July 22, 1958 T. R. SIMKINS 2,843,916

METHOD OF FLUFFING GLASS FIBERS

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Fig. 1

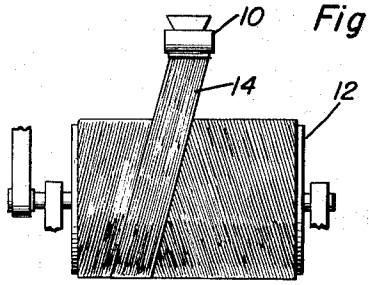


Fig. 2

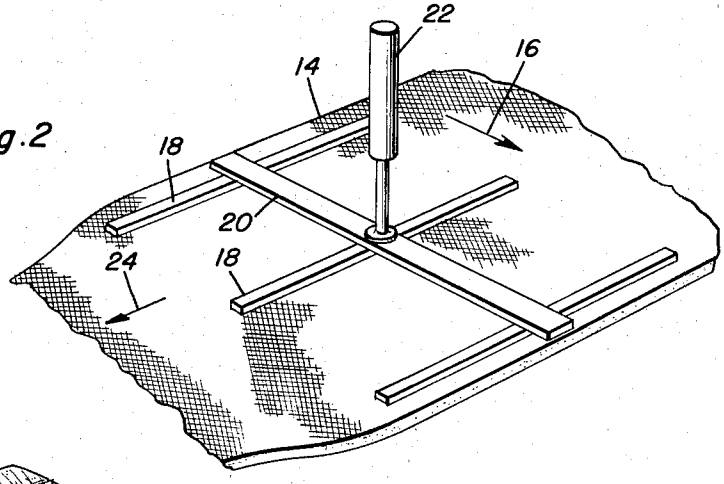
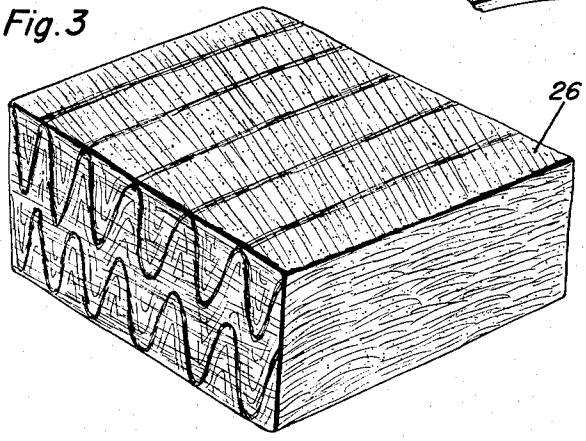


Fig. 3



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METHOD OF FLUFFING GLASS FIBERS

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The present invention relates to a method for expanding a condensed, fibrous mat into a fluffy, very low density, porous mat.

A principal object of the invention is in the provision of an improved method for expanding condensed, fibrous mats into expanded mats having substantially uniform densities and porosities throughout.

A highly important object of the invention is in the provision of a method for expanding condensed, fibrous mats to the desired porosity, density and thickness, solely by retardation of the expansion of the mat fibers during the stretching operation of the mat.

It is another object of the invention, ancillary to the preceding object, to actively promote the curling, twisting and snarling of the mat fibers by the application of controlled pressure to the mat during expansion in order to increase the thickness of the expanded mat from the condensed mat prior to the addition of any binding materials to the mat.

Under the present methods of expanding condensed mats of glass fibers or filaments, the method of production of the expanded mats depends generally upon the application of a material in the form of a binder to the fibers or filaments at some point prior to or during the expansion of the mat from its condensed form. The binding materials vary, and in fact, plain water or moisture has been utilized, the method having been described as one where the surface tension is increased between the substantially parallel fibers of the mat by the addition of a binder. One method of applying this binder has been, and still is, the spraying of the binder on the fibers as they are being formed on the winding drum; however, the method is costly, first because the centrifugal force of the rotating drum throws off much of the binder resulting in waste and also because the drying characteristics of the binder will vary with the atmospheric conditions of the room resulting in non-uniform products after expansion. Another method of applying the binder consists of cutting the mat from the drum without the addition of any binder thereto, partially expanding the mat, adding the binder and then completing the expansion of the mat. A third method is to cut the mat from the drum in a dry state, apply the binder to the mat before expansion of the condensed mat and then to expand the mat. The products from any of these methods, although generally satisfactory, have a tendency to be non-uniform.

The present invention is based on the discovery of a novel method for providing a uniformly expanded mat by controlled, mechanical retardation of the expansion of the dry mat fibers prior to the addition of any binder to the mat fibers.

The invention is directed particularly to the expansion of unwoven, glass fiber fabrics which have found considerable utility as air filter mediums, reinforcing and bulking agents for other fibrous materials, as acoustical insulation material, and many other uses.

In the formation of these unwoven glass fiber fabrics, the individual fibers or filaments are first laid down on

a rapidly rotating drum in a series of superposed layers, each layer being made up of a number of parallel fibers with the fibers on adjacent, superposed layers crossing each other at an angle to one another.

When such a mass has been built up on the drum, the fiber mass is then cut from the drum by slitting the mass longitudinally of the drum, the mass when removed from the drum comprising the condensed mat. No binder material is applied to the mat as yet.

Next, the condensed mat is laid flat and the mat is stretched or expanded in a direction substantially perpendicular to the lay of the fibers in the plane of the mat. At the same time, the mat is subjected to continuous, mechanical pressure perpendicular to the plane of the mat during stretching thereof.

As the mat is expanded between the resistance portions set up by the application of the mechanical pressure thereto, the mat fibers are free to expand between these points but at these points their movement is restricted and as the filaments or fibers are dragged from under these points during the stretching operation, the difference in the resistance to movement causes the fibers to twist, curl and snarl so that when the mass is stretched into its expanded form, an extremely low density, uniform, fluffy product is produced.

A binder may be applied to this resultant mass to increase the resilience of the finished product, but the application of this binder in no way affects the formation of the fluffy mass as described in the foregoing paragraph.

After a binder is applied, the density of the product can be varied by compressing the mat and holding it to thickness while the binder dries or cures. The density can also be controlled and reduced by further fluffing the mat with air or mechanical agitation while the binder is being dried or cured.

One very successful form of mechanically retarding the expansion of the fibers during the stretching operation has been by laying spaced bars on the condensed mat parallel to the direction of force in the stretching operation. However, in one series of experiments, no weights or bars of any type were used and very successful results obtained. In this series of experiments, the weight of the fibers of the upper portions of the condensed mat pressing upon the fibers on the lower portions of the mat created sufficient resistance to expansion to create the effect previously described with the use of the mechanical weights. It is to be noted, however, that when no weights are used to supply the mechanical pressure, a longer expansion or stretching of the mat is required to obtain satisfactory results. The over-all effect of this treatment is that the mat is narrowed and thickened and lengthened as it is stretched.

Basically, therefore, the invention lies in the method of expanding the mat without the use of binders by the mechanical application of pressure to the mat. Whether this pressure is supplied by sheer force of the weight of layers of fibers resting upon other layers of fibers of the mat, or whether other mechanical pressures are employed, the theoretical result is substantially the same. However, by controlling the mechanical application of pressure by the provision of spaced bars, the pressure, and the pressure spacing may be controlled with a resultant control of the thickness, porosity and over-all density of the final expanded product.

In the accompanying drawings, there is shown a suitable furnace **10** which traverses the face of a drum **12** to build up an unwoven fabric formed from layers **14** of glass filaments or fibers deposited on the drum while the furnace **10** traverses the drum.

When a sufficient number of layers of fibers **14** have been built up upon the drum **12**, the mat is cut from

the drum along a line parallel to the axis of the drum and laid flat, as shown in Figure 2. The arrow **16** on Figure 2 designates the general direction which the mat **14** is disposed when unrolled from the drum.

A plurality of pressure bars **18** mounted on flat bar **20** which bar is, in turn, attached to a mechanical pressure applying assembly **22**, are spaced along the mat **14** in a direction perpendicular to the lay of the fibers, and parallel to the stretching force which is next utilized to expand the mat.

The stretching or drawing of the mat takes place perpendicular to or at right angles to the lay of the fibers of the mat, this direction being designated by the arrow **24**. As the mat is stretched to its expanded form along the direction indicated by the arrow **24**, the mat narrows and thickens, the difference in the resistance to movement of the fibers caused by the pressure bars **18**, causing the fibers to twist, curl and snarl so that as the mat narrows and thickens to its final expanded form, a very low density, uniform, fluffy, expanded mat is produced.

When no supplementary pressure is utilized, the upper layers pressing down on the lower layers cause the points of intersection of the fibers in the lower layers to be subjected to a greater pressure per square inch than the upper layers to create a natural retardation against the expansion of the fibers. This difference in expansion rate in some instances causes the fibers to twist, curl and snarl so that in this event also a very low density, uniformly fluffy product is formed.

Obviously, many methods may be utilized to produce the spaced resistance points against expansion to retard the movement of the fibers during the stretching operation, the one shown in the drawing being chosen for illustrative purposes only.

The final product itself is exceedingly hard to convey in a drawing because the fibers of the various layers form essentially corrugated-type undulations which are intertwined with one another with the curled and snarled fiber portions. However, it is believed that this structure is very generally depicted by the portion of the expanded mat designated by the numeral **26** shown in Figure 3.

Since numerous variations of the process will occur to those skilled in the art, after a perusal of the foregoing description, it is not desired to limit the invention to the exact process shown and described and it is desired to cover all modifications and variations which fall within the scope of the appended claims.

What is claimed as new is as follows:

1. A method of expanding a condensed fiber mat in which the fibers are disposed in layers, the fibers within each layer being in parallel relation to one another and the fibers of adjacent layers lying at an angle to one another, said method comprising expanding the mat in a direction substantially perpendicular to the lay of the fibers in the plane of the mat while subjecting the mat to a continuous and substantially unvarying mechanical pressure perpendicular to the plane of the mat only at spaced points thereacross.

2. The method of forming an expanded mat from a condensed mat of glass filaments which comprises stretching the mat at right angles to the lay of the filaments and applying a continuous substantially constant pressure to the mat only at spaced points thereacross in a direction substantially perpendicular to the mat surface and while stretching the mat causing the filaments to curl and intertwine to thereby expand the mat to a cohesive mass.

3. The method of forming an expanded mat from a condensed mat of glass filaments which comprises stretching the mat at right angles to the lay of the filaments, applying a continuous substantially constant pressure to transversely spaced portions only of the mat in a direction substantially perpendicular to the mat surface and while longitudinally stretching the mat causing the filaments to curl and intertwine to thereby expand the mat to a cohesive mass, and thereafter applying a binder to the expanded mat.

4. A method of forming an expanded mat from a condensed mat of layered filaments free from any binders which comprises stretching the mat at right angles to the lay of the filaments while applying a continuous substantially constant pressure only to transversely spaced portions of the mat surface from a direction perpendicular to the face of the mat thereby creating resistance to expansion of certain of the filaments and causing them to curl and twist into an expanded, fluffy, cohesive mass.

5. In the method of expanding a condensed mat of layered fibers wherein the fibers of adjacent layers are angularly related to one another, the steps of retaining the condensed mat free from any binders, stretching the mat at right angles to the lay of the fibers while applying a continuous substantially constant pressure to the mat only at transversely spaced points thereacross perpendicularly to the surface thereof.

6. In the method of expanding a condensed mat of layered glass filaments, the step of stretching the mat at right angles to the lay of the fibers while simultaneously retarding the expansion of certain of the fibers only at selected points across the mat spaced transversely to the direction in which the mat is stretched to promote curling thereof and causing the thickening of the mat to a cohesive mass prior to the application of any binding agent to the mat.

7. The combination of claim 6 wherein the retardation is controlled.

8. In the method of expanding a condensed mat of layered fibers wherein the fibers of adjacent, superposed layers are disposed at an angle to one another, the steps of applying a continuous substantially constant mechanical pressure to the surface of the condensed mat at transversely spaced points thereacross, and then stretching the mat in a longitudinal direction perpendicular to the lay of the mat fibers.

9. The method of forming an expanded mat without the addition of binders thereto from a condensed mat of glass filaments which comprises longitudinally stretching the mat, and applying a constant continuous pressure to the surface of the mat only at transversely spaced points thereacross during stretching thereby causing the thickness of the mat to increase as the mat is stretched while causing the filaments of the mat to intertwine with one another into a cohesive mass without the application of any binders to the filament.

10. The method of increasing the thickness of a mat into a cohesive mass without the application of binders thereto during longitudinal stretching thereof which comprises applying a continuous, constant and controlled pressure to portions of the mat only at transversely spaced intervals thereacross.

11. A process for increasing the thickness of a mat of glass filaments without the application of binders thereto as the mat is lengthened by stretching, the process comprising retarding the expansion of the mat at only spaced points thereacross transverse to the direction in which the mat is being stretched whereby the filaments intertwine with one another into a coherent mass while causing the thickness of the mat to increase.

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