June 30, 1942. H. B. LINDSAY ET AL 2,288,095

METHOD AND APPARATUS FOR PRODUCING BOUND BATTS

Filed May 23, 1939 2 Sheets-Sheet 1

Fig. 1

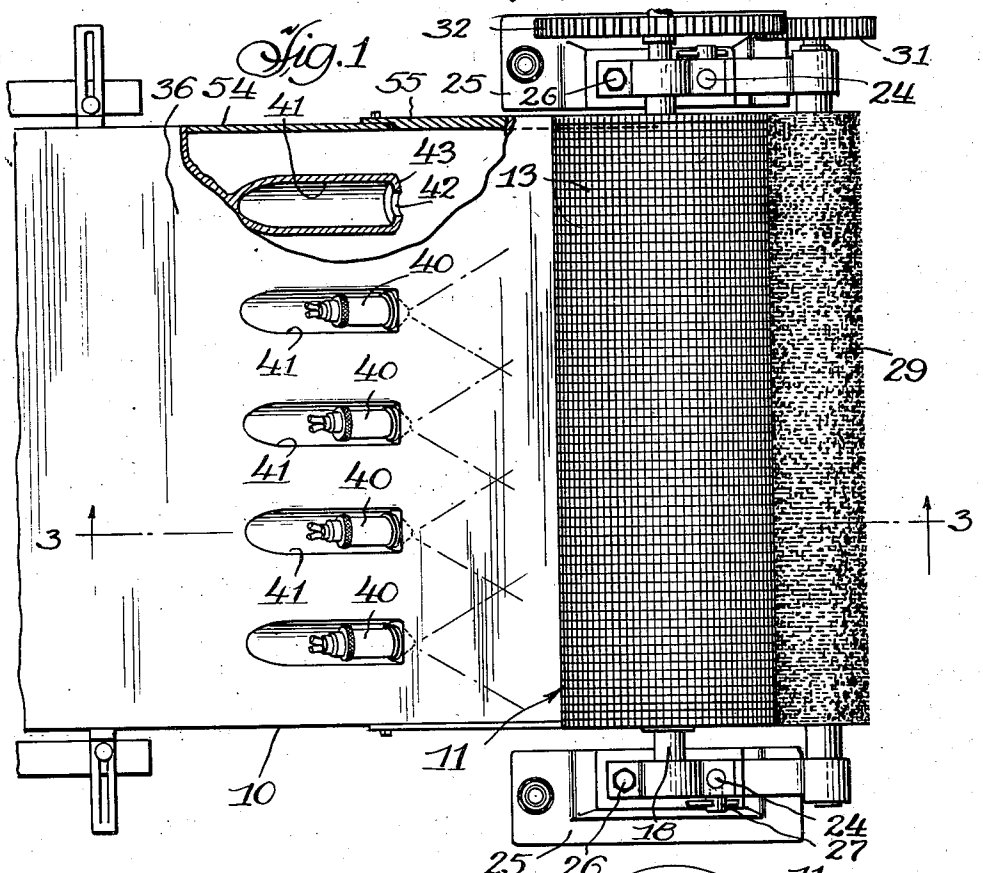
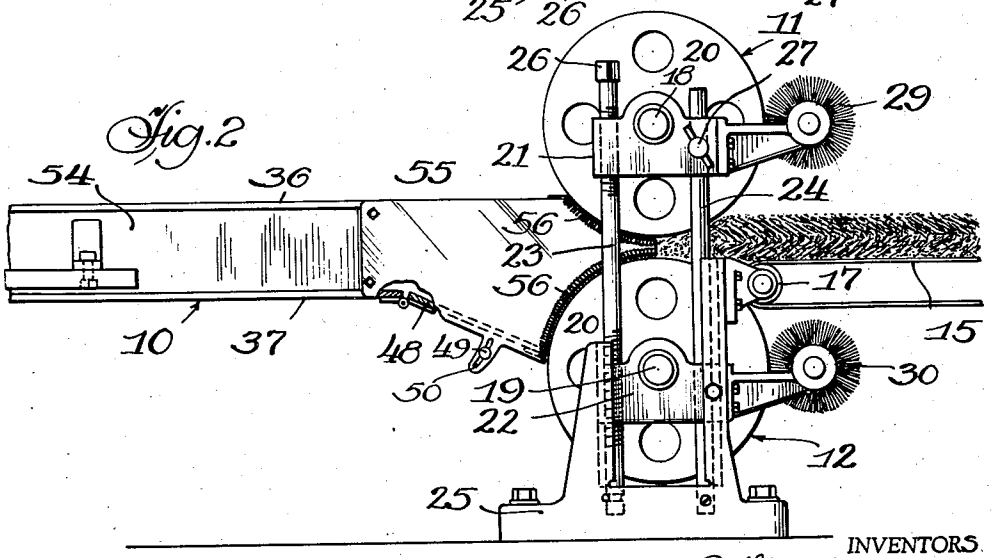


Fig. 2



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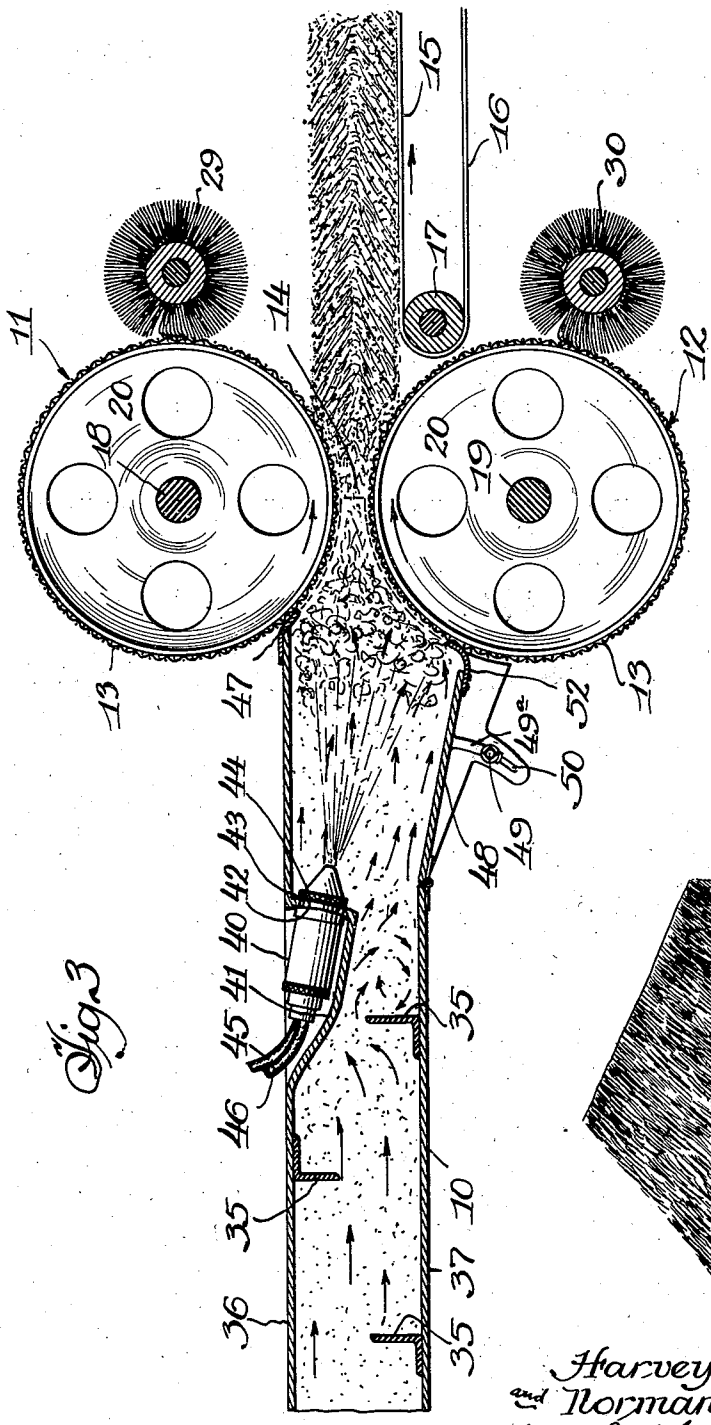

Fig. 3

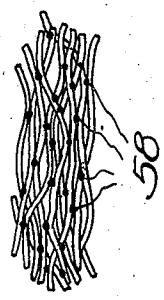

Fig. 5

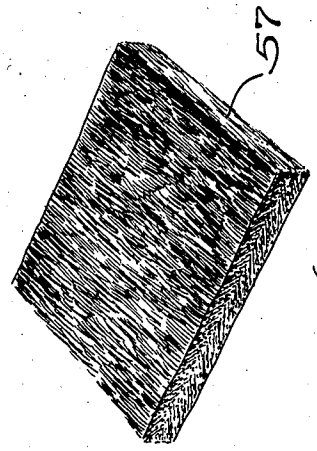

Fig. 4

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METHOD AND APPARATUS FOR PRODUCING BOUND BATTS

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Application May 23, 1939, Serial No. 275,208

8 Claims. (Cl. 154—27)

This invention relates to improvements in methods and apparatus for producing a bound batt of fibrous insulating material. The invention is particularly designed for application to Ceiba fiber, commonly known as Kapok, and similar natural fibers which are particularly useful for their heat insulating properties.

It has heretofore been considered impossible to apply adhesive binding materials to a body of such fibers so as to form a coherent mass, as for instance in the shape of insulating blankets or strips, and yet to maintain the desired light and highly resilient qualities of the fiber and without affecting its insulating properties.

Among the objects of our invention is to produce a light and highly resilient fibrous batt in which the surfaces of the fibers or any appreciable part of such surfaces are not coated or covered with binding material, but in which the adjacent fibers are bound or attached to each other only at occasional, minute points of contact, leaving the fibers between such points free to flex independently in their natural state. In this way the desirable characteristics of the fiber surfaces or of the fiber as a whole are not in any way interfered with by the binder, or by any substantial penetration of the fiber due to to absorption of the binder.

A further object of our invention is to produce a batt of thickness up to several inches, so lightly but firmly bound together that its weight may be reduced to less than one-half pound per cubic foot, and yet so resilient that it may be compressed to one-eighth its thickness, and after release, regain its normal thickness, and so firm that it may be cut in any direction, and the fibers along the edge retain their proper position.

It has been common practice to introduce an adhesive or binder into a body of lightly matted fiber material so as to bind it into a more or less pliable blanket, sheet or block. This is usually done either by spraying successive thin layers of the fiber and placing one layer upon another, or else by saturating or submerging the fiber in a liquid vehicle containing the binder, doctoring the mixture to the desired thickness, and drying it.

For such purposes as heat insulation, however, it is important that neither shall the nature of the fiber surface be changed, as by coating or by substantial deposit thereon, nor that the characteristics of the material composing the fiber be affected by penetration or absorption of the binder or vehicle. In the case of heat insulation, the microscopic smoothness and instant resilience of the individual fiber surfaces throughout the entire body of insulating material form one of the controlling factors of insulating value. Hence where the fiber used possesses these qualities to a high degree, as for instance in the case of the Ceiba fiber and other natural fibers of a similar character, it is important that their surfaces shall not be coated or receive any substantial deposit thereon of a binder, such as the ordinary adhesives, which do not have the same surface qualities.

Furthermore, as is well known, the introduction of solid matter into the fibral construction of applicable or resilient fiber renders the latter brittle or tends to destroy its resilience. It is extremely desirable that light fibrous insulating materials should retain their resilience indefinitely so as not to break down, sag or settle in an insulated wall structure under movement or vibration.

It is for these reasons that so far as we are aware, no light flexible insulation composed of fibers bound together has previously proved lasting, efficient or satisfactory, particularly for uses where movement, impact or vibration are to be encountered.

In carrying out our invention, we have discovered that the binder or adhesive must be introduced to the fibers in such a form and manner that it will not tend to spread out over a substantial part of the fiber surfaces, but on the contrary will tend to stick on the fiber surfaces as minute droplets ready to adhere to another fiber as soon as the other fiber touches that point, thereby forming a bond as the fiber hardens at a single point only and without any appreciable coating of the fiber.

To achieve this we have found it desirable to use such a combination of fiber, and binder solution or emulsion sprayed thereon, that sufficient surface tension of the fiber is set up on the binder liquid to cause the mist droplets to remain in that form after alighting on the fibrous surface, and not to spread or "wet" the fiber substantially beyond the initial point of settlement. As before stated, the Ceiba fiber previously referred to, has not only notable heat insulating properties, but it is one of a number of natural fibers having a waxy constitutent which sets up a high surface tension on water. We find that fibrous material having these characteristics can be successfully bound into batts by proper application of a water solution or emulsion of an adhesive, containing no sort of soap or oil or other "wetting" agent, in such a manner as to produce what might be

termed a "spot" or droplet binding as above described.

The methods of achieving the foregoing purposes and the product thereby produced may best be understood by reference to the accompanying drawings, in which—

Fig. 1 is a plan view showing the principal portions of an apparatus for producing a bound batt in the form of a continuous strip.

Fig. 2 is a side view of the apparatus shown in Fig. 1.

Fig. 3 is an enlarged detail view taken on line 3—3 of Fig. 1.

Fig. 4 is a detail view showing a portion of the batt in bound form after it has passed through the apparatus shown in the foregoing figures.

Fig. 5 is a fragmentary microscopic detail showing individual fibers greatly enlarged and illustrating more or less figuratively the arrangement by which the adjacent fibers are connected together at certain points by individual droplets of binding material.

Referring to details of the apparatus illustrated in Figs. 1, 2 and 3 of the drawings, an air conduit 10 for carrying loose fibers leads to a pair of vertically spaced rollers 11 and 12 having open screen surfaces 13 forming a somewhat restricted throat 14 therebetween, and having a suitable conveyor 15, herein consisting of an endless belt 16 trained on a roller 17, disposed beyond said throat.

The screen 13 on rollers 11 and 12 is preferably of fine wire mesh, as for instance in the order of six to ten mesh, to provide a substantial orifice area per square inch for passage of air therethrough. Said screening is mounted on rotating shafts 18 and 19, respectively, by means of a plurality of spaced circular discs 20, 20 to which the screening is suitably secured. The roller shafts 18 and 19 are journalled respectively at opposite ends in upper bearing brackets 21 and lower bearing brackets 22, which in the preferred form shown are mounted for vertical adjustment toward and away from each other so as to regulate the height of the throat 14 between the adjacent roller surfaces.

In the form shown herein, this vertical adjustment at each end of the rolls is provided by means of two upright supports 23, 24 mounted on a base member 25, as clearly shown in Fig. 2. The support 23 passes vertically through the bearing brackets 21 and 22, and has right and left threaded connection in said brackets as shown, so that the two brackets may be moved toward and away from each other by rotating the support 23, as for instance by engaging the squared upper end portion 26 thereof with a suitable tool. The companion support 24 is fixed on the base 25 so that the upper and lower bearing brackets 21 and 22 are slidably adjustable thereon. In the form shown a set screw 27 on bracket 21 is adapted to engage support 27 to hold the bearing brackets in any desired position of adjustment.

The screen rollers 11 and 12 may be driven by any suitable power means (not shown) connected to the shafts 18 and 19 so as to rotate them in opposite directions, as indicated by the arrows in Fig. 3.

Carried between each pair of upper and lower brackets 21 and 22 is a rotating wire brush 29 and 30, respectively, driven at high speed relative to its associated screen roller by any suitable means, such as gears 31 meshing with gears 32 on the screen roller shafts 18 and 19, respectively. The wire brushes serve to remove any accumulations of material or excess binder that might gather on the screen surfaces of the rollers and thereby maintain the wire mesh open for passage of air therethrough.

The flat conveyor belt 16 may also be driven by any suitable means, not shown herein, in a direction to carry the material away from the rollers, as indicated in Fig. 3.

Referring now in greater detail to the form and arrangement of the conduit 10, it will be understood that air is forced as usual through said conduit at a predetermined speed from a suitable blower or the like (not shown), and loose fiber is fed into this air current by a predetermined rate by means familiar to the art, details of which need not be described herein, as they form no part of the present invention. In the form of conduit shown in the drawings, a series of transverse baffle plates or riffles 35, 35 are also mounted in alternate spaced relation along the top wall 36 and bottom wall 37, whereby substantially all of the fibers are caused to assume a generally parallel relation with each other in a direction transverse to the normal direction of flow of the fibers through the conduit, and thus produce a so-called "graining" effect in the final batt. This means for graining the fibers is broadly disclosed and claimed in Patent No. 1,679,251 issued July 31, 1928, to Harvey B. Lindsay. While the "spot" binding process forming the subject-matter of the present application seems to give somewhat better finished product where the fiber is thus grained, yet the same process can likewise be used without such graining.

Mounted in the conduit 10 adjacent the last baffle or riffle 35 and directed generally toward the throat 14 between the screen rollers 11 and 12 are a plurality of spray guns 40, 40 of any well known form, adapted to throw a very fine mist spray of liquid binding material. These guns are preferably mounted so that the direction of their discharge may be angularly adjusted. In the form shown, said guns are individually supported in a series of elongated recesses 41, 41 formed in the top wall 36 of the conduit 10, said recesses each having an opening 42 in its front wall 43 through which the nozzle of its spray gun 40 is directed. The desired adjustment of nozzles may be provided by slightly dishing or curving its respective front wall 43 and clamping the nozzle thereto for limited universal rocking adjustment by means of a nut 44 on the reduced outer end portion of the nozzle, as clearly shown in Fig. 3.

The spray guns 40 are adjusted to throw a laterally fanwise mist spray, and are preferably positioned at such a distance from the throat 14 that the spray discharge will become spent and be dispersed with a billowing movement in the area substantially at and between the converging surfaces of the screen rollers 11 and 12 immediately in front of the throat 14. The liquid binder and compressed air are fed to the guns as usual through conduits 46 and 47, so as to force the resulting spray through the nozzles at such a pressure that at the beginning of the aforesaid billowing movement the spray mist will be traveling at substantially the same speed as the fiber-laden air at the same point.

Control of the proper billowing point as above described may be afforded to some extent by adjustment of fineness of the nozzle spray on the

one hand, or by adjustment of the distance between the nozzle and the throat of the conduit on the other, or by a combination of both. For best results, however, we find that in practice the nozzle should not be more, and preferably less than fifteen inches from the rolls, because of the tendency of the fine mist spray to dry and become powdered where a much greater distance is utilized. The correct adjustments, however, will depend upon varying factors in each instance, and it may even be necessary to make readjustments due to temporary changes of atmospheric conditions, small changes of fiber density, and other apparent slight causes. As a practical method of determining the proper adjustment at which the billowing mist will be caused to spray uniformly over all of the air outlet area at rolls 11 and 12, and yet to keep the binder from excessive concentration at the throat surfaces, we have found this to be when the nozzles are so directed—without the air current in the conduit—that the mist spray strikes the screen surfaces about at the point where it begins to billow.

It will be observed in Fig. 3 that the top wall 36 of the conduit 10 approaches to within a fraction of an inch of the adjacent screen roll surface 13, and that the remaining gap is closed by a soft and resilient lip 47 such as leather, felt or hair brush strips stiff enough not to blow out, yet soft enough not to hurt the screening of the rolls. The bottom wall 37 is preferably provided with a hinged end portion 48 adjacent the bottom roller 12, adjustable by suitable means such as a bolt 49 on arm 49a operating in a slotted bracket 50, as shown in Fig. 3, so as to enlarge or decrease the size of the throat at the billowing area of the mist when desired. The hinged portion 48 is also provided with a resilient lip 52 similar to the lip 47 on the upper wall.

The side walls 54 of the conduit 10 are preferably spaced from each other substantially the same distance as the total length of the screen rollers 11 and 12, and are continued by tongue portions 55 extending at least to the vertical center line of the rolls. These tongues may be edged with suitable hair-brush strips where they contact the screening as indicated at 56. As the rolls are adjustable vertically for different thicknesses of batt, these tongues may be replaced, if necessary, with similar tongue portions of correspondingly different dimensions.

As a binder suitable for employment in our process, we find that a 2% solution of methyl cellulose in water, or a mixture of commercial "Flextite" which consists of a latex base adhesive with an equal amount of water to form an emulsion, makes a satisfactory binding agent containing no sort of soap or oil or other so-called "wetting" agent. Other adhesives or binders having similar characteristics may also be used with our process.

With the apparatus above described and preferred materials suitable for utilization therewith now in mind, the operation of the process may be generally described as follows:

As an air-borne fiber passes the first part of the nozzle discharge spray, it tends to be pushed away from the binder mist rather than into it. When, however, the discharge begins to billow out just before reaching the throat between the screen rolls, this condition changes, and as both mist and air-borne fiber approach the same outlet area, they mingle. As successive fibers are led against the screen surfaces of the rolls and each other by the air escaping through said screen surfaces, some of the microscopic globules of mist carried by the air are forced to alight on the fibers, while the balance of the mist passes out through the screen rolls. In detail, it appears that a fiber momentarily held against the screen and having several globules of binder mist deposited on it, is followed by another fiber which slides along the first until it hits one of the binder globules, whereupon the two fibers are stuck together at the point of such globule, and so on successively. As the rolls continue to rotate, the fibers on the two rolls, building continuously to a depth of from a fraction of an inch to two or three inches thick (depending upon the controlled volume of fiber for the thickness of batt desired), meet each other and are in turn bound both by free globules on the surface fibers of each lot, as well as by some small amount of mist that may seek outlet through the porous batt itself. Fig. 5 illustrates in a more or less figurative way how the individual dot or globule points of adherence occur between adjacent fibers, as indicated at 58, 58'.

The screen rolls then compress the newly and continuously formed batt considerably to a degree depending on the lightness and resilience of the fiber being run, and it comes out and is deposited on the moving conveyor 15 as a uniform batt, as indicated at 59 in Fig. 4, the fibers of which throughout are adhered to each other as previously described.

It is usually necessary to dry out the binder in the batt by any suitable means before the bound batt is ready for use. In practice, however, we find that this drying process is relatively quick and easy work because the fiber is perfectly dry, excepting at each microscopic binding dot, and the latter are so minute that drying requires little more than getting dry air to pass through the batt.

It will be understood that various modifications may be made in the apparatus shown and described herein as illustrative of a means of carrying out our invention and producing our improved product. For instance, the shape of the conduit can be varied, and spray guns or nozzles can be mounted at the sides, bottom or at intermediate points within the conduit. The screen rollers comprise a preferred form of perforated carriers for the fiber stream, assisting in shaping the fibers into final batt form; but other forms of perforated carriers can be utilized for the same purpose.

It is apparent that these screen surfaces adjacent the throat serve an important function in arranging the fibers in their final adhering positions, as it will often be noted in practice that the batt, as viewed from the side edge thereof, shows that the fibers finally have a distinctly herringbone or V-shaped pattern, as clearly indicated in Figs. 1, 3 and 4. We attribute this to the action of the screen roller surfaces on the fibers at the throat 14, where final adhesion between adjacent fibers is effected.

Although we have shown and described certain embodiments of our invention, it will be understood that we do not wish to be limited to the exact construction shown and described, but that various changes and modifications may be made without departing from the spirit and scope of our invention as defined in the appended claims.

We claim as our invention:

1. The method of forming a bound batt from fibers having a relatively high wet-resistant surface, which comprises blowing loose fibers through an air conduit, spraying an emulsified liquid adhesive into the conduit in the form of a fine mist so as to deposit individual minute globules on localized surface areas of the fibers without substantial penetration thereof, and passing the body of fibers between opposed perforated carrier surfaces in the area of said mist spray.

2. Apparatus for forming a bound batt of fibrous material, which includes an air conduit for blowing loose fibers, two driven rollers having adjacent perforated surfaces spaced from each other so as to form a relatively restricted throat at the discharge end of said conduit, and nozzle means for spraying a liquid binding material into said fibers at a point adjacent said throat, said nozzle being disposed wholly within the line of air flow and arranged so that the billowing action of the spray occurs in the area immediately adjacent the rollers and said throat.

3. The method of forming a bound batt of fibers which comprises blowing the loose fibers through an air conduit, spraying an adhesive in liquid form into said conduit in a fine mist formed of microscopic globules so as to deposit said globules individually on minutely localized surface areas of said fibers, without substantial wetting of said fibers, and partially compressing the body of said fibers to form a batt.

4. The method of forming a bound batt of fibers which comprises blowing the loose fibers through an air conduit, spraying an adhesive in liquid form into said conduit in a fine mist formed of minute globules, and causing said mist spray to move in the same direction and at substantially the same velocity as the fiber-laden air in said conduit so that said globules may settle individually on the surfaces of said fibers and thereby provide individual points of adhesion between adjacent fibers at isolated points of contact of said globules without affecting the normal properties of said fibers between said points of adhesive connection, and partially compressing the body of fibers to form a batt.

5. The method of forming a bound batt of fibers having a relatively high wet-resistant surface, which comprises blowing the loose fibers through an air conduit, spraying an adhesive in liquid form into said conduit in a fine mist formed of microscopic globules so as to deposit said globules individually on minutely localized surface areas of said fibers, without substantial wetting of said fibers, and partially compressing the body of said fibers to form a batt.

6. The method of forming a bound batt of fibers having a relatively high wet-resistant surface, which comprises blowing the loose fibers through an air conduit, spraying an adhesive liquid into said conduit in a fine mist formed of microscopic globules in amounts so limited as to deposit said globules at localized points on said fibers, and partially compressing said fibers so as to form adhesive connection between adjacent fibers at isolated points of contact of said globules without affecting the normal properties of said fibers between said points of adhesive connection, and partially compressing the body of fibers to form a batt.

7. The method of forming a bound batt of fibers having a relatively high wet-resistant surface, which comprises blowing the loose fibers through an air conduit, spraying an adhesive liquid into said conduit in a fine mist formed of minute globules, with said mist spray moving in the same direction and at substantially the same velocity as the fiber-laden air in said conduit so that said globules may settle individually on the surfaces of said fibers and thereby provide individual points of adhesion between adjacent fibers at separated points of contact, and partially compressing the body of fibers to form a batt.

8. The method of forming a bound batt of fibers having a relatively high wet-resistant surface, which comprises blowing the loose fibers through a conduit, by air flow directing a spray of an emulsified liquid into the conduit in the same direction as the air flow to form a mist of microscopic globules and causing the spray to move at substantially the same velocity as said fibers so that said globules may settle individually on minutely localized surface areas of said fibers, and passing the body of fibers between opposed perforated carrier surfaces within the area of said mist spray to partially compress said fibers into a batt.

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