensive, volatile organic solvents are well suited for the production of the reticulated mats or webs of this invention. Elastomeric materials satisfactory for use in the herein described method include natural rubbers such as crepe rubber and synthetic rubbers or rubber substitutes such as chloroprene polymers, for example, neoprenes; butadiene-acrylonitrile copolymers known as Buna-N, for example, Butaprene, Paracril, Ameripol-D, Perbunan, Chemigum, and Hycar-OR; butadiene-styrene copolymers, for example, Ameripol-F, Hycar-OS and GR-S; isoprene-isobutylene copolymers, for example, GR-I and butyl; and organic polysulfides, for example, Thiokol. Mixtures of specific elastomeric materials may be utilized to provide desired characteristics. The specific elastomers are enumerated merely as illustrative and are not intended as limitations of the invention.

The spraying or fiber-forming liquid may be formed by dissolving the fiber-forming elastomeric material in a satisfactory organic solvent such as aliphatic and aromatic hydrocarbons, chlorinated hydrocarbons, aralkyl hydrocarbons and the like, those being preferred which will volatilize readily at moderately elevated temperatures. The solvent utilized in forming the spraying liquid will be dependent upon the specific elastomer and upon characteristics desired in the spraying liquid such as volatility of the solvent. For example, solvents which are satisfactory include benzene, naphtha, toluene, xylene cyclohexanone, ethylene chloride, methylene chloride, carbon tetrachloride, nitroparaffins, ketones and the like. Such inexpensive volatile organic solvents as benzene and naphtha are entirely satisfactory for use in fiber-forming liquid containing natural rubber. The spraying liquids may contain from about 5% to about 50% of the fiber-forming elastomeric material and preferably contain between about 10% and about 35% rubber or rubber substitute.

Gas-forming or blowing agents such, for example, as ammonium carbonate, sodium acid carbonate, diazoaminobenzene and the like, may be added to the elastomeric materials or spraying liquids, if desired. These agents include solids and gases and are commonly employed in the production of sponge rubber and porous rubber sheet and products. They are adapted to release or form a gas such as ammonia, carbon dioxide or other inert gas at temperatures at which the elastomeric material is cured or vulcanized.

The properties and characteristics of the fibers formed from the elastomeric materials may be varied as desired by incorporating additives in the spraying liquid. Substances such as normally employed in preparing finished rubber articles from crude natural rubbers or synthetic rubbers may be added, for example, carbon black, curing or vulcanizing agents such as sulfur, accelerators, antioxidants, plasticizers and the like. Detackifying agents, such as paraffin wax, stearic acid and the like may be incorporated in the spraying liquid so as to decrease the natural adhesive or tacky nature of the unvulcanized fibers. Coloring agents, such as dyes and pigments may be utilized to produce fibers having desired colors or tints. Abrasive particles such as emery dust, Carborundum, silica, etc., may be incorporated in the spraying liquid to provide products having abrasive properties. Fillers such as clay, whiting, kaolin, French chalk and the like may be added to impart desired characteristics and to reduce the cost of the fibers. The amount of the additive may be varied over a wide range as desired. In the case of solid fillers, from about 50% to about 150% filler, such as clay, finely divided pigments and the like, based upon the weight of the elastomer, may be incorporated in the spraying liquid. Lesser or greater amounts, however, may be employed depending upon the type of product desired.

The additive substances may be mixed with the elastomer as by milling the elastomer and the additive, or the additive substance may be mixed with or dispersed in the solution of the elastomer. By varying the amount of solvent and the amount of additive substances and the degree of milling, the viscosity of the spraying liquid may be varied over an extremely wide range. It is possible to utilize spraying liquids in forming the products of this invention which are totally unsuited for use in the usual or conventional spinning methods.

The primary gas stream may be at normal atmospheric temperatures or any other desired temperatures. For example, the temperature may be elevated so as to increase the rate of volatilization of the solvent. The gas may consist of a chemically reactive gas, steam, air or other inert gas such as nitrogen, carbon dioxide and the like. Since the fibers as they are formed by the attenuating effect of the gas stream and the volatilization of the solvent are tacky or cementitious, solid particles or short preformed fibers may be introduced into the primary gas stream so as to provide a coating on the fibers. For example, a detackifying agent such as talc, wood flour, starch, etc., may be introduced to provide a coating which decreases or destroys the natural tackiness of the fibers and allows the collection of the fibers in a body wherein there is little or no adhesion between the crossing filaments. Short, preformed fibers either synthetic or artificial such as viscose rayon staple, cotton, wool, asbestos, etc., or finely divided particles such as leather, rayon flock, cork dust and the like may be introduced if desired.

Similarly, the secondary gas stream may be at normal atmospheric temperatures or at any desired temperature and the gas may consist of a chemically reactive gas, steam, air, or other inert gas such as nitrogen, carbon dioxide and the like.

Before curing or vulcanizing, the freshly formed fibers of elastomeric material are inherently tacky and after curing are potentially adhesive; that is, they may be rendered tacky or cementitious by some treatment as by the application of a solvent. Since the fibers as they are formed are tacky, a reticulated web or structure may be produced by collecting them on a surface, or a composite reticulated web or structure may be produced by collecting them in combination with preformed fibers and/or discrete particles, preferably of a non-adhesive, non-elastomeric material which may be introduced into the secondary gas stream. The preformed fibers and/or discrete particles are thereby brought into contact with the potentially adhesive, elastomeric fibers while the latter are in a tacky or cementitious condition and the preformed fibers or discrete particles adhere to the elastomeric fibers. The fibers may be collected while the fibers are in an adhesive condition or afterwards, or a detackifying substance such as talc may be introduced to counteract the tacky nature of the elastomeric fibers so that upon collection there is little or no adhesion. The fibers as collected are deposited in a completely random distribution or haphazard manner to form a reticulated web or structure. Where the fibers are collected while the fibers are in a tacky condition, the fibers will stick together where they contact each other and where they contact the preformed non-elastomeric fibers. Conventional methods of handling staple fibers, even though elaborate carding equipment is employed, do not produce webs having the totally random and haphazard fiber structure formed by this method. Our method also eliminates the activating procedure required where conventional methods are utilized in forming the mixed fiber or composite bodies..

Among the non-adhesive non-elastomeric fibers which may be employed in forming the composite bodies are natural fibers, such for example as wood or pulp fibers, cotton, flax, jute, kapok, wool, hair and silk, other natural substances such as leather and cork; and synthetic fibers, for example, cellulosic fibers such as cellulose hydrate, cellulose derivatives such as cellulose esters, mixed cellulose esters, cellulose ethers, mixed cellulose ester-ethers, mixed cellulose ethers, cellulose hydroxyalkyl ethers, cellulose carboxyalkyl ethers, cellulose ether xanthates, cellulose xantho-fatty acids, cellulose thiourethanes; fibers made of alginic acid, gelatine, casein; mineral fibers such as spun glass, asbestos, mineral wool and the like; and fibers made of natural and synthetic resins which are not rendered tacky when the potentially adhesive fibrils are rendered tacky; also fibers and filaments made by slitting, cutting or shredding nonfibrous films, such as waste cellophane.

In addition to or as a substitute for such non-elastomeric fibers, particles of various classes may be introduced through the primary or secondary air stream, such for example as cork dust, wood flour, leather dust, or flake particles, or fibers of floc length. Products having abrasive properties may be formed by introducing abrasive particles such as emery dust or larger size particles. The tackiness of the fibers may be reduced by introducing a detackifier such as powdered talc. Two or more different foreign substances may be introduced into the gas stream and the substances may be of different physical form; for example, one may be in fiber form and the other in powdered form, depending upon the nature and characteristics desired in the final product. The gas streams may be air, an inert gas or a chemically reactive gas, such for example as nitrogen, sulfur dioxide and steam.

The present fiber-forming process may be practiced by utilizing apparatus as illustrated more or less diagrammatically in Fig. 1. A tower **1** which may be cylindrical in form is provided with a spraying unit **2** preferably centered within the tower. The spraying unit comprises a conduit **3** which terminates in an upwardly extending spray tip **4** having a suitable orifice at its upper end and a conduit **5** which terminates in an upwardly extending nozzle **6**. The spray tip **4** is preferably mounted concentrically within and it extends slightly above the nozzle **6**. The fiber-forming liquid is continuously extruded through the spray tip by means of a suitable pump, not shown. A stream of gas such as air is continuously passed through conduit **5** and nozzle **6** by suitable means such as a blower, not shown, the velocity of the gas emerging from the nozzle being appreciably higher than the velocity of extrusion of the spraying liquid. The elastomeric composition is forced out of the tip **4** as a single continuous plastic stream which is attenuated and broken transversely into discontinuous fibers or fibrils of varying length by the high velocity primary gas stream. The velocity of the extrusion and the velocity of the gas may be varied so as to regulate the amount of attenuation and hence the diameter of the fiber or fibrils, and may be increased sufficiently to regulate the length of the fiber. Simultaneously, solvent is evaporated to partially harden or set the elastomeric fibers.

The relative velocities of extrusion of the spraying liquid and the gas emerging from nozzle **6** may be varied to some extent so as to provide the desired size and length of fiber within certain limits. In general, for a given spraying liquid, the greater the velocity of the gas with respect to the velocity of extrusion, the finer the fiber or fibrils. The relative velocity of the gas flow to the velocity of extrusion may be increased to provide fibrils of shorter length for the production of lower density products. It is not necessary and in many cases not desirable to heat the primary gas stream.

A secondary stream of gas such as air is passed upwardly through the tower **1** by means of a blower **7** and surrounds or envelops the primary stream of gas. This main column of gas is passed upwardly at a velocity lower than that of the gas which is supplied through nozzle **6**. As the extruded liquid is attenuated and the velocity of the gas from nozzle **6** approaches the velocity of the main stream of gas, the attenuated fibers are then carried upward by the main stream of gas. In order to increase the drying or setting rate of the fibers, the temperature of the secondary gas stream may be elevated above 50° C. so that the fibers as they reach the top of the tower **1** are in an adhesive or tacky condition, or the conditions may be varied so that the fibers are deposited in a non-tacky condition with little or no adhesion between the fibers.

The multiplicity of fibers is carried by the secondary gas stream to a suitable collecting means at the top of the tower such as a porous surface **8**. In the preferred form, the collector is a moving endless screen or a porous drum. As the fibers collect and deposit on the screen, the resistance of the collected reticulated mat **9** to the flow of gas increases and for the production of thicker webs or mats, a suction chest **10** may be provided above the conveyor screen. The suction chest also may be employed to aid in the recovery of the solvent, if desired. The tendency of the air-borne attenuated fibers to contact and adhere to the walls of the tower may be reduced by providing a conical annular ring **11** in the tower positioned above the spinning tip. The velocity of the main column or secondary stream of gas through the tower may be controlled to deposit the fibers on the collecting means **8** in a desired condition. The temperatures of the gas streams may be varied so as to control the evaporation of solvent and the vulcanizing of the elastomeric material so as to deposit the fibers in a desired condition. Where the fibers are to be utilized in forming a more or less coherent reticulated mat, the temperature and velocity of the secondary gas stream are so controlled that the fibers are deposited on the conveyor screen **8** in a somewhat adhesive or tacky, unvulcanized condition whereby they become bonded together at their points of contact.

The collected web **9** may be stripped from the conveyor screen **8** and passed through a suitable heater **12** wherein the elastomeric material is vulcanized. The reticulated web or mat **9** is then accumulated on a take-up roll or drum **13**. The sheet or web is reticulate in structure having the fibers arranged in a completely and totally random or haphazard order and is highly porous and permeable, as shown in Figure 5.

Relatively thick bodies or structures may be produced by a laminating technique. The unvulcanized, reticulated web may be stripped from the conveyor screen and folded upon itself to provide the desired thickness. As alternatives, the unvulcanized web may be cut to a desired size and a plurality of such cut webs assembled, or a plurality of uncut webs of desired lengths may be assembled to form the desired thickness. Since the fibers of the unvulcanized webs are tacky and adhesive, the fibers on contiguous surfaces adhere to each other upon contact so as to bond the adjacent layers into a unitary structure. Additional bonding between adjacent layers may be obtained by the application of pressure to the assembly whereby the exposed fibers lying beneath the plane of the surface fibers of adjacent layers are brought into contact. The pressed assembly is then vulcanized so as to provide a unitary body of the desired thickness. Such unitary body remains permeable and has substantially the same elasticity and strength characteristics in all directions in the plane of the laminations.

The formation of the laminated body before vulcanizing the sprayed elastomeric fibers preserves the reticulated structure whereas the use of a rubber adhesive or solvent which would be required if the layers were first vulcanized might reduce the porosity of the product.

If it is desired to produce a mat or layer of loose separable fibers which are not bonded together, then the collector is spaced further away from the tip or nozzle and a detackifier is incorporated in the spraying liquid and another detackifier such as talc is blown in with the primary or secondary gas stream. Also, the temperature of the gas is elevated to evaporate more of the solvent from the fibers before they are deposited or collected.

In the production of fibrous webs comprising preformed non-adhesive fibers and/or discrete particles and the elastomeric sprayed fibers formed as described, the preformed non-adhesive fibers and/or discrete particles are preferably introduced into the secondary gas stream and may be introduced through the blower 7. The non-adhesive fibers or particles are thereby carried or blown into contact with the sprayed elastomeric fibers while these latter fibers are in a tacky condition and thereby become firmly attached to the sprayed fibers. The spraying conditions are maintained so that the sprayed fibers are still in a somewhat tacky condition when they are collected on the conveyor screen 8. The mixed web is subsequently subjected to treatment to cure or vulcanize the elastomeric fibers therein.

Although the chamber or tower 1 is shown as being provided with a spraying unit 2 consisting of a single spray tip and nozzle, it is to be understood that such illustration is merely for purposes of simplifying the drawing and the foregoing discussion. A plurality of spaced spray tips may be mounted within a large chamber provided with a single secondary gas blower. In a preferred embodiment of the apparatus, a plurality of chambers are employed, each containing a number of spaced spray tips and nozzles. It is necessary to provide an appreciable spacing such as 10 inches to 12 inches between the spray tips or orifices so as to avoid contact between the formed fibers before a majority of the solvent has vaporized. In any case, each spray tip is provided with its separate primary gas nozzle surrounding it.

A product of uniform thickness over the width of the web may be produced by utilizing a tower 14 having a square or rectangular section. A plurality of spraying units 15 are positioned in spaced relationship at or adjacent the base of the tower. Each spraying unit comprises a spraying liquid conduit 16 provided with a plurality of spaced, upwardly projecting spray tips 17 and a gas conduit 18 provided with a plurality of spaced, upwardly projecting nozzles 19 surrounding the tips. A spraying liquid is continuously extruded through the spray tips and a stream of gas is continuously passed through the nozzles.

The spun fibers are carried by a single secondary stream of air supplied by the blower 7 and are collected as a reticulated web 20 on the collecting screen 21 supported at the top of the tower. A suction chest 22 may be mounted above the conveyor screen 21, as described hereinbefore. The web may be stripped from the conveyor 21 and passed through a heating chamber 12 wherein the elastomer is vulcanized and the web or sheet finally accumulated on a take-up roll 13.

As illustrated in Figure 1, a laminated product may be produced by bringing together two or more webs from different chambers or towers between squeeze rolls 23 and 24 while the elastomeric fibers are tacky and adhesive. The tacky fibers on contiguous surfaces adhere to each other upon contact and additional bonding of the layers or piles is obtained by the application of pressure whereby the exposed fibers lying beneath the plane of the surface fibers are brought into contact. The pressed assembly is then vulcanized so as to provide a unitary body by passing the laminate through a heating chamber 12. The laminate is finally accumulated upon a suitable take-up drum 13.

By the introduction of preformed fibers or discrete particles of non-adhesive, non-elastomeric materials into the blower 7, both of the webs 9 and 20 will consist of composite webs. If desired, one of the webs may be formed of the elastomeric material containing desired additives and the other web may be a composite structure containing preformed fibers or discrete particles. The preformed fibers or particles may be introduced into the duct 7A or 7B which supplies the secondary air stream to the respective towers in which the composite structure is to be formed.

If desired, where a plurality of spraying units are positioned within a tower, all of the spraying units may be supplied with the same spraying liquid and each nozzle may supply the primary gas at the same velocity. The resulting reticulated web thus consists of a single composition and the fibers will be of about the same size and length. If desired, the relative velocities of extrusion of the spraying liquid and of the primary gas stream may be varied in different spraying units to provide fibers of different size and length. Products containing fibers of two or more different elastomers or different elastomeric compositions may be formed by supplying spraying liquids of the different elastomers or of different composition to separate spraying units. Products having color blends may be prepared by supplying spraying liquids containing different coloring agents to separate spraying units.

Laminated reticulated products wherein the outer plies or surfaces are of different characteristics or properties may be prepared in a similar manner by providing different spraying liquids to spraying units in adjacent or separate towers and by maintaining different conditions of spraying in the separate towers. For example, one web may be formed of one type of elastomer and the spraying conditions maintained so as to form a reticulated web of relatively coarse and long fibers and the other web may be formed of another elastomer having a different coloring agent and the spraying conditions maintained so as to form a reticulated web of relatively fine and short fibers. The two webs are subsequently laminated and the elastomers vulcanized. By applying a stencil over a first formed web a layer of the same or different elastomer fibers may be formed on the first web in predetermined areas.

Our method may also be practiced by passing the secondary or low velocity gas stream in a direction countercurrent to the primary or high velocity gas stream, as illustrated in Figure 2. A spraying unit 26 consisting of a spray tip and nozzle, as described hereinbefore, is mounted at the top of tower 25, preferably concentric with respect to the walls of the tower. The primary or high velocity gas stream is supplied to the nozzle by suitable means and the spraying liquid is extruded through the spray tip by suitable means, not shown. The direction of travel of the primary gas stream and the direction of extrusion are downwardly. The attenuation of the spraying solution and evaporation of the solvent by the primary gas stream is identical to that described hereinbefore.

The secondary or low velocity gas stream is passed upwardly through the tower as by means of a blower 27. The secondary gas stream is passed at a velocity sufficient to support or retard the fall of the attenuated fibers so as to deposit the fibers on the collecting screen 28 in any desired condition. The fibers may be deposited in a tacky or cementitious, unvulcanized condition to cause them to effect an immediate bonding at their points of contact. The reticulated web may be passed through a suitable heater 29 to effect a curing or vulcanization of the elastomer. The cured web is then stripped from the conveyor as by means of a doctor blade 30 and the vulcanized web collected on a take-up roll or drum 31.

In the production of composite sheets or webs, it is not necessary that the preformed non-adhesive fibers or particles be introduced with the secondary gas stream. As shown in Figure 3, the tower **32** is provided with the desired spinning unit **33** and a duct **34** through which the secondary gas stream is supplied to the tower. Suitable heating means **35** may be mounted in the duct **34** so as to permit a control of the temperature of the secondary gas stream. A tertiary gas supply may be introduced by positioning suitable blowers **36**, preferably above the point at which the fibers are formed. The preformed non-adhesive fibers or particles may be introduced by means of the tertiary gas stream. For example, powdered talc may be introduced by the tertiary air stream after the fibers are formed. If desired, one type of preformed non-adhesive fiber or particle may be introduced by means of the secondary gas stream. For example, rayon staple fibers may be introduced by means of the secondary gas stream and powdered talc introduced in the tertiary gas stream to form a loosely bonded composite body.

In forming the fibers, there is some tendency toward the inter-twining or roping of the adhesive fibers as they are carried upwardly in the gas stream. This is particularly noticeable when spinning from multiple spinning units and results in the formation of rope-like or band-like fibrous strands as shown in Figure 5. The resulting reticulated web is thereby formed of single individual discontinuous fibers and band-like fibers formed by individual fibers bonded together longitudinally as shown in Figure 5. There is also a tendency for some fibers to deposit along the walls of the tower to form a very loose and open web in which the fibers are in a more orderly arrangement. This material may be employed for some purposes or the web, since the elastomer has not been vulcanized, may be reused in an additional batch of elastomeric composition and used as the spraying liquid.

The fibers may be deposited on a shaped collecting surface as illustrated in Figure 4. The collector **44** of any desired shape, as for example, a girdle shape, may be rotatably supported at the top of tower **45** and provided with suitable means for rotation. The fibers are thereby deposited in the form of the desired article and a desired thickness is obtained by slowly rotating the shaped collector until a body of the desired thickness is formed. The shaped collector is porous and is preferably provided with a suitable conduit **46** which communicates with a suitable pump not shown to maintain a vacuum within the shaped collector. Before the shaped web is removed from the collecting form its surface may be flocked. It is then cured and stripped inside out to form a girdle, bathing suit or other article of wearing apparel. If desired, electrostatic means may be employed in forming the fibers and depositing fibers on such shaped collector. The fibers may be deposited directly upon a previously shaped article, the article itself serving as the collecting means to provide a layer of a reticulated, fibrous elastomeric web.

As explained hereinbefore, the fibers may be deposited under conditions so as to provide a high degree of bonding at the points of contact. The sheet or web as thus formed, after suitable treatment to cure or vulcanize the elastomer may be utilized in sheet form or may be secured or laminated to other materials to form a composite laminate.

If individual elastomer fibers are desired, the spinning conditions are maintained so as to provide a sheet or web having substantially no adherence between the deposited fibers and consisting of separable fibers. After curing or vulcanization, the fibers may be separated from the web for use in other products such as in the manufacture of special types of papers or the manufacture of textiles. The fibers may be cut into flock lengths if desired.

Figure 5 is a photograph, at an enlarged scale, of the reticulated, fibrous web of elastomeric fibers formed as described hereinbefore. As shown by the photograph, the fibers are in a totally and completely random or haphazard arrangement and form a permeable, lacy or reticulated web. Although there is little or substantially no coalescence of fibers, the fibers are firmly bonded together at their points and areas of contact. Where the fibers came into contact with each other longitudinally they become firmly bonded together to form a bundle of fibers and the reticulated web includes such bundles as well as individual, discontinuous fibers. In the formation of this sheet or web, the conditions were maintained so as to deposit the fibers while they were in a tacky or cementitious condition. The thickness of the sheets or webs may be regulated by controlling the speed of the conveyor or collector surface where such collector consists of an endless belt as shown in Figures 1 and 2, or, in the case of a rotating shaped collector as shown in Figure 4, the thickness of the deposited web is controlled by the speed of rotation of the mold and by the number of revolutions during the deposition operation.

In Figure 6 there is illustrated schematically and in flow diagram fashion, a method for commercially producing a laminated reticulated fibrous web in accordance with this invention. The elastomeric material and the desired additives such as fillers, vulcanizing agents, accelerators, anti-oxidants and the like are thoroughly mixed in a conventional type rubber mill **50**. After the required milling period, the elastomeric composition is transferred to a conventional jacketed rubber mixer **52** and dissolved in the solvent, supplied from a suitable tank **51**, to form the spraying liquid. The spraying liquid is then transferred to a suitable storage tank **53** from which it passes to a pump **54**. A strainer or filter **55** may be interposed between the storage tank and the pump. From the pump **54**, the spraying liquid passes to the spray tips **56** mounted in adjacent towers **58**. The primary gas stream is supplied to the nozzles **57** by means of a blower **59**. The secondary gas streams are supplied to the bottom of towers **58** by means of a blower **60**. The spraying liquid is attenuated and the discontinuous elastomeric fibers are formed in the towers as described hereinbefore.

The fibers are collected on endless conveyor screens **61** which are disposed at the top of the towers and the vaporized solvent and gases supplied to the towers are removed through suction chests **61**. The reticulate webs are stripped from the collector screens **60** and are brought together under pressure between squeeze rolls **62**. The laminated sheet may then be passed through a dusting chamber **63** wherein a detackifier such as talc is applied to the outer surfaces to reduce the tackiness of the surfaces. The sheet then may be passed between another pair of rolls **64** from which it is passed through a pre-curing or pre-vulcanizing chamber **65**. The sheet is then passed over steam heated rolls **66** in a curing chamber **67** to effect a final curing or vulcanization of the elastomeric material. The cured or vulcanized sheet may then be passed through a suitable trimming device **68** to cut the sheet to a desired width. The finished sheet is then dusted with talc in a dusting chamber **69** and collected on a suitable wind-up roll **70**.

The fibrous, reticulated web or mat of elastomeric material has much the same feel as foam and sponge rubber. However, because of the completely random or haphazard arrangement of the fibers and due to the fibrous structure of these webs or mats as compared to the cellular structure of foam and sponge rubber, the permeability of the mats is substantially greater per unit of thickness than foam and sponge rubber. The tear strength and tensile strength of the webs and mats are also substantially greater per unit of thickness than foam and sponge rubber although the permeability is greater.

It is well known that calendered rubber exhibits an appreciably different elasticity and strength in the direction of calendering as compared to the elasticity and strength in a direction transverse to the direction of calendering. It is also well known that fibrous products wherein the fibers and filaments are more or less oriented exhibit different elasticities and strengths in the direction of orientation and in a direction transverse to the direction of orientation. The products of this invention possess substantially the same elasticity and strength characteristics in all directions in the plane of the sheet or web. It is also well known that upon puncturing rubber sheet, foam and sponge rubber, the rubber tears or rips readily. The totally random arrangement of the fibers in the webs and mats of this invention results in an apparent localization of any puncture, hole or abrasion and the web or sheet does not rip or tear upon stretching of the punctured web.

The fibrous, reticulated webs or sheets are entirely unique in the field of elastomeric sheets in this respect and may be sewed, tacked or nailed by conventional means without tearing.

Elastic fabrics are very costly compared to the sheets and mats of this invention because in the manufacture of such fabrics it is customary to first form a rubber thread or filament, combine the filament with a non-elastic thread and finally weave or knit the fabric. Such woven or knit elastic fabric may have elasticity in two directions, only if the elastic thread has been used for both the warp and the weft or filling. The reticulated webs of this invention are substantially lower in cost and have a substantially uniform elasticity in not only two directions, but in all directions in the plane of the web or mat.

Because of their high porosity and permeability, the webs and mats of this invention are particularly well suited for uses wherein the material contacts the human body. The porosity permits a "breathing action" not possessed by foam rubber and may be used to replace elastic textiles formed of "rubber thread." Thus, these webs in themselves or when combined with other materials are particularly well suited for the production of upholstered furniture, mattresses, pillows, surgical dressings, elastic stockings, bathing suits, foundation garments such as girdles, belts, garters, galluses, shoe parts such as inner soles, and the like. The webs are also highly satisfactory for other purposes such as gas filters, thermal insulation, sound insulation, sound absorbing materials, vibration absorbing or dampening materials, rug and carpet pads, conveyor belting and the like. The specific elastomer employed in producing the fibrous web may be selected to provide the required resistance to oils, greases, solvents, heat, light, abrasion and other conditions of use.

In a small scale production of the fibrous reticulated mats or webs of this invention, a tower may be employed having a diameter of four feet and a height of fifteen feet. The spraying unit is mounted concentrically within the tower at a point from about 10 feet to 12 feet from the top of the tower, the spray tip and nozzle being directed upwardly. A plurality of spraying units may be employed, if desired. A blower is provided to introduce an inert gas such as air at the bottom of the tower and suitable heating means may be provided to permit regulation of the temperature of this secondary air stream. The collecting conveyor mounted at the top of the tower may consist of a suitable screen such as a screen formed of Saran. The spraying orifice for the elastomers may be varied. A diameter of 0.04 to 0.06 inch has been found very satisfactory for the production of fibrous reticulated webs from the elastomers. The primary gas stream may be provided through a nozzle having an internal diameter of from about 0.5 inch to about 0.75 inch. The external diameter of the spray tip may be about 0.15 inch to about 0.2 inch and the tube may extend from the nozzle to position the orifice about ¾ inch from the nozzle. The thickness of the filamentary web or mat is controlled by regulating the speed of the collecting conveyor.

The following specific examples are set forth herein to illustrate the production of fibrous reticulated webs formed of natural and synthetic rubbers. The tower dimensions were as set forth above. The outside diameter of the spray tip was 0.165 inch and the inside diameter of the nozzle was 0.493 inch.

Example 1

A rubber mix was prepared containing a commercial anti-oxidant, namely, AgeRite White, and a commercial accelerator, namely, Tepidone, the mix having the following compositions:

	Parts by weight
Pale crepe	100
Zinc oxide	5
Lime	5
AgeRite white	1
Sulfur	2.5
Stearic acid	1
Paraffin wax	2
Tepidone	[1] 2.5

[1] Added just before spinning.

The foregoing materials were thoroughly mixed by milling and a spraying liquid or solution was formed containing 18.7% of the rubber composition in a solvent consisting of 98 parts of benzene to 2 parts of ethyl alcohol. The apparent viscosity of this solution as measured by the shearing disc viscosimeter was 10,000 cps. The spraying solution was extruded through an orifice having a diameter of 0.042 inch at a uniform rate of 24 cc. per minute or at a velocity of about 88 feet per minute. The primary air stream was supplied to the nozzle at the rate of 48 c.f.m. or at a velocity of about 40,800 feet per minute. The secondary air stream was passed through the tower at the rate of 8,550 c.f.m. or at a velocity of about 680 feet per minute and at a temperature of about 40° C. The paraffin wax and stearic acid incorporated in the spraying liquid serve as detackifiers and, in addition, a small amount of talc was introduced into the secondary air stream periodically to reduce the tacky nature of the fibers as they were deposited. The fibrous reticulated mat was cured after removal from the collector screen. The presence of the small amounts of these detackifiers permits the production of a loose, open web, however, the rubber fibers were firmly bonded together at their points of contact.

The web so formed, had much the same feel as sponge rubber but differed therefrom in having a uniform elasticity and strength in all directions in the plane of the web. It had the appearance of a closely matted mass of fine long fibers in a completely random arrangement with the filaments bonded together at their points of contact. The reticulated mat or web was also distinguishable from foam rubber in that it was air and liquid permeable and had a higher tear strength.

Example 2

The same rubber composition as employed in Example 1 was also dissolved in a naphtha base solvent having a boiling range of 140° to 250° F., namely, a solvent consisting of 95 parts of Amsco rubber solvent and 5 parts of alcohol, to form a spraying liquid containing 27% of the rubber composition. The apparent viscosity of the solution was 14,000 cps. The liquid was extruded at the rate of from 30 to 51 cc. per minute or at a velocity of from about 110 to 187 feet per minute. The primary air stream was supplied to the nozzle at the rate of 40 c.f.m. or at a velocity of about 34,000 feet per minute. The secondary air stream was passed through the tower at the rate of 3,000 c.f.m. or at a velocity of about 240 feet per minute and at a temperature of about 29° C. An additional detackifier consisting of finely divided starch was introduced into the secondary air stream periodically. The cured mat differed from the mat as prepared in Example 1 in that the fibers were somewhat coarser. In other respects, the mat prepared was similar to that prepared in Example 1.

Example 3

A rubber mix was prepared containing the rubber substitute, neoprene, having the following composition:

	Parts by weight
Neoprene Gn–M–2 (Du Pont)	300
Zinc oxide	15
AgeRite stalite	6
Stearic acid	1.5

A spraying liquid was formed consisting of 10% of the composition dissolved or suspended in benzene. The apparent viscosity of the solution was 4,100 cps. The liquid was extruded at the rate of 30 cc. per minute or at a velocity of about 110 feet per minute. The primary air stream was supplied to the spraying nozzle at the rate of 36 c.f.m. or at a velocity of about 30,600 feet per minute. The secondary air stream was passed through the tower at the rate of 8,500 c.f.m. or at a velocity of about 680 feet per minute and at a temperature of about 30° C.

The reticulated webs and mats formed from this composition resemble those prepared from the natural rubber compositions differing therefrom only in having a lower strength.

The following examples illustrate the preparation of webs or mats from a rubber composition containing about 100% filler based upon the weight of the elastomer:

Example 4

A rubber composition was prepared containing whiting, Titanox and McNamee clay as fillers and the commercial accelerators Ethyl Tuads, captax and butyl eight.

	Parts by weight
Pale crepe	100
Whiting	50
Titanox	20
McNamee clay	30
Zinc oxide	5
AgeRite white	1
Sulfur	2.5
Ethyl Tuads	0.5
Captax	1
Butyl "8"	4

A spraying liquid was formed containing 40% of the rubber composition in Amsco rubber solvent. The apparent viscosity of the solution was 7400 cps. The spraying liquid was extruded through an orifice having a diameter of 0.060 inch at a rate of 31.5 cc. per minute or at a velocity of about 57 feet per minute. The primary air stream was supplied to the nozzle at the rate of 35 to 45 c.f.m. or at a velocity of about 29,700 feet per minute. The secondary air stream was passed through the tower at the rate of about 6,430 c.f.m. or at a velocity of about 500 feet per minute and at a temperature of about 66° C. The reticulated mat was removed from the collector screen and the rubber vulcanized by heating to 100° C. for about 1 hour. Further portions of the uncured mat upon removal from the collector screen were stacked and pressure applied to bring the adjacent surfaces into firm contact with each other. The laminated pad was then vulcanized by heating to 100° C. for about 1 hour.

The reticulated mat and pad was light in color and had the appearance of a closely matted mass of fine and coarse fibers which were firmly bonded together at their points of contact. The mat and pad was very porous and possessed a very high permeability. The products had much the same feel as sponge or foam rubber but were substantially more firm. Upon flexing or bending a corner of the mat or pad and releasing the force, the corner portion returns to its original position with a much more brisk action or snap than a sponge or foam rubber mat or pad of the same thickness. The products had substantially uniform elasticity in all directions in the plane of the mat or laminations and had a high tear strength.

Example 5

A spraying liquid was prepared consisting of 40% of a rubber mix in Amsco rubber solvent, the composition consisting of

	Parts by weight
Pale crepe #2	100
Whiting	60
McNamee clay	40
Zinc oxide	5
AgeRite white	1
Sulfur	2.5
Ethyl Tuads	0.5
Captax	1
Butyl "8"	4

The apparent viscosity of the solution was 2600 cps.

For the preparation of products from this spraying liquid, four spraying units were mounted in the tower at a position about 10 feet from the top of the tower, the units being spaced from each other about 10 inches on a circle concentric with respect to the axis of the tower. Each spray tip was provided with an orifice 0.060 inch in diameter.

The spraying liquid was extruded through each orifice at a rate of about 30 cc. per minute or at a velocity of about 54 feet per minute. The primary air stream was supplied to each nozzle at the rate of 25 c.f.m. or at a velocity of about 21,200 feet per minute. The secondary air stream was passed through the tower at a rate of about 6,430 c.f.m. or at a velocity of about 500 feet per minute and at a temperature of about 55° C. The reticulated mat was removed from the collector screen and the rubber vulcanized by heating to 100° C. for about 1 hour. A laminated product was also prepared by assembling laminations before vulcanizing.

The reticulated mat and pad resembled those of Example 4, however, the products appeared more lacy and open than those of Example 4.

Although the reticulated webs and mats as formed may be employed for many uses, for many other purposes, it is desirable to incorporate in the mat non-adhesive preformed fibers and/or discrete particles. The non-adhesive fibers or discrete particles may be introduced into the secondary air stream through the blower 7 and are carried into contact with the elastomeric fibers as they are formed and while they are in a tacky condition. For example a ½ inch rayon staple fiber or cotton staple and/or cork or leather dust may be introduced into the air stream in the blower. The individual preformed fibers or particles as they contact the undried and tacky fibers adhere to the fibers, and the fibers and attached non-adhesive fibers or particles are deposited on the collecting means in a completely random or haphazard arrangement. The presence of the preformed fibers and elastomeric adhesive fibers produces a porous, highly permeable web which has a low elasticity or substantially no elasticity depending upon the relative amounts of the elastomeric fibers and preformed fibers. This type of product is well adapted for use as conveyor belting, surgical dressings and the like and the properties may be varied by altering the proportions of preformed fiber or discrete particles introduced into the product.

The elastomeric fibers may constitute from about 10% to about 90% of the composite material depending upon the characteristics desired.

In the manufacture of elastic fabrics, as for use in the manufacture of foundation garments, galluses, garters and the like, one or both surfaces of the reticulated fibrous, elastomeric web may be provided with a suede-like finish. Such velvety finish may be obtained by the application of a suitable flock such as a rayon flock to the surface or surfaces, as described and claimed in the copending application of Laurence R. B. Hervey, Serial No. 400,360, filed December 24, 1953. The flock may be applied while the surface of the web is tacky or a suitable cement may be applied before application of the flock and the elastomer vulcanized following the application of the flock.

In the manufacture of foundation garments and the like in which rubber sheeting has been combined with a woven or knitted textile, it has been necessary to perforate the rubber sheet to obtain the necessary air permeability. The perforations generally have been provided after assembling the rubber and textile to form the composite sheet. Subsequently, it has been necessary to treat the composite sheet because of the damage to the knitted textile caused by the perforating operation. The use of the reticulated, fibrous elastomeric mats or webs of this invention obviates the necessity of the perforating treatments because the webs are permeable and porous. The reticulate web may be bonded or secured to the knitted or woven textile.

Crinkled rubber sheet is very desirable for the manufacture of such articles as bathing garments, for example, bathing suits, caps, shoes and the like, because it is light in weight, does not stretch when wet, conforms closely to the body contours and dries quickly. However, such sheet is easily punctured and when punctured the sheet is very readily torn. It is necessary therefore, to reinforce the sheet with a knitted or woven fabric which is stretchable in all directions. The resulting material is highly objectionable because it is substantially impervious and will not permit the passage of perspiration. The reticulated, fibrous, elastomeric web of the present invention while possessing substantially all of the desirable characteristics of thin, crinkled rubber sheet, possesses the decided advantage that it is sufficiently permeable to permit the passage of perspiration and because of its fibrous structure does not tear or rip readily when punctured. Material, highly satisfactory for bathing suits and the like may be prepared by securing thin fibrous, elastomeric webs to a woven or knitted fabric which is stretchable in all directions, as described and claimed in the copending application of Worth Wade and Ralph M. Winters, Jr., Serial No. 400,172, filed December 24, 1953. If desired, one or both surfaces of the composite sheet material may be provided with flocked fibers such as flocked rayon to improve the feel of the material or to provide a desired suede-like or velvety appearance to the material.

The elastomeric web may be bonded to other types of nonelastic fibrous sheets or mats for the production of padding materials and upholstery materials. Such composite bodies will possess the desirable resilient characteristics of sponge or foam rubber but, because of the permeability and porosity of the elastomeric web, will be superior to foam rubber in that the fibrous, reticulated web is sufficiently porous and permeable to permit the passage of perspiration. The elastomeric web or mat, either a single ply or a laminated body, as described hereinbefore, may be secured to the fibrous mat while the elastomeric web is tacky and before the elastomer has been vulcanized or the surface of the elastomeric web may be rendered adhesive or tacky by treatment with a solvent and the reticulated web and the fibrous mat brought into contact and the solvent evaporated.

The fibrous, elastomeric web may be employed also in forming composite bodies consisting of at least one layer of the reticulate web bonded to other types of non-fibrous flexible sheet materials or to rigid substantially non-porous materials.

Since variations and modifications may be made in carrying out the invention, without departing from its spirit and scope, it is to be understood that the invention is not to be limited except as defined in the appended claims.

For example, although Figures 1, 2 and 6 illustrate a single collecting screen positioned at substantially right angles to the axis of the tower, the collecting screen may be mounted at any other desired angle. If desired, a plurality of collecting screens may be provided as illustrated in Figures 7 and 8. In the modification shown in Figure 7, the tower **71** is provided with two inclined collecting screens **72**. The supporting rolls **73** are so positioned as to serve as squeeze rolls between which the webs deposited on each of the collectors are brought together to form a laminated, reticulated web **74**. As shown in Figure 8, the removal of the loose, open web formed by the deposition of some fibrils on the walls of the tower **75**, as described hereinbefore, may be facilitated by collector belts or screens **76** and **77** which may comprise a part or all of the walls of the tower. The fibers which are not deposited on the collecting screen **78** may thereby be collected on the belts **76** and **77** and may be continuously removed. Further modifications will be apparent to those skilled in the art.

We claim:

1. The method of producing an elastic, reticulated, fibrous shot-free body which comprises providing a fiber-forming liquid containing a fiber-forming elastomeric material; establishing a high velocity stream of gas; discharging the stream of gas into the ambient atmosphere; extruding the fiber-forming liquid into and within the stream of gas at a point beyond the point of discharge of the stream of gas, the direction of extrusion being coincident with the direction of the gas flow; attenuating the extruded fiber-forming liquid, breaking the attenuated fiber-forming liquid into discontinuous lengths and at least partially setting the attenuated fiber-forming liquid to form discontinuous fibers substantially free of shot by maintaining the velocity of the stream of gas at the point of discharge at a value greater than the velocity of extrusion of the fiber-forming liquid; and collecting the discontinuous fibers in random distribution to form a reticulated, sheet-like, fibrous shot-free body.

2. The method as defined in claim 1, wherein the fiber-forming liquid comprises a solution of natural rubber.

3. The method as defined in claim 1, wherein the fiber-forming liquid comprises a solution of a synthetic rubber.

4. The method of producing an elastic, reticulated, fibrous shot-free body which comprises providing a fiber-forming liquid containing a fiber-forming elastomeric material; establishing a primary stream of gas; discharging the stream of gas into the ambient atmosphere; extruding the fiber-forming liquid into and within the primary stream of gas at a point beyond the point of discharge of the stream of gas, the direction of extrusion being coincident with the direction of the gas flow; attenuating the extruded fiber-forming liquid, breaking the attenuated fiber-forming liquid into discontinuous lengths and at least partially setting the attenuated fiber-forming liquid to form discontinuous fibers substantially free of shot by maintaining the velocity of the primary stream of gas at the point of discharge at a value greater than the velocity of extrusion of the fiber-forming liquid; and suspending the fibers, completing the setting thereof and depositing the fibers in random distribution to form a reticulated, sheet like, fibrous shot-free body by passing the ambient atmosphere upwardly at a velocity greater than the velocity of extrusion of the fiber-forming liquid but lower than the velocity of the primary stream of gas.

5. The method of producing an elastic, reticulated, fibrous shot-free body which comprises providing a fiber-forming liquid containing a fiber-forming elastomeric material; establishing a primary stream of gas; discharging the primary stream of gas upwardly into the ambient atmosphere; extruding the fiber-forming liquid upwardly into and within the primary stream of gas at a point beyond the point of discharge of the stream of gas, the direction of extrusion being coincident with the direction of the gas flow; attenuating the extruded fiber-

forming liquid, breaking the attenuated fiber-forming liquid into discontinuous lengths and at least partially setting the attenuated fiber-forming liquid to form discontinuous fibers substantially free of shot by maintaining the velocity of the primary stream of gas at the point of discharge at a value greater than the velocity of extrusion of the fiber-forming liquid; and suspending the fibers, completing the setting thereof and depositing the fibers in random distribution to form a reticulated, sheet-like, fibrous shot-free body by passing the ambient atmosphere upwardly at a velocity greater than the velocity of extrusion of the fiber-forming liquid but lower than the velocity of the primary stream of gas.

6. The method of producing an elastic, reticulated, fibrous shot-free body which comprises providing a fiber-forming liquid containing a fiber-forming elastomeric material; establishing a primary stream of gas; discharging the stream of gas into the ambient atmosphere; extruding the fiber-forming liquid into and within the primary stream of gas at a point beyond the point of discharge of the stream of gas, the direction of extrusion being coincident with the direction of the gas flow; attenuating the extruded fiber-forming liquid, breaking the attenuated fiber-forming liquid into discontinuous lengths and at least partially setting the attenuated fiber-forming liquid to form discontinuous fibers substantially free of shot by maintaining the velocity of the primary stream of gas at the point of discharge at a value greater than the velocity of extrusion of the fiber-forming liquid; suspending the fibers, completing the setting thereof and depositing the dried fibers in random distribution to form a reticulated, sheet-like, fibrous shot-free body by passing the ambient atmosphere upwardly at a velocity greater than the velocity of extrusion of the fiber-forming liquid but lower than the velocity of the primary stream of gas; laminating the sheet-like body before the elastomeric material has been cured; and curing the elastomeric material to form a unitary, elastic, reticulated, fibrous body.

7. The method of producing an elastic, reticulated, fibrous shot-free body which comprises forming a fiber-forming liquid containing a fiber-forming elastomeric material; establishing a primary stream of gas; discharging the primary stream of gas upwardly into the ambient atmosphere in each of a plurality of chambers; extruding a fiber-forming liquid upwardly into each of the primary streams of gas at a point beyond the point of discharge of the stream of gas, the direction of extrusion being coincident with the direction of the gas flow; attenuating the extruded fiber-forming liquid, breaking the attenuated fiber-forming liquid into discontinuous lengths and at least partially setting the attenuated fiber-forming liquid to form discontinuous fibers substantially free of shot by maintaining the velocity of each of the primary streams of gas at the point of discharge at values greater than the velocity of extrusion of the respective fiber-forming liquid; suspending the fibers, completing the setting thereof and depositing the fibers in random distribution to form a reticulated, sheet-like, fibrous shot-free web in each of the chambers by passing the ambient atmosphere upwardly in each of the chambers at a velocity greater than the velocity of extrusion of the fiber-forming liquid but lower than the velocity of the respective primary stream of gas; bringing the sheet-like, fibrous webs together under pressure before the elastomeric material has been cured; and curing the elastomeric material to form a unitary, elastic, reticulated fibrous body.

8. The method of producing a reticulated, fibrous body which comprises forming a fiber-forming liquid containing a fiber-forming elastomeric material; establishing a primary stream of gas; discharging the primary stream of gas upwardly into the ambient atmosphere; extruding the fiber-forming liquid upwardly into and within the primary stream of gas at a point beyond the point of discharge of the stream of gas, the direction of extrusion being coincident with the direction of the gas flow; attenuating the extruded fiber-forming liquid, breaking the attenuated fiber-forming liquid into discontinuous lengths and at least partially setting the fiber-forming liquid to form discontinuous fibers substantially free of shot by maintaining the velocity of the primary stream of gas at the point of discharge at a value greater than the velocity of extrusion of the fiber-forming liquid; passing the ambient atmosphere upwardly; introducing particulate, non-adhesive material into at least one of the streams of gas, the particulate, non-adhesive material being selected from the group consisting of preformed, non-adhesive fibers, preformed, non-adhesive, discrete particles and mixtures thereof; and suspending the fibers and the particulate non-adhesive material, completing the setting of the fibers and depositing the fibers and the particulate, non-adhesive material in random distribution to form a reticulated, sheet-like fibrous body by maintaining the velocity of the ambient atmosphere greater than the velocity of extrusion of the fiber-forming liquid but lower than the velocity of the primary stream of gas.

9. The method as defined in claim 8, wherein the particulate non-adhesive material is introduced into the ambient atmosphere.

10. Apparatus for the production of permeable, elastic, reticulated, fibrous shot-free bodies of elastomeric materials which comprises a tower, a spraying unit positioned within the tower including an upwardly projecting nozzle for passing a primary stream of gas at a high velocity through the tower and an upwardly projecting spraying tube extending through the nozzle and having an extrusion orifice positioned beyond the end of the nozzle and in the path of the high velocity stream of gas for extruding a spraying liquid containing an elastomeric fiber-forming material into and within the primary stream of gas at a point beyond the end of the nozzle thereby attenuating the extruded liquid and breaking the extruded liquid into discontinuous shot-free fibers, means for passing the ambient atmosphere in the tower upwardly at a low velocity through the tower to carry the fibers upwardly and means including an endless conveyor positioned at the top of the tower for collecting the fibers.

References Cited in the file of this patent

UNITED STATES PATENTS

468,216	Birge	Feb. 2, 1892
1,979,251	Chapline	Nov. 6, 1934
2,152,901	Manning	Apr. 4, 1939
2,411,660	Manning	Nov. 26, 1946
2,476,283	Castellan	July 19, 1949
2,586,275	Toulmin	Feb. 19, 1952

FOREIGN PATENTS

804,987	France	Aug. 17, 1936