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METHOD FOR FORMING AN INTEGRATED MASS

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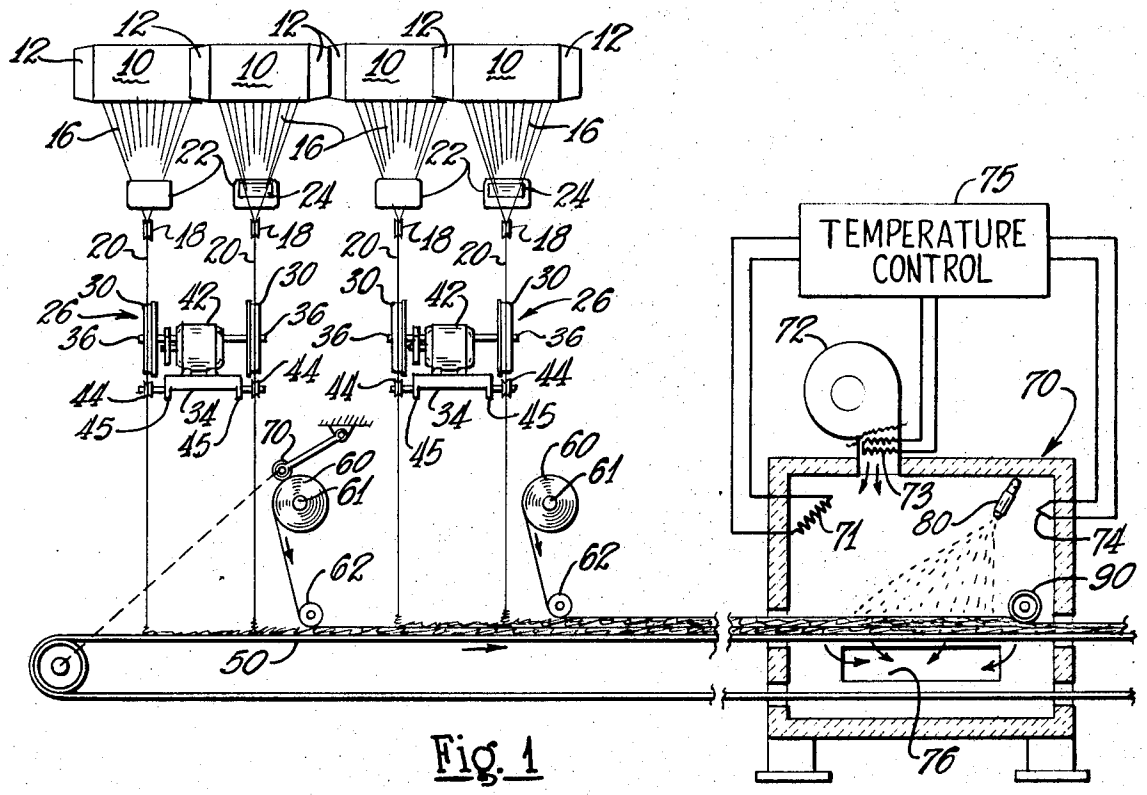


Fig. 1

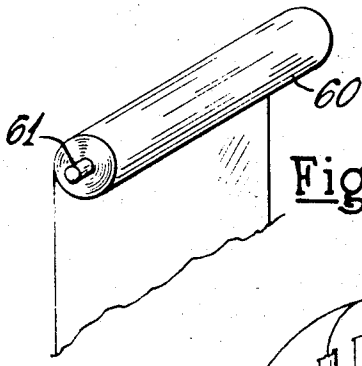


Fig. 2

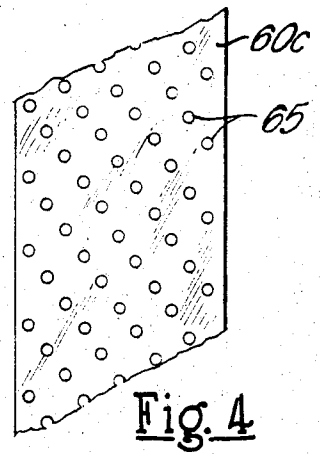


Fig. 4

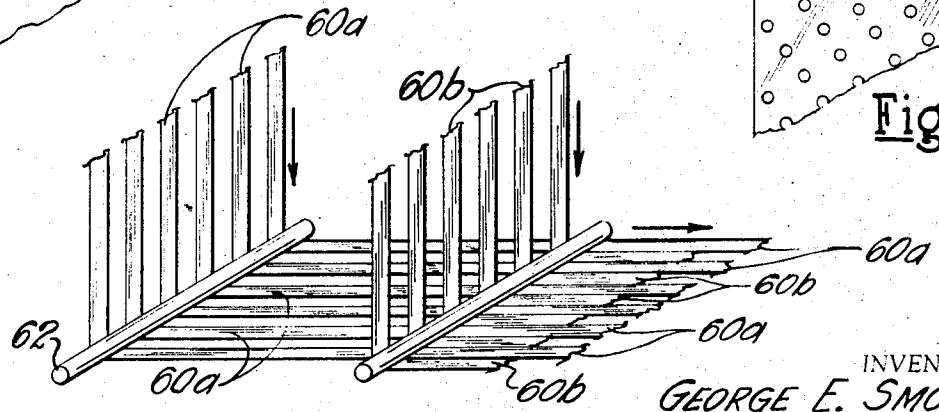


Fig. 3

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METHOD FOR FORMING AN INTEGRATED MASS

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Continuation of application Ser. No. 785,045, Dec. 12, 1968, which is a continuation of application Ser. No. 517,225, Dec. 29, 1965. This application Mar. 12, 1970, Ser. No. 18,372

Int. Cl. B32b 17/00

U.S. Cl. 156—62.2 4 Claims

ABSTRACT OF THE DISCLOSURE

Method for forming fibrous mats or integrated fibrous masses for a collection of linear bodies by providing a plurality of mat-like layers which may result from the deposition of linear bodies on a collecting surface, interleafing binder in film form between the layers, and activating the film to disperse the binder among the individual bodies to bind them into an integrated fibrous mass, such as air filter mats, insulating mats, or the like.

This application is a continuation of application No. 785,045, filed Dec. 12, 1968, now abandoned, which in turn is a continuation of application No. 517,225, filed Dec. 29, 1965, now abandoned.

This invention relates to a method of forming an integrated mass from a collection of linear bodies generally, and more particularly to a method useable in the formation of fibrous masses or products wherein successively arranged stations deliver fibrous or filamentary materials onto a moving collector to produce an assemblage or product.

In the manufacture of fibrous products such as fibrous mats, it is a practice to employ several fiber or filament forming and processing stations or units arranged to concomitantly and continuously deposit attenuated filaments or fibers on a moving conveyor belt or collector to form a built-up fibrous mass or mat as a composite of the filaments or fibers from the several stations or units. In such methods or processes it is essential, in order to produce a uniform product to maintain, insofar as possible, the continuous operation of the several fiber or filament forming and depositing units. Great strides have been made in mechanical and process approaches for attaining the uniformity of deposition of the product and thus the uniformity of the fiber content of the mat. However, it is also normally desirable to integrate the continuous strands in mat form through the application of a suitable binder. Difficulties have been encountered in prior methods of applying the binder in attaining a uniform deposition and dispersion of the binder throughout the mat or fibrous product. Variations resulting from the use of prior art processes have resulted in weight and density differences across the width and along the length of the mat, sometimes requiring additional processing of the mat before its use in the end product. In the past, liquid binders have been sprayed upon the mat as it has been formed, the binder usually consisting of a resin type of binder carried in an aqueous solution or suspension. In another method powdered binder has been sifted onto the mat shortly after formation and the water or liquid lubricant on the strands is relied upon to adhere the powdered binder to the strands.

In both of the prior art methods, the mat is then moved along a conveyor into a treating area which may comprise an oven for drying and curing the binder or a means for applying accelerator or other chemical curing methods to the binder, whether in liquid form, fumes, etc.

As more sophisticated uses have developed for the integrated fibrous mats and similar products, the distribution of the binder within the interior of the mat has become increasingly important. The distribution may, for example, change the molding characteristics of the mat whenever it is utilized in making a reinforced product. Further, the exact amount of binder in the mat has become more important for certain applications and it is evident that the prior art methods can insure neither the distribution nor the amount in weight or volume of binder in a mat with the degree of certainty required.

Accordingly, it is an object of this invention to provided an improved method and means for forming an integrated mass from a collection of linear bodies.

It is a further object of this invention to provide an improved method and means for applying a binder to a fibrous mat.

It is still a further object of this invention to provide an improved method and means for controlling within very close tolerances the distribution and/or the quantity of a binder in weight or volume that is to be applied in a mat of fibrous materials to integrate the linear bodies into mat form.

A still further object of this invention is to provide a method and means for forming fully loaded sheets of fibrous material with an exact amount of the various reactants and binders required therein which may be immediately used after the forming step in the making of the final product without requiring intermediate steps to insure that the full percentage of binder and filler that is required is present.

Yet another object of this invention is to provide an improved method and means of integrating continuous or discontinuous strands in mat form through the application of a suitable binder without encountering the blocking, clogging, etc., on the forming chains or belt of the collecting conveyor that is associated with the application of wet or powdered type binders.

The invention features a method of forming an integrated mass from a collection of linear bodies which comprises the steps of providing a layer of said bodies, overlaying the layer with binder in film form, and activating the film to disperse the binder among the individual bodies to bind them into an integrated mass. The method may, of course, be extended to providing a plurality of layers of individual linear bodies and interleafing binder in film form between the layers. The activating step may include exposing the film to a predetermined chemical catalyst or accelerator. In addition to the use of an accelerator or as an alternative thereto, the activating step may include exposing the film to a heat treatment. The heat treatment may include melting and flowing the film to bond abutting individual bodies. In the case of the smaller strands discussed herein, the film may be melted and flowed around the intersections of the bodies and then solidified and shrunk around the intersections. In addition to the steps above that are commonly used with thermoplastic binders the activating step for a thermosetting binder may include heating the film to shrink and separate the film into discontinuous segments and curling the segments around the bodies to mechanically integrate the mass. Obviously the thermoplastic and thermosetting binders in film form may be combined, either in separate sheets or in the same sheet to provide the melting and flowing and bonding of intersections as well as the mechanical integrating action of the curling of thermosetting segments around the linear bodies. By using the method of this invention a sufficient amount of binder in film form may be interleafed in the layers of individual bodies to enable the use of the combined layers and interleafing film in a final molding process without intermediate steps to insure that a sufficient percentage of binder is present.

In the inventive method disclosed herein the steps of providing a plurality of layers of individual linear bodies may include the steps of forming linear bodies of heat softened material, such as glass, from supplies at a plurality of body forming and delivery stations, continuously delivery a group of linear bodies from each of the stations to a collecting zone where the bodies are collected into an assemblage, and continuously moving the assembladge of bodies away from the collecting zone thereby forming a layer. When the pluarality of forming and delivery stations are utilized, the interleafing step may advantageously be accomplished by providing supplies of binder in film form intermediate the forming and delivery stations, dispensing film on top of a layer from a preceding station, and collecting a layer of linear bodies from a succeeding forming station on top of the dispensed film.

The invention also features novel apparatus for carrying out the methods of this invention.

Other objects, advantages and features of this invention will become apparent when the following description is taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic side elevational view illustrating an apparatus for carrying out the method of this invention by the use of a plurality of fiber or filament attenuating stations or units:

FIG. 2 is a view in perspective of a film roll suitable for use in the apparatus of FIG. 1;

FIG. 3 is a view in perspective of a different application of film in the apparatus of FIG. 1; and

FIG. 4 is an illustration of a variation of the film that may be utilized in the method of this invention.

While the invention is illustrated in association with apparatus for attenuating heat-softened material, such as glass, to filaments or fibers which are distributed onto a moving conveyor, it is to be understood that the invention may be utilized in many other mat making or mass integrating processes wherein an even distribution, control of quantity, or other very accurate integrating requirements are specified.

In the arrangement illustrated in the drawings, the attenuating apparatus is particularly usable for attenuating streams of heat-softened glass or other heat-softened material to continuous filaments converged into strands and the strands from the several units distributed onto a moving conveyor to form a collective mass or mat of the continuous filaments.

As noted above, the invention does not have to be used with the continuous line nor with a continuous mat making process. Even if the invention is to be used with a continuous line, it may also be used with a chopped strand, spinner or centrifugal drawing of fibers, or other processes to build up depth of mat on a continuously moving conveyor.

Referring to FIG. 1 there is illustrated an apparatus for attenuating groups of streams of glass into continuous filaments which are converted into strands which are collected to form an assemblage or fibrous mass. A plurality of stream feeders **10** are arranged in two spaced parallel rows, each adapted to contain a supply of heat-softened materials such as heat-softened glass. The feeders **10** may be directly connected with a forehearth of a melting furnace to receive glass therefrom, or pieces or spherical bodies of glass may be delivered into the feeders and melted directly therein.

Each of the feeders **10** is provided at its ends with terminals **12** connected with an electric current of high amperage and low voltage for maintaining the softened glass at a proper viscosity for attenuation or for melting and conditioning material where the latter is introduced into the feeders in pieces or spherical bodies. Each of the stream feeders is provided with a plurality of orifices in the bottom or floor through which flow groups of streams adapted to be attenuated to continuous filaments **16** by rotating attenuating instrumentalities.

As illustrated, the group of filaments formed from the streams from each feeder is converged by a suitable gathering shoe **18** into a multi-filament strand **20**, each group of filaments forming a strand.

It is desirable to applied a liquid, such as water, onto the filaments prior to their convergence into strand form for lubrication and other purposes. Disposed above each of the gathering shoes **18** is a receptacle **22** adapted to contain water or other liquid applied to a fan or group of filaments by belt-like applicator **24** which, moving through the liquid in the receptacle, acquires a film thereof which is transferred to the filaments by a wiping contact.

A fiber or filament attenuating and distributing unit **26** is disposed beneath or adjacent each of the stream feeders **10** for attenuating the filaments of each group by mechanical means. Each attenuating unit is inclusive of a rotatable strand-engaging means or pull wheel **30** journally mounted upon a support which in turn is mounted on a frame construction **34**. The pull wheel **30** is mounted on a shaft **36** on which is secured a sprocket driven by a belt from a second sprocket mounted on a shaft of an electrically energizable motor **42**. Journally supported on means **45** carried by the frame member **34** are idler rolls **44**. A pull wheel or attenuating unit and at least one idler roll is provided for each strand **20**.

The strand **20** passes around the idler roll **44** and around the attenuating or pull wheel **30** and is delivered or project from the pull wheel for distribution on a relatively movable collector or conveyor belt **50**. Each of the attenuating units **26** embodies means for disengaging the strand from the pull wheel **30** at varying peripheral regions of a pull wheel to effect transverse or lateral distribution of the strand over the width of the collector or conveyor **50**. As the conveyor is advanced past the several fiber attenuating stations or units, the several strands are successively overlapped in building up a mat of desired thickness. The water or other liquid delivered onto the filaments by the applicators provides adequate wetting or lubricating of the filaments without incurring an excess of liquid in the mass or mat of the accumulated strands on a conveyor **50**.

The apparatus just shown thus is capable of performing steps of providing a layer or a plurality of layers of individual linear bodies by forming the linear bodies of heat-softened material from the supplies at the plurality of body forming and delivery stations, continuously delivering a group of linear bodies from each of the stations to a collecting zone where the bodies are collected into an assemblage, and continuously moving the assemblage of bodies away from the collecting zone.

In order to accomplish the interleafing step of the method, supplies of binder in film form are provided intermediate the forming and delivery stations. Rolls of binder **60** in film form are carried on a dispensing shaft **61** located above the conveyor and intermediate the forming stations. If necessary, a guide roller **62** may be placed just above the previously formed layer to assist in the disposition of the binder film on top of a previously formed layer without interfering with the deposition as a successively formed layer on top of the film being dispensed. The shaft **61** may be mechanically tied to the drive means of the conveyor to insure that the film is dispensed at a speed substantially equal to the conveyor speed. In order to insure an exact deposition speed according to a predetermined conveyor speed, a rubber or other yieldably engageable roller type means **70** may be placed directly on the surface of the roll insuring that the circumference of the roll travels at the same speed as the conveyor even though the diameter of the roll becomes successively smaller as each wrap is taken therefrom. In such a driving means the shaft **61** would be journaled to roll freely and the driving

means geared to the speed of the conveyor. The roller or shaft **62** may, of course, be directly driven by the conveyor since its circumference does not change or vary, or it may be allowed to rotate freely.

Referring to FIG. 2 there is illustrated in perspective a roll **60** of the binder in film form mounted on the shaft **61**. The material used in the binder film may vary according to the applications in which the integrated mat will be utilized after integration. For example, thermoplastic binders may be made up in film form such as the resin vinyls, polyesters, polyethers, etc. This type of film may be activated through a heat treatment which will cause the film to melt and flow on the fibers themselves, particularly at the intersections thereof, and which will solidify and shrink around the intersections after the heat treatment to integrate the mass together. Thermosetting binder films may be used which may be activated by external temperatures but more probably by the use of accelerators in combination with externally applied temperatures, which accelerators may be applied in liquid spray, fumes or other forms so that the integrated mass may be molded or cured quickly and then put into an oven for the final setting or curing.

Combinations of thermoplastic and thermosetting binders in film form may be utilized in which the thermoplastic may be activated at a first predetermined time, usually by the application of heat, while the thermosetting film binder may be activated at a second predetermined time, usually in conjunction with the accelerators or catalysts discussed hereinbefore. The thermoplastic and thermosetting binders may be combined into a single sheet or film form, or the film dispensing station intermediate the forming stations may include two or more rolls of film for inclusion between the layers of linear bodies to accomplish the results as desired at a later time. In this connection it may be noted that fully loaded sheets may be formed from this process in which everything is in the combined layers of linear bodies and interleafed films of binder so that the combined layers and interleafing may be used directly in the final process with the full percentage of fiber and binder needed, without intermediate stages or treatment to insure that the percentage and/or distribution is correct.

It is obvious that by using various thicknesses of film binder and by interleafing the film as desired between suitably thickened layers of fibers, that binder may be applied to integrate the mass in a most exact quantity in weight or volume and that the distribution of the binder will be uniform.

As noted in FIGS. 3 and 4, the binder in film form need not be applied as a sheet of film. For example, in FIG. 3 strips of binder film may be unrolled from a previous binder dispensing station, which strips **60***a* will be interstiched with, although a layer below, similar strips **60***b* at a succeeding film dispensing station. Thus the film may be interleafed in staggered layers and three dimensional matrices to accomplish the result desired. Further, the strips **60***a* may be of a thermoplastic nature to achieve a first result, while the strips **60***b* may be of a thermosetting or other nature, to be described hereinafter, to accomplish a separate result. The three dimensional matrix formed by the use of the strips shown herein does allow an air circulation up through the mat, particularly a heated air circulation, when it would be desirable to activate the thermoplastic binder. When combining one or more types of binders in full sheet form as shown by the sheet **60** in FIG. 2, air circulation through the mat would be difficult. Alternatively, there is shown in FIG. 4 a sheet **60***c* which has formed therein perforations **65** which would permit air circulation through the mat for drying or curing purposes while still retaining substantially the uniformity of distribution and density of the binder in the mat when finally integrated.

It is to be noted that the mat may also be integrated by using films which include a cellulose acetate, viscose yarn, etc., which do not melt, but instead curl and shrink in response to a heat treatment. The curling and shrinking action performs a mechanical locking or bonding of the fibers into an integrated mat. The films of this nature may be provided in the solid sheet type shown in **60** which, upon application of heat, will tack or separate and shrink and split into discontinuous segments, which segments will curl and shrink further and perform the mechanical locking and integrating action described above. As an alternative discontinuous threads of the curling and shrinking nature may be placed in a carrier film of a thermoplastic base to provide a double action. Such threads, yarns or discontinuous segments may be also utilized in a carrier film which will disintegrate after heat or other treatment and not stay in the mat, leaving only the discontinuous threads or segments so that only mechanical locking is accomplished. This would be of particular importance in special applications such as, for example, filter mats in which it is desirable to provide as much fiber surface as possible to filter air or gases being driven therethrough. The fiber surfaces in this instance are more capable of collecting the dust or dirt from air, other gases, or liquids being driven through the filter than certain binders, which may be utilized to integrate the mass and of necessity cover a portion of the fibrous dirt collecting surfaces.

Referring again to FIG. 1 there is illustrated means for activating the binder film to integrate the fibrous mass.

If a heat treatment is desired an oven **70** may be utilized. Heat may be provided by a radiant type heating means **71** and or by blower means **72** circulating air or other gases past heating elements **73**. Both heating methods may be controlled by a thermostat means **74** connected to a suitable temperature control means **75**. If desired the heated air or gases may be recriculated in a closed system via an exhaust port **76** connected to blower **72**.

Depending upon whether the binder film is thermoplastic or thermosetting or a combination of both a chemical accelerator or catalyst may be applied. As shown in FIG. 1 the accelerator is being applied by nozzle **80** in liquid spray form although prior art methods of using fume applications, etc., may be used.

To indicate that fully loaded sheets may be assembled by this process for immediate use, a compression roller **90** is shown in FIG. 1 to note that compression or molding may be initiated directly. Obviously a series of compression rollers, mating compression platens, or mating molds may be used.

In the method described herein the shelf life of a binder film, particularly that of the mechanical locking nature would be much longer than the aqueous solutions which must be continuously agitated to keep its capabilities or the powdered forms of binder which may cake or otherwise become aged. Further, the collecting conveyor, such as the conveyor **50** illustrated in FIG. 1 moving beneath the forming stations, would have little or no tendency to become clogged or blocked with the use of the film binder as illustrated as opposed to the previous use of binder in an aqueous solution or the distribution of powdered binder on a wetted mass. Thus the expense of storage, the stocking requirements, the labor and equipment involved, are all smaller with the use of the method disclosed herein. The method enables insuring an exact amount of binder distributed in any desired fashion within very close tolerances on weight or volume when integrating a mat or mass and when providing fully loaded sheets for final processing.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure

is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. The method of accurately and uniformly dispersing a metered amount of binder throughout the interior of a mass of loose glass fibers to form a single integrated mat-like collection of individually interconnected loose fibers having a uniform density, comprising the steps of depositing a plurality of layers of loose glass fibers, metering and uniformly distributing predetermined amounts of binder by interleafing binder in film form between said layers of loose fibers, and dispersing said binder in film form through said layers of loose fibers to interconnect adjoining portions only of said loose fibers within and between said layers to form an integrated collection of individual glass fiber bodies.

2. The method according to claim 1 in which said dispersing step includes heating said film.

3. The method according to claim 1 in which said dispersing step includes the application of sufficient heat to melt and flow said film.

4. The method according to claim 1 in which said dispersing step includes changing the temperature of said film to separate the film into discontinuous segments and cause the segments to curl around adjacent fibers to mechanically interconnect said loose fibers.

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