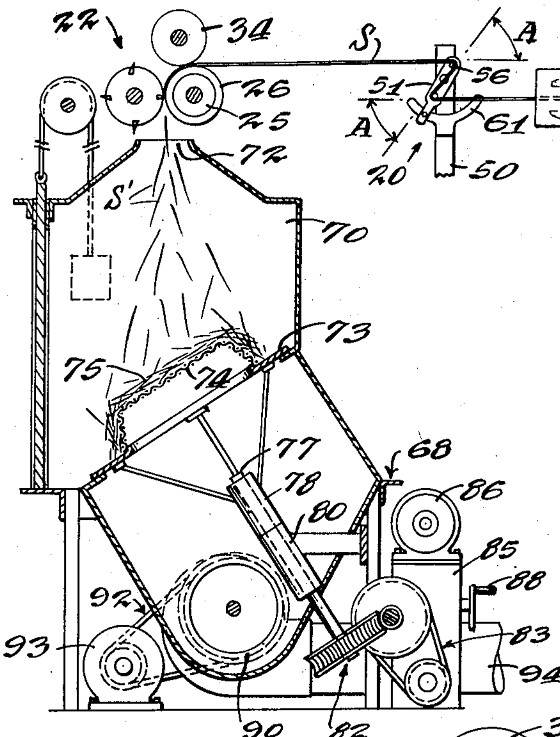
Sept. 29, 1953 H. W. ESSMAN 2,653,355

METHOD FOR PROCESSING MINERAL FIBERS

Filed Aug. 30, 1950

FIG-1-



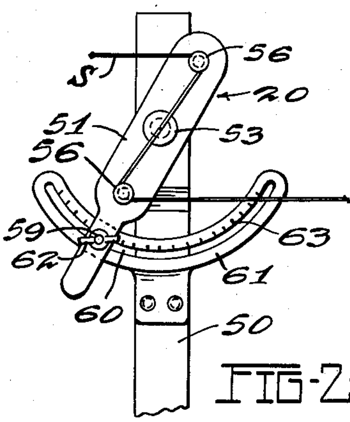


FIG-2-

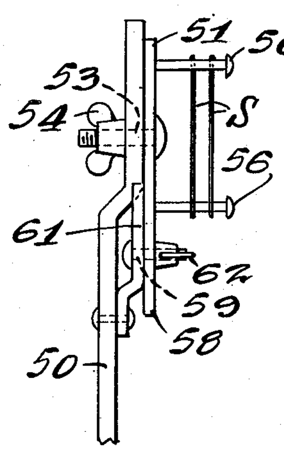


FIG-3-

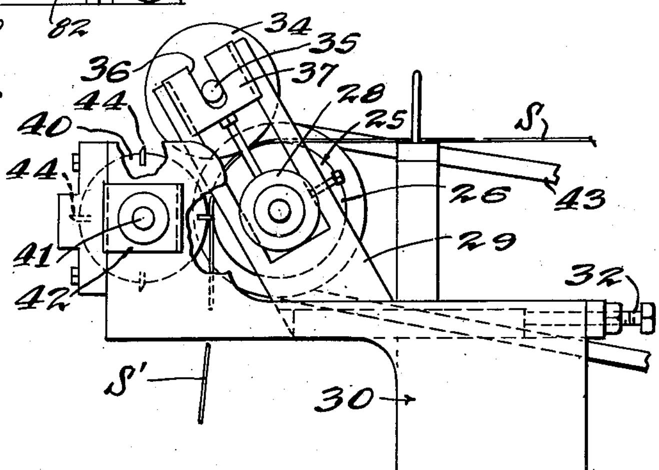


FIG-4-

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METHOD FOR PROCESSING MINERAL FIBERS

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This invention relates to a method and apparatus for treating or conditioning linear groups or strands of mineral fibers and more especially to a method and apparatus for conditioning and severing strands of glass fibers suitable for particular uses where control of strand and fiber orientation is essential.

It has been a practice to process strands of continuous mineral fibers, as for example attenuated glass fibers, to produce masses of short length strands and individual fibers which are especially adaptable for forming fibrous mats and particularly predetermined shapes termed preforms usable as reinforcing mediums in molded plastic or resinous articles. Such masses of short strands of continuous fibers are especially desirable as the multifiber strand or yarn possesses great strength with a minimum of weight or quantity of material used. Such masses of short length strands and fibers are extremely flexible and are admirably suited as reinforcing means for articles of varying contours as they may be readily shaped to any desired configuration.

A strand or yarn formed of comparatively fine attenuated glass fibers usable for the purposes mentioned contains upward of two hundred or more continuous fibers which are usually held in strand or yarn formation through the application of an adhesive or bonding material such as starch, gelatin or other bonding agent. After the strands or yarns are severed or reduced to short lengths, the adhesive or bonding material holds the fibers in strand form. For most satisfactory results it is desirable that some of the severed strands be opened up or disintegrated to result in separated or individual fibers and strands containing fewer fibers.

The various uses for short length strands or fibers require different ratios of intact strands, partially opened strands and individual fibers depending upon the particular use for the fibrous material. If a dense mat or fibrous mixture is desired, it should contain a high percentage of unopened or partially opened strands with comparatively few individual fibers. If a relatively light weight, fluffy, resilient mass is to be had, the amount of individual or separated fibers predominate in the collected fibrous mass. The strength factor of the mass may be varied by modifying the ratio of intact strands to subdivided strands and individual fibers or zones of different strength characteristics set up by varying the ratio during collection of the strands and fibers to form a mass.

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Heretofore a difficult problem has been presented to obtain desired mixtures of cut strands and fibers and control the ratio of unopened strands to subdivided strands and separated fibers. One method that has been employed involves collecting an adhesive bearing strand of glass fibers by winding same in spool or package form, splitting the strand package lengthwise, and feeding the mass of strands to a spiral cutting device or chopping machine to form short length strands. The severed strands formed in this manner are not of uniform length because the strand mass fed to the spiral cutter is not susceptible of precision control of the severed strand lengths.

Another factor affecting the character of the collected mass of severed strands is the condition of fixation or set of the adhesive or binder. If the binder is substantially set or hardened, the fibers of the severed strand are integrated or strongly bound together so that the resulting collected mass is composed of substantially intact or unopened fibers. If the binder is not completely hardened, then the severed strands tend to adhere together in tangled clumps or groups, a condition which renders the collected mass wholly unsuitable for most purposes.

In an endeavor to surmount these difficulties, the mass of severed strands and tangled clumps or groups of strands are subjected to a series of mechanical picking devices to separate tangled clumps or groups of severed strands and to open up some of the strands to smaller strands and individual fibers. This method is incapable of accurate control and is inadequate to attain a collected mass of severed strands or fibers of predetermined character or to selectively obtain individual strands, partially opened strands or those having fewer fibers, individual or separated fibers or various combinations thereof. Furthermore, such method is not well adapted for collocating the types of fibers during assembly so as to orient the unopened or partially opened strands interiorly of a preform for desired strength characteristics with surface areas predominating in separated or individual fibers.

The present invention embraces the provision of a method of treating continuous strands of adhesive-bearing mineral fibers in a manner to establish uniform fixation of the adhesive complement of the strands to enable the establishment of better control of the character of a collected mass of individual fibers and groups of fibers formed from continuous strands or yarns.

An object of the invention is the provision of a simple method and apparatus for treating multifiber strands of mineral material in a manner to produce a fibrous mass of controlled character in which tangled clumps or groups of strands are completely eliminated without resorting to the use of mechanical pickers or other extraneous devices.

The invention is inclusive of a method of establishing uniform fixation of the adhesive complement in a strand of fibers and of setting up interflexure or intermovement of the fibers of the strand to disintegrate the adhesive complement to a predetermined controlled degree so as to subdivide severed strands into smaller strands and liberate or free a portion of the fibers in the severed groups from the remainder of the adhesively joined fibers.

An object of the invention is the provision of a method of directing a strand of bonded mineral fibers in a controlled path whereby intermovement of the fibers in a strand is set up to reduce the cohesion of the individual fibers and of severing the treated strand of fibers into comparatively short lengths whereby a controlled mass of individual fibers and groups of fibers may be formed, the ratio of individual fibers to the integrated groups being controllable through the alteration of the path of movement of the strand.

An object of the invention resides in the provision of a method of controlling the opening up of severed strands of mineral fibers through the uniform fixation of the adhesive complement in the strand and of moving the strand in a manner to cause interflexure of the fibers in the strand to fracture or loosen the integrating adhesive or bond holding fibers in the strand formation so that upon subsequent severing of the strand to comparatively short lengths, a mass of individual fibers and integrated groups of fibers may be collocated during collection or intermingled in a controlled ratio.

Another object of the invention is the provision of a method for controlling or regulating the density or degree of fluffiness of a mass of severed individual fibers and groups of fibers by establishing and controlling relative movement among the fibers of a strand prior to the severing operation for disintegrating the severed strands to smaller strands and individual fibers to any predetermined desired extent.

Another object is the provision of method and apparatus for readily obtaining unopened and partially opened strands for the interior body of a preform to enhance the strength factor and for obtaining a predominence of discrete fibers for the surface zones of the preform.

Another object of the invention resides in the provision of a method of treating a strand of glass fibers to fix or harden an adhesive complement or coating on the fibers of the strand and direct the movement of the strand in an ogee path to effect a separation or partial separation of individual fibers in the strand, the extent of flexing of the fibers and hence the extent of loosening individual fibers from the strand being controlled by the character or condition of acuteness of the ogee curve traversed by the moving strand.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

Figure 1 is a semidiagrammatic view of apparatus for carrying out the method of the invention illustrating the utilization of the cut strands or fibers in producing fibrous preforms;

Figure 2 is a detail elevational view illustrating a portion of the apparatus shown in Figure 1;

Figure 3 is a side elevational view of the structure illustrated in Figure 2, and

Figure 4 is an elevational view of a combined strand conveying and severing means usable in carrying out the method of the invention.

The strands of mineral fibers, as for example glass fibers, processed by the method and apparatus of the present invention may be formed by conventional methods. One method employed includes flowing fine streams of molten glass from a perforated bushing, attenuating the molten streams to comparatively fine continuous fibers and gathering the attenuated fibers into strand or yarn formation. Strands or yarns formed in this manner are economically produced at a high rate of speed.

In order to maintain the attenuated fibers in strand formation to facilitate handling and processing, it is a usual practice to apply an adhesive, binding or integrating medium to the strand during its formation. Adhesives such as starch, gelatinous materials, resins or binders capable of hardening are usually applied to the strand concomitantly with the winding of the strand into a tube, spool or package form. Due to the relatively high winding speed of the strand, the adhesive may not be completely "set" or hardened on the strand in the collected package.

After a strand package or tube is thus formed, it is ofttimes stored preparatory for use in further processing operations. The outermost layers or convolutions of adhesive-bearing strand being exposed to the air results in the adhesive thereon being substantially set or hardened while the adhesive in the interior of the same package may remain "green" or incompletely hardened or may even be in a cohesively plastic or tacky condition. Thus effective control of the extent of subdivision of groups of fibers or separation of individual fibers from the strands after severing is not attainable unless a substantial uniformity of set or hardness of the adhesive or binder on the strand is first attained.

In carrying out the present method of processing strands to form severed strands of fibers, subdivided strands and individual fibers, reference is first made to Figure 1 which illustrates a form of apparatus for carrying out the method. There is provided a frame or creel 10 supporting one or more tubes or packages 12 each containing a quantity of continuous strand S formed of attenuated mineral fibers as, for example, glass fibers. The strand or strands S are directed by means of guides 14 and 15 through a suitable oven 16 or other means for effecting a uniformity of hardness or set of the adhesive or binder on the fibers of the strand. As illustrated, the oven 16 through which the strands S are conveyed may include one or more series of heating devices 18 in the form of electrically energized heat lamps or jets of burning combustible mixture for establishing a zone of elevated temperature to fix or harden the adhesive. If desired, for certain types of adhesive that may be readily air dried, the heating devices may be supplemented with a current of air passing through the adhesive hardening oven.

By this or an equivalent means the adhesive or binder on the strand leaving the oven 16 is conditioned to a uniform hardness so that an effective control of the opening up or separation of individual fibers or groups of fibers from the strands may be attained. The strands S are directed into engagement with a strand conditioning means 20 hereinafter explained in detail from whence the strands move to a severing means 22. The use of the oven may be dispensed with if the packages or spools of strand are stored or treated at room or elevated temperature for a sufficient period to attain a desired and uniform degree of set or cure of the adhesive or binding agent.

The strand severing means 22 is inclusive of a strand conveying or tensioning means for withdrawing the strands from the supply packages or spools 12, moving same through the oven 16 to the strand conditioner 20 and thence to the strand severing device. The strand severing means illustrated and particularly shown in Figure 4 is inclusive of a strand conveying roll 25 which is provided with a resilient exterior cylindrical surface formed as a sleeve 26 of yieldable or resilient material, as for example, rubber or the like. The strand conveying roll 25 is preferably mounted in bearings 28 carried in a suitable supplemental frame 29 which is mounted upon a main frame 30, the frame 29 being adjustable relative to the frame 30 by means of an adjusting means or screw 32.

Disposed above the strand conveying roll 25 is a roll 34 having a shaft 35 disposed in slots 36 formed in guides 37, the latter being slidably engageable with the bifurcated portion of the frame 29, only one of the guide members 37 being illustrated. The roll 34, which is preferably in the form of a solid metal cylinder is adapted to be superposed against the strand or strands S to urge the same into frictional engagement with the strand conveying means or roll 25. The roll 34 is mounted in a manner whereby it is freely movable in a direction parallel with the bifurcated portion of the frame 29 so that the weight of the roll 34 is at all times effective to hold the strands in engagement with the conveyor 25.

The severing means for the strands is inclusive of a cylindrical roll or member 40, the shaft 41 of which is mounted in bearings 42 supported upon the main frame 30. The roll is provided with strand severing bars or knives 44 which are spaced at predetermined peripheral distances on the roll 40 equal to the length or lengths desired for the severed strands. The cylinder 40 is preferably formed of metal and the knives 44 are held in grooves or slots formed in the roll 40 by means of collars arranged at the ends of the roll.

The severing knives or bars 44 project outwardly of the peripheral surface of roll 40 a distance sufficient to sever the strands S with the cutting edges of the knives contacting and slightly depressing the resilient or rubber surface of the conveying roll 25. The position of the latter may be adjusted by the adjusting means 32 so as to insure a strand severing action between the knives 44 and the strand conveying roll 25.

The strand conveyor roll 25 and the knife carrying roll 40 are simultaneously driven by means of gearing (not shown) and a belt 43 connected to a motor (not shown) whereby the strand severing knives 44 move at a linear speed substantially equal to that of the strand conveying roll 25 so that there is no appreciable relative movement between the strands S and the roll 40. Thus the severing of the strands is effected by means traveling at substantially the same linear speed as the strands.

The severed strands and fibers may be collected in any desired manner dependent upon the particular purpose for which the severed materials are to be used. As illustrated in Figure 1, the cut strands and fibers may be immediately utilized to produce fibrous preforms through the use of a suitable apparatus hereinafter further described. If a uniplanar fibrous mat is to be formed, the cut strands and fibers may be collected upon a suitable foraminous conveyor and a suitable binder or adhesive applied to insure mass integrity in the mat. The cut strands and fibers may be transferred to a station remote from the severing zone for further processing or use through the employment of a moving air stream or other conveying or transferring medium.

As has been previously stated herein, it is highly desirable to effect a disintegration of the severed strands to separate individual fibers, groups of fibers or a combination thereof depending upon the purpose for which the collected fibrous mass is to be used. For example, in some types of preform construction incorporated as reinforcement in translucent or light transmitting resins or plastics, the appearance of the molded article is enhanced through the presence of a predominate ratio of individual fibers at the surface of the reinforcing preform with the high strength groups of fibers in the interior.

Another advantage of separating individual fibers from severed strands lies in economy of the amount of glass in a mat or preform where the required strength factor may be adequately supplied by relatively few unopened or partially opened severed strands of fibers. The fluffiness, resiliency and density of the mat or preform may be accurately controlled by regulating the ratio of unopened strands, partially opened strands and separated fibers in the mass.

The apparatus for accomplishing this control is inclusive of a means for fracturing or partially fracturing the adhesive or integrity forming medium in the fibers of a strand in a manner whereby upon severing of the strands, individual fibers and groups of fibers are separated therefrom. The apparatus involves an adjustable mechanism for regulating or controlling the extent of fracturing or reducing the bonding effectiveness of the integrity factor in the fibers of a strand to control the extent of disintegration of the severed strands.

The method of accomplishing this result involves an alteration or change in the direction of movement of a strand while the latter is in a state of tension to set up or establish intermotion or relative movement or flexure among the fibers or certain of the fibers of the strand to reduce the integrity factor or fracture the adhesive joining the fibers in strand formation.

One form of means for accomplishing this purpose is illustrated in Figures 1 and 2 being in the nature of a snubbing device which is inclusive of a support or frame member 50 upon which is movably mounted an arm or element 51. The element 51 and support 50 are formed with registering openings adapted to receive a threaded bolt 53 upon which is threaded a wing nut 54 or other suitable securing means. The arm 51 carries a pair of spaced pins or rods 56 adapted to be engaged by the strands S prior to their movement to the severing zone.

The strands S traverse a path around the pins 56 in general configuration of an ogee curve, one adjustment of the member 51 for causing such traverse of the strands being illustrated in Figure 1. The arm 51 may be provided with an extension 58 carrying a bolt 59 adapted for traverse in a slot 60 of a member 61, the latter being secured to the frame 50. The bolt 59 is provided with a wing nut 62 for tightening the extension 58 of arm 51 into fixed engagement with the member 61 so as to provide adequate means for retaining the arm 51 in adjusted position supplementing the securing means 54.

It is to be understood that other equivalent means may be utilized to secure arm 51 and pins 56 in adjusted position without departing from the spirit of the invention. The member 61 may if desired be provided with graduations 63 arranged for cooperation with the arm extension 58 to accurately position or determine the relative adjustment of the arm 51 and pins 56.

By adjusting the relative angularity of the direction of travel of the strand between pins 56 with that of the strand approaching and leaving the snubbing device, designated as angles A in Figure 1, the acuteness or sharpness thereof controls the amount of relative intermovement and flexure of the fibers and the extent of fracturing the binder on the fibers. The extent of fracturing or loosening of the binder determines the relative proportions of severed unopened strands, strands containing fewer fibers and independent fibers resulting from the severing operation.

Through adjustment of the plate 51 so that angles A are made larger or smaller, the fluffiness of the mass of severed strands and fibers is respectively reduced or increased. It has been found that when angles A are of the order of fifteen to thirty degrees, the resulting cut strands separate into individual fibers to a large extent whereby the mat, preform or other product made therefrom is very fluffy in nature and of low density.

If the plate 51 is adjusted so that the angles are quite large approaching an obtuse character in the order of one hundred and twenty degrees, the major number of severed strands remain integral and separate into smaller strands and into individual fibers only to a limited extent whereby the resulting product is of comparatively high density and lacks fluffiness. Various adjustments of the plate 51 may be made dependent on the character of cut strand and fiber proportions desired, the degree of hardness of the binding agent, the type and character of the binding agent, the size and number of fibers making up the strands and the linear speed at which the strands are drawn through the snubbing or strand flexing instrumentality.

As the method and apparatus of the invention are especially suited for the economical production or formation of fibrous preforms as reinforcement for articles molded of resin or plastic, a semidiagrammatic view of a type of apparatus for fabricating preforms is illustrated in Figure 1. The arrangement is inclusive of a frame 68 supporting a plenum chamber 70 provided with an inlet or entrance 72 for the admission of cut strands and fibers directly from the strand severing device 22. Disposed at a lower wall of the plenum chamber is a platen 73 adapted to support a foraminous matrix 74 upon which the cut strands and fibers are deposited or collected to produce a preform configuration 75. The platen is preferably angularly disposed and is relatively movable to facilitate uniform distribution of the fibrous material on the matrix. The platen 73 is secured to a shaft 77 and a bushing 78, the shaft being journaled for rotation in a bearing means 80 carried by the frame. The shaft 77 is driven by reduction gearing 82 which in turn is connected by a belt and pulley assembly 83 with a speed changing mechanism contained within a housing 85. The speed changing mechanism is driven by an electric motor 86. A control of the speed of rotation of the matrix 74, platen 73 and shaft 77 is effected through regulation of the speed changing mechanism by means of a control handle or member 88. The cut fibers and strands are entrained in an air stream as they leave the severing zone and are carried to the matrix 74. In the embodiment illustrated, the air stream is provided by a blower or suction producing device 90, the rotor thereof being driven by means of a pulley and belt arrangement 92 from an electrode motor 93. Under the influence of the suction producing device 90 which exhausts through duct 94, air is admitted through the entrance 72 of the plenum chamber carrying the cut fibers and strands to the matrix 74 where they are filtered from the air stream and build up into a fluffy preform 75.

It is to be understood that the severing means 22 may be remotely disposed with respect to the preform producing device and the air stream or other suitable conveying means utilized to transfer the cut strands and fibers to the plenum chamber 70.

The method and apparatus is especially suited to vary the proportions of strand groups and individual fibers in an accumulated mass during collection of the cut strands and fibers to modify the proportions in various zones of the product. For example, a surface lamina of a mat or preform may be formed substantially entirely of individual or separated cut fibers by adjustment of plate 51 to render the angles A extremely acute, and by making angles A less acute, a succeeding lamina in the product may be formed with unopened severed strands or smaller strand groups.

The snubbing instrumentality may be arranged to be automatically shifted by suitable means during the formation of a preform whereby initially the cut strands are fully opened to provide discrete fibers, the instrumentality being then shifted to a position to produce unopened or intact cut strands and subsequently moved to a position to again produce fully opened strands or discrete fibers to thereby impart a smooth finish on both surfaces of a molded resinous article embodying the reinforcing preform.

Thus the method and apparatus provides for a broad range in variation of the character of the fibrous product yet with precision control exercised at all times. Furthermore, due to the fact that the binding agent on the fibers is completely dried or hardened, the fibrous product contains no tangled clumps or cohering groups of severed strands thus assuring uniform character of the product.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than is herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. A method of conditioning a continuous strand of mineral fibers including feeding an adhesive-bearing strand in a rectilinear direction, of engaging the strand with an instrumentality for altering the direction of movement thereof to loosen the adhesive on the fibers, and of controlling the extent of change in the direction of the moving strand for regulating the extent of loosening of the fibers in the strand.

2. A method of conditioning a continuous strand of bonded mineral fibers including feeding the strand to a bond fracturing instrumentality for loosening fibers of the strand, and of modifying the bond fracturing effectiveness of the instrumentality for regulating the extent of looseness of the fibers in the strand.

3. A method of conditioning a continuous strand of bonded mineral fibers including feeding the strand to a bond fracturing instrumentality for loosening fibers of the strand; and of modifying the bond fracturing effectiveness of the instrumentality for regulating the release of the fibers in the strand, and of conveying the strand from the bond fracturing instrumentality to a strand severing zone, and of severing the strand into comparatively short lengths whereby a mass of groups of severed fibers and individual fibers is produced.

4. A method of conditioning a continuous strand of mineral fibers, of treating the strand with an integrating medium to establish interadhesion among the fibers in the strand, of treating the integrating medium in the strand to establish substantially uniform fiber integrity; of engaging the strand with an instrumentality for modifying the effectiveness of the integrating medium to effect a loosening of the fibers, and of modifying the operative relation of the strand with the instrumentality to control the extent of loosening of the fibers in the strand.

5. A method of conditioning continuous strands of mineral fibers which includes the steps of applying an adhesive to a strand of fibers; of treating the adhesive constituent in the strand to secure substantially uniform fiber integrity in the strand; of moving the strand in a tortuous path to set up relative intermovement among the fibers of the strand to loosen fibers in the strand, and of reducing the strand to predetermined comparatively short lengths whereby some of the reduced strands are subdivided into smaller strands and separated fibers.

6. A method of conditioning continuous strands of attenuated glass fibers which includes the steps of applying an adhesive to the fibers of the strand; of treating the adhesive constituent of the strand to secure a substantially uniform hardness; of moving the strand in a tortuous path to set up relative intermovement among the fibers of the strand to reduce the bonding effectiveness of the adhesive; and of varying the character of the tortuous path of the strand for controlling the reduction of bonding effectiveness of the adhesive.

7. A method of conditioning continuous strands of attenuated glass fibers which includes the steps of applying a bonding agent to the fibers of the strand; of treating the bonding agent in the strand to secure substantially uniform fiber integrity; of moving the strand in a controlled tortuous path to set up relative intermovement among the fibers of the strand to loosen fibers in the strand, and of reducing the strand to predetermined comparative short lengths to provide a mass of fibers the density of which is determined by the character of the tortuous path traversed by the strand.

8. A method of treating a continuous strand of adhesive-bearing mineral fibers including the steps of subjecting the strand to an adhesive hardening treatment; of directing the treated strand to a fiber loosening station; of flexing the strand at the fiber loosening station for dislodging the adhesive; of controlling the character of strand flexure for regulating the extent of dislodgment of the adhesive, and of severing the flexed strand into lengths whereby a controlled mass of short length strands, divided strands and separated fibers is produced.

9. A method of treating a continuous strand of adhesive-bearing mineral fibers including the steps of subjecting the strand to an adhesive hardening treatment; of directing the treated strand in a tortuous path to flex the fibers of the strand for dislodging the adhesive; of controlling the character of the tortuous path of the strand for regulating the extent of fiber flexure and dislodgment of the adhesive, and of severing the flexed strand whereby comparatively short length separated fibers and groups of adhesively joined fibers are produced.

10. A method of processing a continuous strand of mineral fibers bearing a fiber integrating medium including the steps of subjecting the strand to an integrating medium fixation treatment; of moving the treated strand to a strand flexing station; of flexing the fibers of the strand to reduce the interfiber bonding effectiveness of the integrating medium; of controlling the extent of flexure of the fibers at the strand flexing station for regulating the extent of reduction of interfiber bond, and of severing the flexed strand into predetermined comparatively short lengths to form a fluffy mass, the density of the mass being dependent upon the extent of reduction in interfiber bonding effectiveness of the fiber integrating medium.

11. A method of processing a continuous strand of mineral fibers bearing a fiber integrating medium including the steps of subjecting the strand to an integrating medium fixation treatment; of moving the treated strand to a strand flexing station; of flexing the fibers of the strand to reduce the interfiber bonding effectiveness of the integrating medium; of controlling the extent of flexure of the fibers at the strand flexing station for regulating the extent of reduction of interfiber bond, and of severing the flexed strand into predetermined comparatively short lengths to produce a mixture of individual fibers and groups of interbonded fibers.

12. A method of producing a mat of mineral fibers including the steps of conveying a continuous linear group of mineral fibers bearing an interfiber bonding material to a fiber flexing zone; of directing the group of fibers in a tortuous path in the flexing zone to establish relative movement of some of the fibers in the group to reduce the effectiveness of the interfiber bond; of severing the flexed group of fibers to comparatively short lengths; of collecting the severed lengths to form a fibrous mass, and of controlling the character of the tortuous path and the effectiveness of the interfiber bond for varying the density of the collected mass of fibers.

13. A method of producing a mat of attenuated glass fibers including the steps of conveying a

continuous linear group of fibers bearing an interfiber bonding material to a fiber flexing zone; of directing the group of fibers into engagement with a fiber flexing instrumentality to establish relative movement of some of the fibers relative to others to reduce the effectiveness of the interfiber bond; of severing the group of flexed fibers to predetermined short lengths; of collecting the severed lengths to form a mat composed of a mass of individual fibers and bonded groups of fibers; and of controlling the effectiveness of the fiber flexing instrumentality to fracture the interfiber bond for varying the density of the collected mass of severed fibers.

14. A method of controlling the density of a collected mass of individual fibers and bonded groups of fibers produced from fiber-forming mineral material including moving a continuous linear group of bonded fibers to a fiber flexing zone; of flexing the linear group in a manner to cause relative intermovement of some of the fibers and a fracturing of the bond on some of the fibers; of reducing the flexed group to comparatively short lengths and collecting them into a mass; and of regulating the character of flexure

of the linear group to vary the ratio of individual fibers to bonded groups of fibers in the collected mass for establishing a predetermined density for the mass.

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