Feb. 15, 1955 G. M. LANNAN 2,702,069

METHOD FOR FORMING FIBROUS MATS

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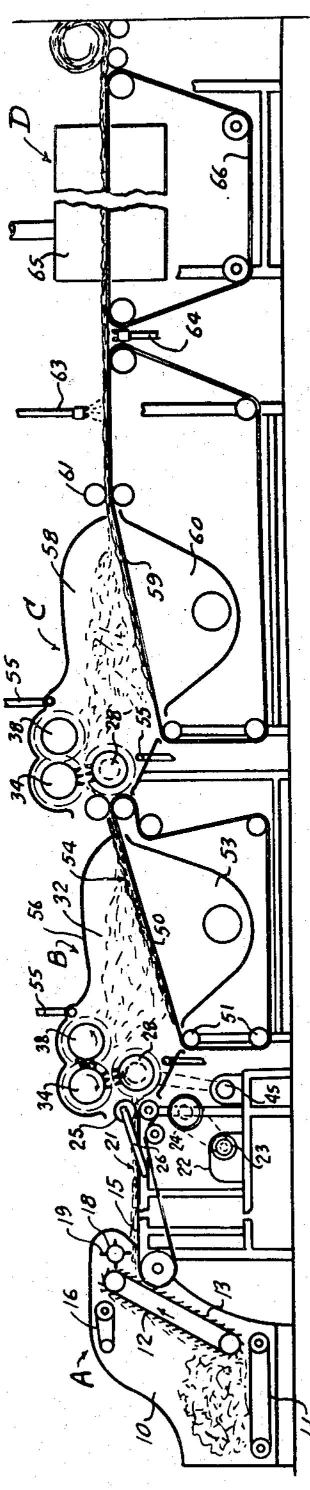

FIG. 1.

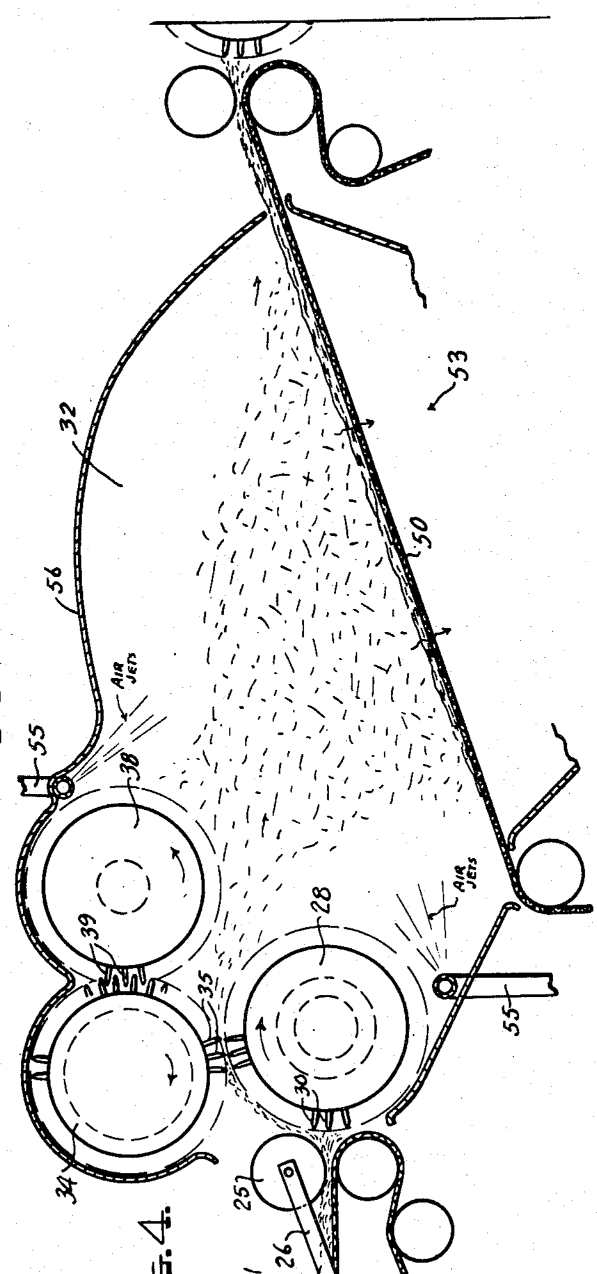

FIG. 4.

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FIG. 2.

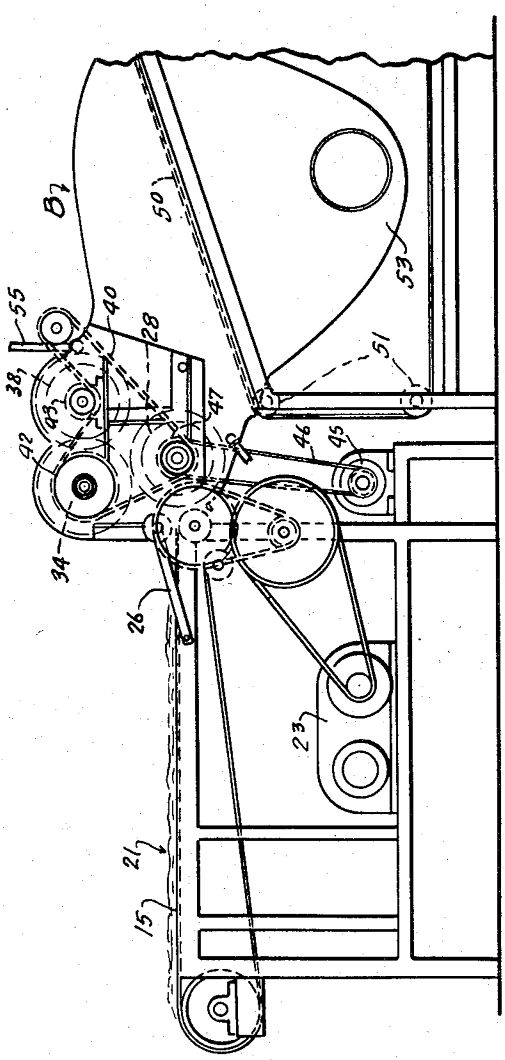


FIG. 5.

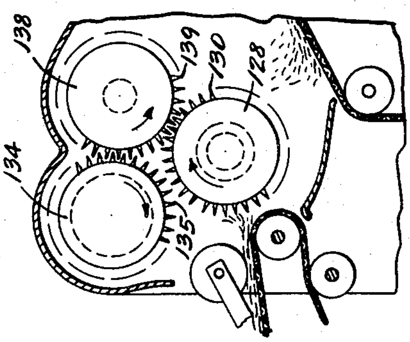
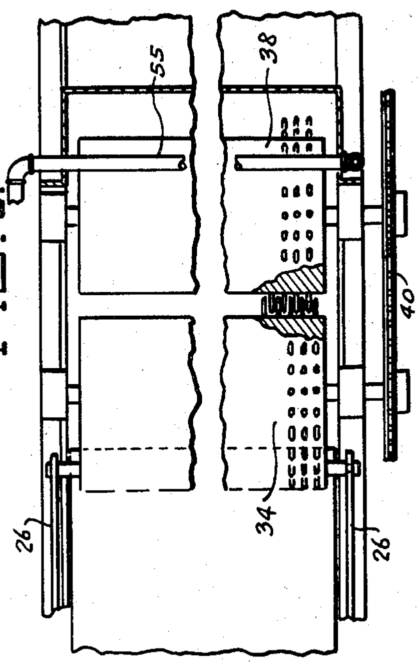


FIG. 3.



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METHOD FOR FORMING FIBROUS MATS

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Application January 30, 1951, Serial No. 208,501

1 Claim. (Cl. 154—28)

The present invention relates to a production of mats of fibrous material and more particularly to a process for forming mats of glass fibers.

It is an object of the present invention to provide a process for making fibrous glass mats of haphazardly arranged glass fibers that will be replete with voids or air spaces to obtain high acoustic and thermal insulating properties.

It is a further object of the invention to make mats of fine glass fibers that will be highly resilient, have a high degree of integrity and are highly uniform in character for use as a reinforcement for plastics.

It is another object of the invention to produce fibrous glass mats that, while being resilient, have also a certain resistance to compression, making them suitable for cushioning, padding and as clothing inter-liner material.

A still further object of the present invention is to provide a process for forming mats of fibrous material efficiently at high speed and in an economical manner.

Other objects and purposes of the invention will become apparent during the course of the following description.

In the present invention glass fibers have been selected as one fibrous material particularly adapted for handling in the process and because of their inorganic nature, high strength characteristics and other features inherent in the fibers. Glass in fibrous form may be produced by many well known processes. Glass fibers designated generally by the term "glass wool" are usually produced by flowing streams of molten glass and engaging the molten streams in a high speed gaseous blast to attenuate the streams to fibers. Fibers formed in this manner may vary in length from a few inches to many feet and are customarily collected on a moving foraminous belt in the form of a mat or bat. Material of this form has been found useful as thermal and acoustical insulation when impregnated with a binder and molded into substantially rigid or self-sustaining shapes.

A second form in which glass fibers are used commercially includes strands or yarns of continuous length which may be woven into textiles. Glass fibers in this form are produced by flowing streams of molten glass, gathering the streams together to form a strand and winding the strand on a support at a high speed to attenuate the streams to very fine fibers. Each of the streams is continuously attenuated and the strands formed thereby may be produced in unlimited lengths. A binder is usually applied to the strand as it is formed to preserve integrity of the strand and prevent separation of the filaments during later processing operations. The single filaments in the strand may number from 100 to 200 and have a nominal diameter of from .0002 to .0004 inch while single glass wool fibers may average from .0005 to .0006 inch in diameter but may if desired be much smaller, say .0003 inch.

Strands formed by the above continuous forming process both in woven and unwoven forms have found great utility as a reinfoicement for molding resins and are widely used in laminated plastics because of their high strength, and non-hygroscopic characteristics. In addition, these strands of continuous type fibers may be cut into short lengths to form mats in which the strands are present in the form of haphazardly arranged bundles of fibers.

The present invention not only provides for the production of mats from a single type of fibers but contemplates combining fibers formed by both the glass wool and continuous fiber forming processes. In addition organic fibers may also be processed in accordance with the present invention or combined with the glass fibers.

The glass wool fibers, as an example may be formed in accordance with the process shown in the patent to Slayter and Thomas, No. 2,133,236, dated October 11, 1938 and continuous type fibers may be formed in accordance with the showing in the patent to Slayter and Thomas No. 2,234,986, dated March 18, 1941.

The present invention is illustrated in the accompanying drawings in which:

Figure 1 is a schematic view of novel apparatus by which the present invention may be carried out;

Figure 2 is a side elevational view of a part of the apparatus shown in Figure 1;

Figure 3 is a sectional plan view of the mechanism of Figure 2;

Figure 4 is a vertical sectional view through the picker rolls taken substantially along the line 4—4 of Figure 3; and

Figure 5 is a view similar to Figure 4 but showing a modified form of the invention.

This application is a continuation-in-part of my copending aplication Serial No. 758,925, filed July 3, 1947, now Patent No. 2, 589,008.

The present invention is readily adaptable for producing mats of any desired fibrous material which may be either organic or inorganic fibers or a combination of such fibers depending upon the end use of the material. Combination materials may be produced to provide any desired characteristics inherent in the materials being combined. As an example, mats of glass wool fibers have low tensile strength, particularly when very thin and it is sometimes desirable to incorporate and bond therein high strength continuous type fibers to provide a mat having relatively high tensile strength while retaining the characteristics of the mats of glass wool fibers. The bonding material may be applied by spraying or the mat may be dipped in an adhesive solution. Bonding may also be accomplished by mixing with the fibrous material a dry resin which upon the application of heat or in the presence of a solvent becomes softened and adheres the mat fibers together. Such resins may be in either fibrous or powdered form. In addition, the mat material may be bonded by incorporating a small percentage, say 10 percent or so, of continuous type strands which are heavily coated with a heat reactable resin. The resin coated strands are interspersed throughout the mat and upon the application of heat the resin is caused to soften and flow and thereby effect a complete bonding of the mat material.

In general, the steps by which mats are formed in accordance with the present invention will now be described, reference being made especially to Figure 1 of the accompanying drawings. One apparatus found suitable for the processing of the fibrous material includes a primary fiber opening and feeding mechanism A. In forming a mat of a single fibrous material the bulk fibers are supplied to the feeder A which delivers a thin layer of the material to the first picking stage B. The fibers which at this point may be in non-uniform clumps or irregular masses are fed into the picking roll which opens or tears apart the masses and separates the fibers into small tufts or bundles of fibers. These opened or partially separated fibers as they are discharged from the picker collect in the form of a loosely felted mat or sheet having a relatively uniform thickness and distribution of fibers.

The mat as it forms is continuously fed to a second picking stage C where the fibers are again separated and recollected. The greater uniformity of the sheet of material thus being fed is transmitted to the final mat so that the resulting product has the highest degree of uniformity in thickness, density and texture. The importance of the two stage picker operation is readily apparent when materials which are dissimilar in character are to be combined into a single mat. The operation of the picking rolls is such that the different materials are mixed and blended into a uniform product.

The mat of material flowing from the stage C comprises an unbonded heterogeneous arrangement of fibers to which it is necessary to incorporate a binder in order to preserve the integrity of the mat. The binder may be applied by spraying the mat from one or both sides with a suitable adhesive containing solution and then passing the mat through a heated oven D to dry or cure the binder. Binders may also be applied in a dry form either as a powder or as a fibrous material which is mixed with the mat fibers before passage through the picker, or the dry powder may be sifted into the formed mat and subjected to heat to set the adhesive.

After passage of the mat through the oven the mat may be rolled or cut into sheets for storage or shipment or it may pass directly into other fabricating operations.

Referring particularly to Figure 1 of the drawings the fibrous material is placed in a hopper **10** which forms a part of the feeding mechanism A. A movable belt **11** forms the floor of the hopper **10** and moves the fibers in a rolling motion to a fiber picker belt **12**. The movement of the belt **11** provides a continuous feed to the belt **12** as long as any fibrous material remains thereon. The picker belt **12** is provided with a plurality of spikes or needle points **13** which pick an even mat from the mass in the hopper as it advances and passes it over to a feeder belt **15** which carries the material into the first picking stage mechanism B. As the picker belt **12** conveys the fibrous material upward a short belt **16** removes any unduly large masses from the belt **12** so that a substantially uniform layer of fibers is carried to the feeder belt **15**.

In order to remove the fibrous material from the picker belt **12** as it is carried from the hopper **10** a stripper **18** comprising a plurality of blades **19** of leather, rubber, or the like has been provided. Rotation of the stripper **18** causes the blades **19** or paddles to wipe the material from the spikes **13** so that it is deposited on the feeder belt **15**.

The feeder belt **15** conveys the fibrous material as a substantially uniform sheet **21** of loosely matted fibers in the direction of the mixing or picker station B. The belt is preferably continuously driven by means of a motor **22** and gear reduction unit **23** through a chain **24** to carry the mat beneath a feed regulating roll **25**. The feed roll **25** is weighted to provide tension on the fibers and is mounted on arms **26** pivoted to the framework of the picker mechanism. This mounting permits movement of the roll toward and away from the surface of the feeder belt **15** as mats of varying thickness are fed therebeneath.

As the mat of fibers issues from beneath the roll **25** it is engaged by a picker roll **28** which is cylindrical in form and is provided with rows of pointed spikes or needles **30** which tear small tufts of fibers from the end of the mat **21**. The needles **30** are arranged in rows spaced uniformly radially of the roll and the rows are set in staggered relation, consecutive rows being offset approximately ⅓ of the distance between the needles of each row. With this arrangement of the spikes the fibers are pulled from the mat in a substantially uniform manner.

Rotation of the roll **28** in a clockwise direction tends to throw the fibers forwardly into a settling chamber **32**. Should the spikes **30** of the roll **28** dislodge a greater mass of fibers than normally required, a non-uniform mat would be produced. To guard against this possibility a second roll **34** is provided. The roll **34** is mounted above the roll **28** and is provided with spikes **35** arranged in uniformly spaced rows about the periphery of the roll. The roll **34** is positioned slightly to the rear of the roll **28** and is also rotated in a clockwise direction. The rolls **28** and **34** are spaced apart only sufficiently to permit clearance of the spikes since the two rolls are rotated at different speeds as will be brought out in detail presently. Any large tufts of fibrous material picked up by the roll **28** and which extend beyond the ends of the spikes **30** will be engaged by the spikes **35** of the other roll and torn apart or thrown rearwardly onto the incoming mat.

Should such a mass of fibers adhere to the spikes **35** and be carried around as the roll rotates, a third roll **38** has been provided. This roll **38** is constructed similarly to the previously mentioned picker rolls and carries spikes **39** arranged in rows about the periphery. The rolls **34** and **38** are mounted in a common horizontal plane and are spaced apart so that the spikes intermesh throughout substantially their entire length. Thus any tuft or mass of fibers carried by or between the spikes **35** are engaged by the spikes **39**. The axial spacing of the spikes carried by each roll are such as to provide a clearance of ⅛ of an inch or less so that the tufts of fibers are completely disrupted and dispersed. The roll **38** is rotated in a counterclockwise direction at approximately twice the speed of the roll **34**.

As shown in Figure 2 the rolls **28**, **34**, and **38** are driven by means of a chain **40** trained over sprockets **41**, **42**, and **43** carried respectively by the supporting shafts of the rolls **28**, **34**, and **38**. A variable speed motor **45** may be employed to drive the rolls through a belt **46** trained over a pulley **47** mounted on the drive shaft of the roll **28**. As an example of the relative speeds of the rolls it may be assumed that the roll **28** rotates at the rate of 1200 R. P. M. The roll **34** is geared to rotate at approximately 800 R. P. M. and the roll **38** is geared for rotation at approximately 1600 R. P. M. The speed of rotation of the rolls may be regulated by means of the motor **45** depending upon the type of fibrous material being processed and the facility with which the material is dispersed.

As the fibers discharged from the picking mechanism enter the settling chamber **32** they are collected on an inclined foraminous belt **50** mounted on rollers **51** for continuous movement. A suction chamber **53** is provided beneath the surface of the belt so that the fibers are drawn downwardly and collect on the belt in the form of a pad **54**. The belt **50** or conveyor corresponds substantially to the feeder belt **51** previously described and carries the fibers collected thereon to the second stage picker mechanism C.

The rotation of the picking rolls just described sets up currents of air which move generally in the direction of the rolls causing some of the fibers in the material to be carried thereby. In order to offset this difficulty I have provided air jets **55** arranged above the roll **38** and beneath the roll **28** to direct blasts of air in the direction of the settling chamber **32**. This movement of air not only counteracts the tendency of the fibers to follow the surface of the rolls but augments the action of the suction chamber **53** in uniformly dispersing the fibers. The wall **56** which forms the roof of the settling chamber **32** may be suitably curved to provide a streamlined flow to carry the fibers over at least a major portion of the settling area. The wall **56** which may also form a closely fitting cover for the rolls extends forwardly and terminates adjacent the picker mechanism C. It is believed that a more uniform layer of fibrous material may be obtained if the fibers are permitted to float in a circulating air stream before settling to the belt **50**.

The pad **54** is fed by the belt **50** into the second stage picking mechanism C, the construction of which is a counterpart of the mechanism B and the parts therein are designated by the same numerals. As the mat **54** is torn apart by the picking rolls the fibers are projected forwardly within a settling chamber **58**, the bottom of which is formed by a travelling foraminous belt **59**. A suction chamber **60** is provided beneath the belt in the area of the chamber to collect the fibers into the final mat structure. A gate roll **61** is arranged at the end of the settling chamber to initially compress the mat **59** as it is conveyed forwardly.

When it is desired to apply binder to the matted fibers spray guns indicated at **63** are arranged above the mat to apply binder to the surface of the mat or saturate it. Binder may be applied to the bottom of the mat by spray guns indicated at **64** arranged at the end of the belt **59** if desired. As an example, the binder may include emulsions of phenol formaldehyde, methyl methacrylate, polystyrene or polyvinyl acetate. Such materials may be present in the finished product in amounts ranging from 7½ to 12½ per cent by weight of the fibers.

The binder impregnated mat is then cured or dried by passing the mat through a suitable oven **65** associated with a conveyor flight **66**. Suitable mechanism may be provided for circulating heated air through the mat to cure the binder thereon. As the mat leaves the oven it may be either coiled into a roll, cut into sheets or passed directly into other fabricating operations.

Mats formed in the present manner may be employed as a base for roll roofing, shingles or siding in which the mat after passing from the present apparatus is impregnated with an asphalt composition and further processed into the desired material.

The modified arrangement of picker rolls shown in Figure 5 results in finer and more drastic picking of the fibrous material. In this arrangement the rolls **128** and **134** are in the same relation as rolls **28** and **34** in the form of the invention shown in Figures 1 to 4. Rolls **128** and **138** are so related that the teeth **130** and **139** respectively on the two rolls are in intermeshing relation similarly to the teeth **135** and **139** on the rolls **134** and **138**. As a result of this relation of the rolls, all material passing between the rolls **128** and **134** receives a final working or picking by the intermeshing teeth of the rolls **128** and **138**. The speeds of rotation of the rolls may be the same as those previously mentioned.

The following examples illustrate the operation of the apparatus in connection with the forming of mats of various fibrous materials. One type of mat found especially suitable for the reinforcement of plastics because of the high fiber density obtainable comprises short lengths of strands of parallelly arranged glass fibers bonded together into substantially discrete bundles. These bundles of fibers may be in random lengths of from 1 inch to 3 inches but preferably all should be within the range of 1½ to 2½ inches.

Masses of these fibrous bundles are deposited in the primary opened and fed to the picker rolls. The action of the picker rolls is such that the bundles of fibers are separated from one another without destroying the integrity of the individual bundle. The mat formed by the first picker section while substantially uniform in cross-section is reprocessed through a second set of rolls by which it is again disrupted and the bundles of fibers collected into a final mat of uniform density. A binder or impregnant may be applied to the mat by spraying or the like.

Glass wool fibers may be processed through the present apparatus either in the form of loose unbonded fibers or as the scrap from thermal insulating board manufacturing processes in which the fibers are compressed and bonded together into products of high density. In either case the fibers lie predominantly in planes parallel to the surface of the sheet or board. Processing this material through the present picker mechanism is accomplished by feeding the loose wool or boards directly into the picker rolls where the fibers are torn into tufts and collected in a sheet. This type of material while lacking in tensile strength as compared to the fibrous material previously described has been found suitable for thermal and acoustical insulation and provides a material in which the fibers extend in all directions.

The tensile strength of mats of the above material may be increased by concomitantly processing therewith continuous type textile glass fibers or strands. This is readily accomplished by distributing the continuous type fibers in the desired percentage by weight on the mass of wool fibers before processing and feeding the combined material through the rolls. For instance, a mixture of 80 per cent wool fibers and 20 per cent textile may be combined into a product having increased properties. In the final product the strands are randomly dispersed throughout the depth of the mat. This mat when produced at a thickness of about one-half inch provides a suitable base material for roofing or the like and may be impregnated with the desired asphalt composition and compressed.

Mats of very fine staple length glass fibers are produced in light densities of from 20 to 40 square feet per pound for thermal and acoustical insulation as well as for padding and clothing interliner material. The individual fibers range in diameter from .00003 to .00015 inch and form a highly resilient mat. This material at times has a tendency to condense when held under compression for a length of time. This condition may be remedied by processing the previously formed mat through the present apparatus and including a small percentage of cut strands of continuous type fibers in the manner previously described. The strands which are bundles of fibers bonded together provide resistance to compression and prevent a matting together of the fibers. These strands of material may be added to the mat without materially otherwise altering any of its characteristics.

Organic fibrous materials including such vegetable fibers as ramie, jute, sisal hemp or cotton, and natural fibers such as wool, hair or fur may be processed by the present apparatus either alone or in any desired combination. Such inorganic fibrous materials as long or short fibered asbestos, rock wool or slag wool may also be processed and mixed with the organic fibers or glass fibers. Of the vegetable fibers ramie is preferred because of the greater fiber length and strength. These, as well as other fibers may be employed to provide bulk to glass fiber mats and conversely glass fibers may be employed to reinforce mats of ramie or other fibers.

Modifications may be resorted to without departing from the spirit of the invention or the scope of the appended claim.

I claim:

The method of processing fibrous material to form mats thereof which comprises distributing a mass of relatively coarse glass wool fibers in the form of a sheet, superposing thereon a layer of textile glass fiber strands, advancing the assembly of sheet and superposed layer into a primary mixing stage, concomitantly comminuting said sheet and layer and discharging the comminuted material into the atmosphere within a confined zone, collecting the comminuted material into a felted sheet of substantially uniform thickness, advancing the felted sheet into a secondary mixing stage, comminuting said felted sheet to rearrange and redistribute the coarse glass fibers and textile glass fiber strands into a homogeneous mixture thereof, collecting the rearranged and redistributed material into a mat having a high degree of uniformity of composition in which the fibers and strands are haphazardly arranged and interfelted, applying a binder to the mat and curing the binder therein to preserve integrity of the material of the mat.

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