Dec. 5, 1950 A. J. P. CARE 2,532,660

APPARATUS FOR PRODUCING FIBER STAPLES

Filed May 11, 1944 3 Sheets-Sheet 1

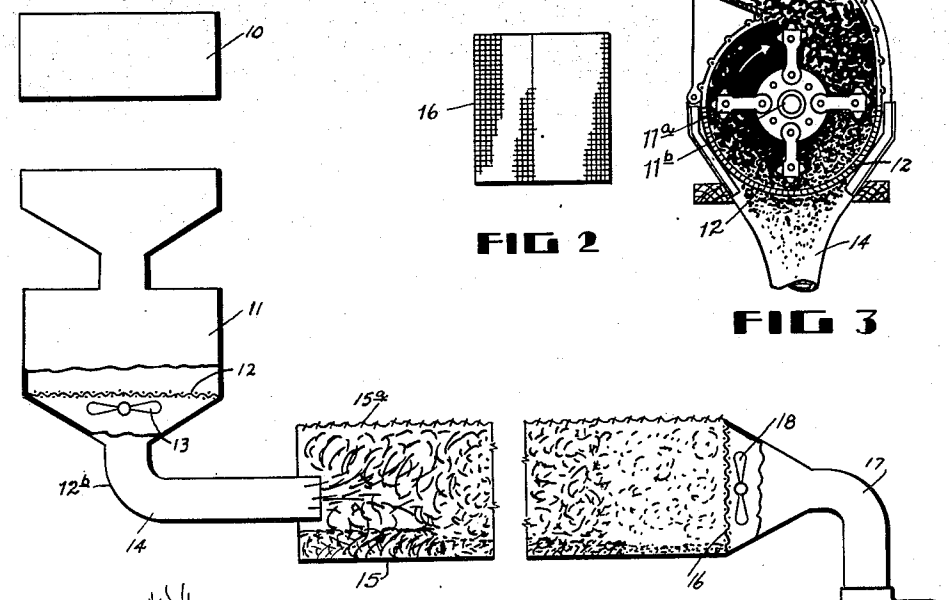


FIG 1

FIG 2

FIG 3

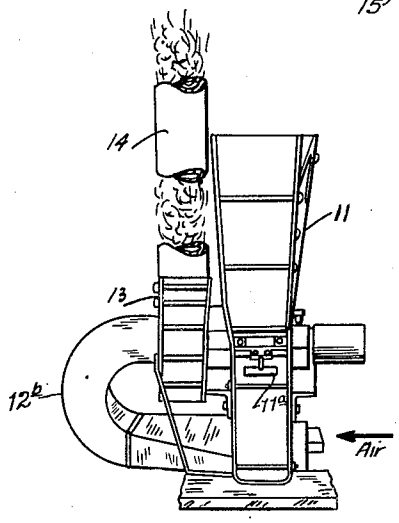


FIG 4

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Fig. 5.

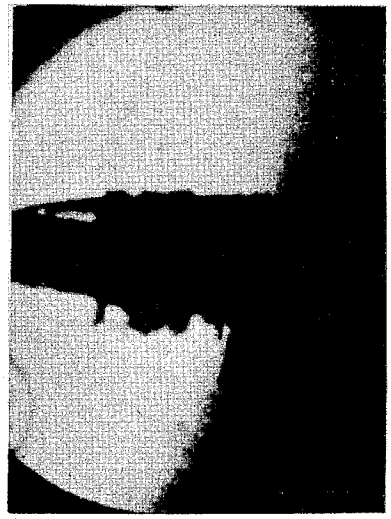


Fig. 6.



Fig. 7.



Fig. 8.

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Fig. 9.

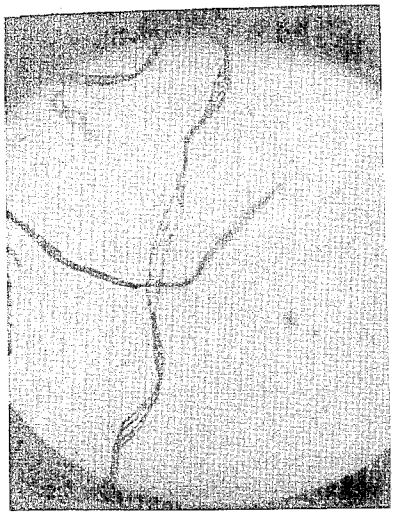


Fig. 10.



Fig. 11.



Fig. 12.

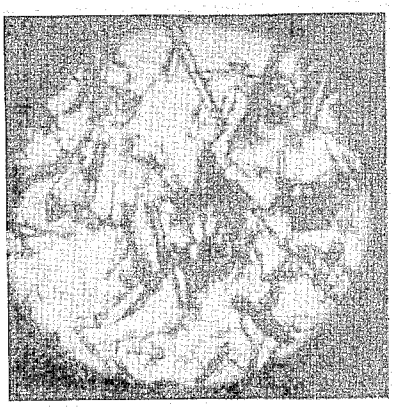
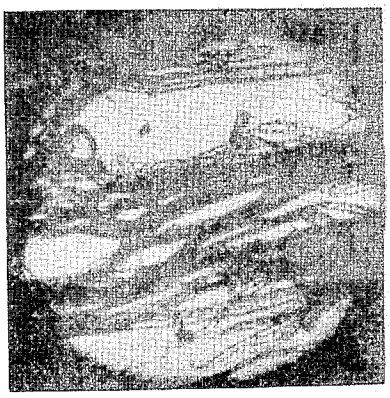


Fig. 13.



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APPARATUS FOR PRODUCING FIBER STAPLES

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1 Claim. (Cl. 241—51)

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The invention relates to an apparatus for the production of fibres, to an improved fibre staple, and to products made from them or by combining the same with other matter to produce other products.

The object of the invention is to provide a fibre staple which has novel and special characteristics tending towards an increase in tensile strength and modulus of rupture when such staples are used in combination with other matter to manufacture wall-boards, plaster lath and the like; and in combination with other matter for the purpose of improving the molding qualities.

One of the principal features of my invention resides in the fact that when the fibres of this invention as produced by the method disclosed herein, and when compounded in combination with other matter and materials will result in a product which is suitable for casting in various shapes, sizes and thicknesses and which may be used for wall-boards, plaster lath sheathing boards, roof and floor slabs, partition tile, and like structural elements. Wall-boards and plaster lath when cast of such materials so compounded are self-supporting and possess sufficient resilience, strength and flexibility to permit shipping and handling, and may be applied to walls and ceilings by fixing them firmly in place by nailing, by screws, bolts or any of the well known means for holding wall-boards, plaster lath or tile in place.

While the use of the products and methods of this invention in combination with other matter will produce wall-boards and plaster lath which do not require paper or paper-board coverings, if it is so desired, such paper or paper-board coverings may be used in the production of wall-boards and plaster lath, which may be covered on one or both sides, or may be completely enclosed in paper or paper-board coverings.

The method of the present invention comprises, in general, subjecting suitable fibres to the action of hammer forces to form fibre staples and then to whirling air, to subject such staples to a special treatment, which on the one hand twists the staples, and on the other hand, opens the fibrils, and in many cases opens out the staples substantially along the length of such fibre staples, imparting to them an open lattice-like or similar structure of apparent flatness. Also, hammered ends have attenuations of beard-like character.

The improved apparatus comprises, in general, a hammer mill for dried fibrous materials, having a screened outlet communicating with a

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turbulent air casing or chamber, and induced air producing means for said chamber or casing.

The improved apparatus comprises a means for drying pulps and/or fibrous materials, preferably in a circulating drying medium, such means may be any of the commonly used mechanical means as now found in the market, a means for separating said dried pulps or fibrous materials into suitable size for feeding into a hammer mill having a screened outlet communicating with a turbulent air chamber, induced air producing means for said chamber, and a suitable connecting tube leading from the hammer mill, and connecting with and into a suitable elongated collecting chamber.

The improved fibre staple of the present invention is characterized in that it is either provided with a twist with expanding fibrillae, in flat open lattice-like form, with attenuated ends, and/or has a combination of these characteristics.

The improved product consists in a novel composition of matter in which the improved fibre staple forms an essential ingredient.

The embodiment of the invention results from the use of wood pulp which is comprised of cellulose fibres from which the lignins and other impurities have been removed by any known standard and accepted process. Such wood pulps being those of standard grades and obtainable in the markets.

The wood pulp as required for this invention and as commonly purchased in the markets usually contains an excess quantity of moisture. In order for these pulps to be suitable for use in this invention, they must be subjected to a drying treatment to remove excess moisture, to reduce the moisture content to an average of not more than about six (6%) per centum.

The invention will be further described, embodiments thereof shown in the drawings, and will be finally pointed out in the claim.

In the accompanying drawings:

Figure 1 is a diagrammatic view of an apparatus suitable for carrying out the invention;

Figure 2 is an end view of the outlet end of the elongated turbulent air chamber;

Figure 3 is a diagrammatic view of the hammer action upon a fibre;

Figure 4 is a diagrammatic view of the whirling action of the air upon the fibres;

Figures 5 to 8 are photomicrographs of fibres during the process of disintegration; and

Figures 9 to 13 are photomicrographs of various forms of fibre staples prepared by the process of the present invention.

Like reference numerals refer to like parts throughout the specification and drawings.

The pulp is usually received in the form of sheets, rolls or "blankets," and normally has a much higher moisture content than desired. It is dried, preferably in circulating air, and broken down into smaller fragments or sizes suitable for feeding into a machine commonly referred to as a hammer mill where the pieces or fragments are subjected to a further breaking up, squeezing, and opening up or cracking, by a hammer shock action, to form fibre staples. The hammer mill has its hammers strike the pulp while in suspension and brings about a separation of the pulp fibres. The separated fibre is subjected to a shock action by the hammer striking the pulp in suspension whereby the pulp is separated into its individual fibre staples. This shock action produces the result of breaking the separated fibres by elongation and tearing apart, and such elongation or torn ends or breakage resembles closely the rupture obtained by a tensile test providing the separated ends with beard-like attenuations. Naturally, such ends are flattened by the pressure applied, but the shock action seems to tear the portions apart as under tensile strains. This bearded end of a fibre staple is one desired characteristic of the same. After this hammering action, the fibre staples are transferred by high velocity air flow from the hammers and to and through a screen over an opening in the hammer mill frame of the hammer mill to a zone of whirling air. The fibre staples pass from the hammer mill through a screen having openings of such size as may be desired to furnish fibre staples of various lengths and thence by the blast of air produced by a rotary fan located in the bottom of the hammer mill through a suitable tubing or conduit to an elongated collection chamber or zone of whirling air. This action on the one hand prevents the fibre staples from matting together, and on the other hand twists the fibre staples, and in the case of cracked fibre staples opens them out, and more or less flattening originally cylindrical or other shapes while they still substantially contain the moisture content as of the time they passed into the hammer mill, and probably still have a certain amount of heat resulting from the hammering action. These fibre staples as they enter the turbulent air zone still moist and heat laden and in moldable state, are in a state so as to be readily shaped from their configuration resulting from the hammer action, to a twisted form.

They may expand after having been compressed by the hammer, and it is during this state that they are readily moldable or shapeable. Thus, when being conveyed at varying velocities by and in the turbulent air, the fibre staples are subjected to different forces. The twirling of the air accessory to the main induced air stream subjects their ends to different forces askew to each other and gives the fibre staples a spiral form, or they may be wry, bent, and off position, contorted or askew.

These fibre staples are very small to the naked eye, and when being whirled by the turbulent air, form a mist-like appearance. Under the microscope, the twist is clearly visible. Some of the fibre staples appear flat, with the cells and basts clearly visible as if in a plane, with some provided with a twist and some without. They form a lattice-like structure. Some, in fact most of them, have very fine fibrils, combined with the lattice-like structure and twisting of each fibre staple and attenuated ends, or with some of them, that enables the fibre staples when matted with or without water or other matter, or are felted together either alone or in combination with other matter, to form a structure of high tensile strength and high modulus of rupture. Such skeleton-like cellulose structures, interlocking and interlacing with each other when such fibre staples are matted or felted, require force to separate. The fibre staples described when distributed in a binder and uniformly distributed therein, interlace with the binder, with the binding material entering the interstices of the fibre staples. The fibre staples absorb surrounding fluid by capillary action.

It is believed that when subjected to such turbulent air, the fibre staples have some of their moisture removed, or they may take in some moisture if atmospheric conditions are such as to induce them so to do, or some of their latent heat may be removed, but the combination of all these factors causes them to take their final form, due to a slight hardening of the cellulose. They pile along the bottom of the collection chamber in which the turbulent air is enclosed, with the largest fibre staples falling and collecting near the air inlet, and the smallest near the air outlet.

Thus, a cellulose fibre staple is produced either twisted, flattened, provided with fibrils, with attenuations at the end thereof, and/or having any or all of these characteristics.

The improved method thus comprises the subjection of dried cellulose fibres to a hammering force and to the forces of turbulent air, to form cellulose fibre staples of recognizable characteristics.

The invention has been described in connection with the use of the fibres separated from pulps comprised of cellulose fibres from which the lignins and other impurities have been removed. Instead of wood fibres, other vegetable fibres may be used. In all cases, including animal fibres, it is desirous of skeletonizing the fibres by the removal of impurities when such are present, for example, animal fibres require degreasing before processing.

An embodiment of the apparatus including a drying chamber is indicated by the numeral 10 in Figure 1, wherein the pulp is exposed to the drying action of circulating air maintained at temperatures according to standard drying practices. Normally, fibrous material such as wood cellulose, known to the trade as sulphite or sulphate pulp, is received from the pulp mills in sheets, rolls or "blankets" having a relatively high moisture content. Material such as this must be dried before processing by the method of the present invention.

With the fibres properly conditioned, the sheets are reduced to parts small enough to be fed into a hammer mill, indicated by the numeral 11. In the hammer mill, the parts or fragments are separated into their individual fibres, and these are (at the same time) hammered by the impact of a series of hammers 11*a* loosely mounted on a shaft 11*b* rotating at a relatively high speed. The impact of the hammers on the dried material progressively separates the material into individual fibres and into fibre staples.

A screen indicated by the numeral 12, is provided in the bottom of the hammer mill through which screen the proper sizes of fibre staples pass into a conduit 14 which has a curved portion 12*b*,

The screen openings are of a size such as to permit the withdrawal of fibre sizes satisfactory for the use to which they are to be put.

The fibre staples produced in the hammer mill are continuously withdrawn through the screen 12 by the action of a suction fan 13, producing an induced flow of air through the screen.

The screen serves the dual purpose of preventing the withdrawal of oversize fibres, and, also, ensures that the fibres remain separated from each other and form lines during their passage from the hammer mill and through the conduit 14. Over-size fibre staples remain in the mill until reduced to a size at least not greater than the maximum size of fibre staples desired, which is determined by the size of the screen openings, the screen interstices controlling the size of fibres to be passed therethrough.

The conduit 14 extends from the screened outlet opening of the hammer mill to an elongated collection chamber 15.

The collection chamber or casing 15 is long and of relatively restricted vertical section as compared with its length, but of greater vertical section than that of conduit 14.

The outlet end wall of the collection chamber has a screen 16, the openings of which are of a size to obstruct the passage of fibres of a size larger than the minimum size of fibres desired but provides passage for the dust entrained with the air passing therethrough and withdrawn from the chamber.

The roof of the collection chamber is preferably of cotton or other suitable fabric 15*a* of sufficiently open weave to permit the passage of air and thus to prevent explosion of dust laden air and to permit fibres to rebound downwardly to settle out gradually to the base of the collection chamber. The heaviest or coarse fibre staples drop down first, next the medium, and next the finest, providing a separating or sorting operation along the bottom of the chamber or casing from its inlet to its outlet end. Dust can also pass through the pores of the roof material and through the screen 16, thereby minimizing or eliminating the danger of dust explosion. A conduit 17 extends from the outlet end of the collection chamber to a dust collector, preferably in the form of a bag 19.

The conduit 14 extends into the chamber or casing 15 for a distance of about three to five feet. The outlet opening of the conduit 14 is coaxially disposed to the opening of the outlet wall in which an exhaust or suction fan 18 is located. The suction produced by the fan produces an air flow through the chamber from the outlet opening of the conduit to the fan forming an air column of considerable velocity and which velocity translates itself to the screen opening in the hammer mill. As this column of air is surrounded by air in a relatively quiescent state the peripheral parts of the air column branch out in whirling streamlets having also a high velocity. Thereby the relatively quiescent peripheral zone becomes turbulent, and the fibre staples are twirled around above and below and at the sides of the column until they descend helter-skelter to the bottom of the chamber, their weight determining the location, the intensity of the induced draft being regulated accordingly.

The velocity of the air passing through the collection chamber can be regulated to result in a separation between various sizes of fibre staples along the length of the chamber.

The fibre staples which are of a size such that they are unsuitable for use as a filler, are carried with the air through the screen 16, through the conduit 17, and into the dust collector 19, wherein they are separated from the air and may be recovered for other uses.

The fibres produced by the process of the present invention are illustrated in Figures 5–13. Figure 5 illustrates the first stages of fiberizing, showing the original stem or stalk from which fibre staples are beginning to separate. It is noted that even in that early stage of the processing, some of the fibre staples appear to be twisted and opened out in a lattice-like structure. Figure 6 shows the same stem and fibre staples as in Figure 5 in a slightly more advanced stage of processing. The fibre staples, as they are separated from the stem, show the same twisted lattice-like structure due to the pressure of the hammers upon the cellulose cells and basts. Figures 7 and 8 show further stages of the action of the separation in fiberizing.

Figure 9 is a photomicrograph of several fibre staples after processing. These fibre staples are typical of the fibre staples produced by the process of the present invention, the fibre staples being twisted and opened out in a lattice-like structure. Reference is also made to the fibrils extending from the fibres and to the attenuated ends.

Figure 10 illustrates a group of sulphite pulp fibre staples after processing. Figures 11 and 12 illustrate the fibre staples mixed with foreign matter. Figure 13 illustrates the fibre staples incorporated with a synthetic resin binder.

The fibre staples illustrated in Figures 5–13 are typical of the fibre staples produced by the process of the present invention. It is found that the fibre staples can be used with advantage as fillers, binders, extenders, reinforcers and the like, for various types of compositions of matter such as with gypsum in prefabricated plaster wall boards and plaster lath of various shapes and dimensions, sheathing boards, roof and floor planks or slabs, backer tile, partition tile, hollow blocks and tile, furring tile, fireproofing tile, bulk plaster and stucco, acoustical tile, and like construction elements, as well as with various synthetic resins in the manufacture of plastics, the combination of the twists in the fibre staples and the fibrillae, that is, the fine hair-like projections from the main portion of the fibre staples, causing adjacent fibres to interlock and form a tight bond which requires force to separate.

Mineral fibres, which may also be used, that is, glass fibres, for instance, glass threads, present a somewhat different problem, in that a cellulose structure is absent, nevertheless, even in the finest threads, the exterior surfaces do not form a true plane, though such is apparent to the eye. When continuous filaments or short staple glass fibres have been twisted into yarn, the fibres present spiral shapes. The hill and valley configurations and the spiral shapes lend themselves admirably to a binding action when combined with other matter to form a plastic composition. Glass fibres lend themselves especially to use with a plastic composition in combination with cellulose fibre staples as described herein, resembling the action of spirally shaped metal reinforcing bars or rods, as used in the production of reinforced concrete. The very fine glass threads at their breakage points when subjected to the shock action of the hammer tear, so to say, the

threads apart, and thus form the attenuations at the separated ends.

The fibre staples themselves may be intermingled to form a body of such fibre staples to take the place of balsam wool or the like as now used in acoustic blocks of the Norris type, and this body may be supported by a sheet of composition in which the improved fibre staples are embedded, which sheet would be provided with openings to make it sound absorbent to take the place of the metal facings of the Norris type. Such a combination would also take the place of a Celotex unit and result in high acoustic properties, which would be independent of the use of steel, metal or other types of surface coverings.

I have described my invention in connection with the several embodiments thereof, but it is clear that changes may be made therein without departing from the spirit of my invention as defined by the following appended claim.

What I claim as new and desire to protect by Letters Patent of the United States is:

Apparatus for the production of fibre staples comprising in combination a hammer mill for separating dried pulp into individual fibre staples, a closed, elongated collection chamber for receiving individual fibre staples from the hammer mill, said collection chamber having an air outlet closed by porous material, a conduit extending from the hammer mill a short distance into the collection chamber, a finely screened outlet for said collection chamber in alignment with said conduit, suction means for drawing a mixture of air and finely divided particles through said screened outlet, blower means adapted to create an air current for maintaining the fibres in the hammer mill in air suspension, said air current being effective for conveying sized fibres from the hammer mill to the collection chamber in a turbulent air suspension and for maintaining individual fibres in the collection chamber in an air suspension.

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