July 23, 1963 E. GRETEN 3,098,781

APPARATUS FOR PRODUCING WOOD PARTICLE BOARDS

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Fig. 6.

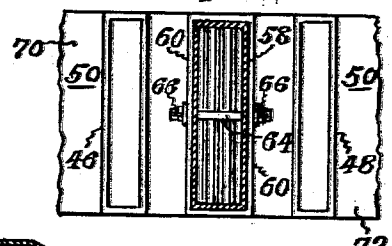
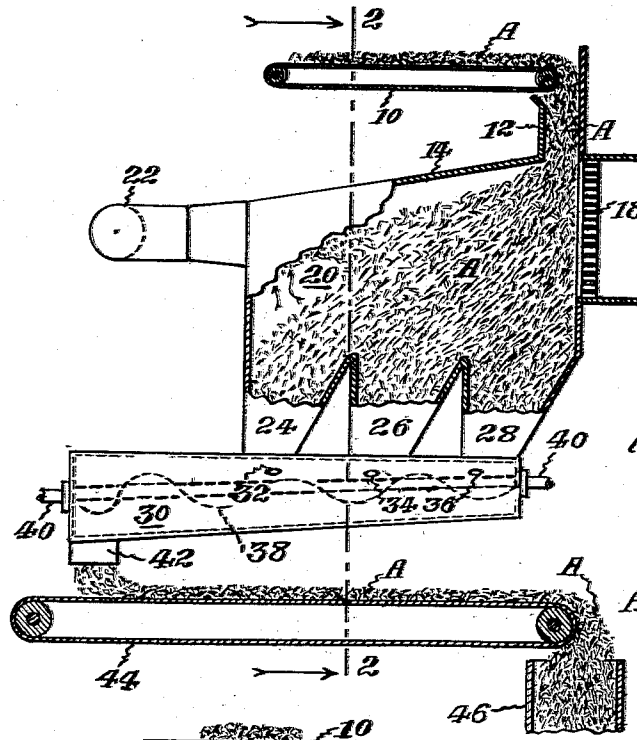


Fig. 1.



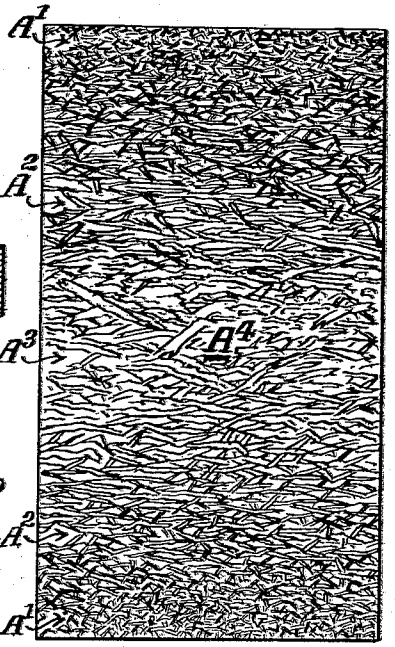


Fig. 7.

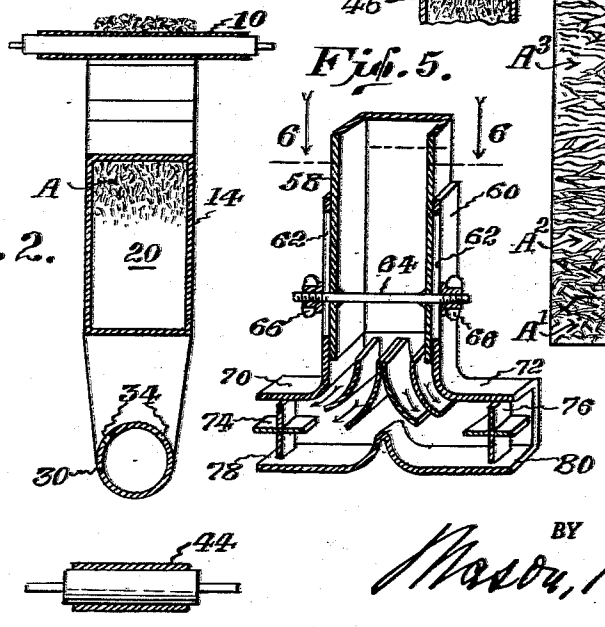


Fig. 2.

Fig. 5.

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APPARATUS FOR PRODUCING WOOD PARTICLE BOARDS

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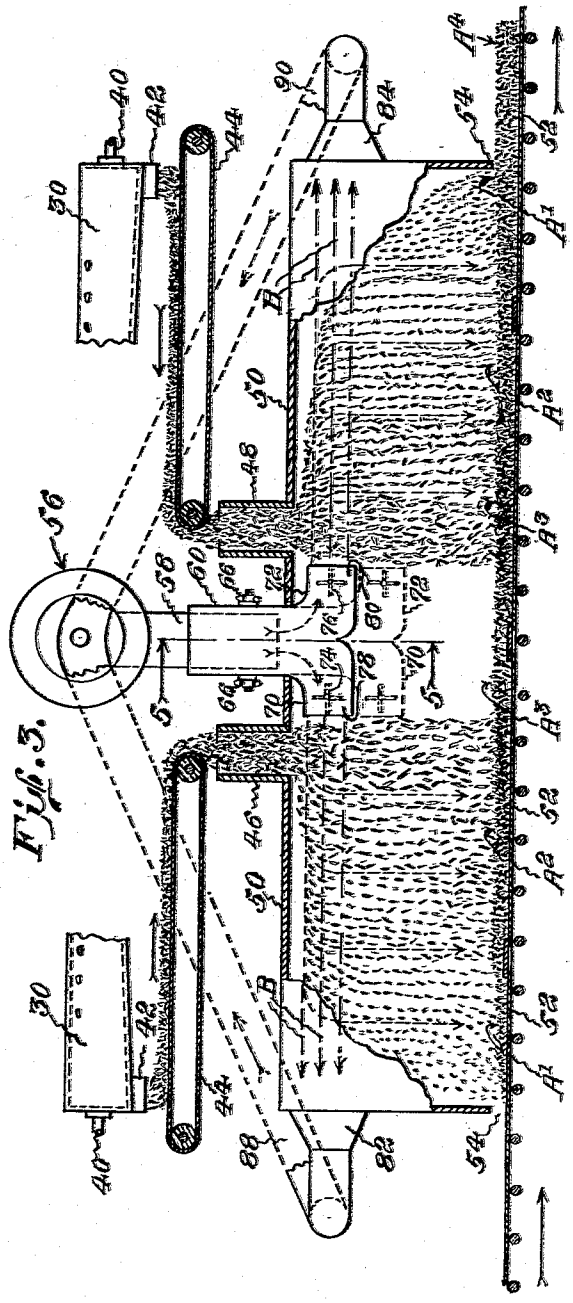


Fig. 3.

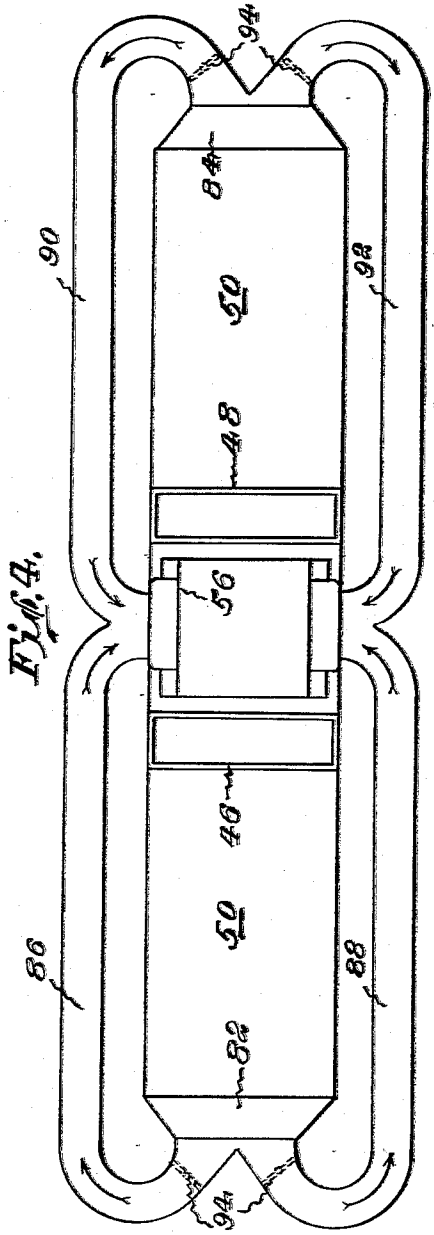


Fig. 4.

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APPARATUS FOR PRODUCING WOOD PARTICLE BOARDS

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1 Claim. (Cl. 156—373)

This invention relates particularly to the method and apparatus for producing wood particle boards.

This application is a continuation-in-part of my application Serial No. 694,975, filed November 7, 1957, now Patent No. 3,028,287, entitled "Apparatus for the Manufacture of Chipboards."

An object of the invention is to provide an apparatus and method for producing wood particle boards in a continuous operation, the upper and lower surfaces of which are composed of finer flakes, the inner portion or core being composed of coarser wood particles. These particles are not separated into layers of finer and coarser particles, but are graduated in size from outer surfaces to an inner or central zone or core. Thus the finest particles will be located adjacent the upper and lower surfaces of the mat. Such wood particle or flake boards may, by subsequent operations, be provided with veneers, paper covers, or plastic overlay on their opposite flat surfaces.

Another object of the invention is to provide an improvement in the economy of manufacturing wood particle boards.

An additional object is the production of particle boards in a continuous operation wherein the wood particles are first separated according to coarseness. Following such separation, an adhesive, preferably in liquid form (although solid forms of adhesive are not excluded), is mixed with each of the several grades of wood particles in different amounts. The largest amount of adhesive is mixed with wood particles having the largest superficies; the next largest amount of adhesive is mixed with wood particles having the next largest superficies; and so on until the minimum amount of adhesive is mixed with the wood particles having the smallest superficies.

Yet another object is to provide an apparatus and method for manufacturing wood particle boards whereby the particles are evenly distributed widthwise onto a moving conveyor so that the thickness will be the same along the entire length and width of the board. The board is subjected to various operations, such as heating and pressure, to form particle boards of greater or less density in accordance with the use which is to be made of the particle boards, as noted hereinafter. The particle boards may be used either with or without a wood veneer, paper covering, or plastic material, in accordance with their ultimate use, i.e., whether for furniture, building construction, etc.

An additional object is to provide an air laid mat of the type above set forth, employing the present process or method in which the wood particles are laid on a moving conveyor in a plane or planes parallel to the face of the conveyor, in the same manner that a sheet of paper gravitates to a surface located below the same.

Other objects will appear hereinafter throughout the specification.

Referring to the drawings:

FIG. 1 is a vertical section partly in full lines of the apparatus for separating wood particles according to size, and the means for applying adhesive thereto while so separated;

FIG. 2 is a vertical section taken on the line 2—2 of FIG. 1;

FIG. 3 is a view of the air laid mat forming mechanism, shown partly in full lines and partly in vertical section;

FIG. 4 is a top plan view of the structure shown in FIG. 3;

FIG. 5 is a sectional view taken on the line 5—5 of FIG. 3;

FIG. 6 is a horizontal section taken on the line 6—6 of FIG. 5; and

FIG. 7 is a vertical sectional view, partly broken away, of the particle board as it leaves the mat forming conveyor prior to pressing and other finishing operations.

Wood particle boards are produced from non-chemically processed dry wood particles mixed with an adhesive, either natural or synthetic, wet or dry, although a dry adhesive is preferred. In some processes chemical treatments may be used although such is not the preferred process in the production of particle boards.

The basic materials from which particle boards are produced may be described as follows:

Chips, which are wood particles used in pulp manufacture;

Flakes, which are mechanically produced sliced wood particles (similar in grain direction to sliced veneers), generally having less than 1/10 inch thickness, and are relatively greater in length than width;

Ribbons, which are wood particles of the desired thickness, and which vary as to length, but whose length exceeds their ability to retain a straight form. Examples of these include shavings from hand planing, cut parallel to the grain of the wood. Excelsior is another example of ribbon cut material.

Shavings are the wafer-like wood particles cut by rotary head power-driven planers. These are characterized by thinness, great width, short length, and ruptured fibers.

Splinters are wood particles somewhat similar in appearance to broken toothpicks, with cross sectional dimensions (of a usual width of less than 1/8 inch) and are of relatively greater length than width.

Wood particles also include some fines that are usually separated from other wood particles, some of which, however, find their way into the mass of wood particles as they move from one station to another in the course of the various processing steps referred to hereinafter.

Fiberboard is distinguished from the wood particle board which is the product of the method and apparatus of this invention by the degree of fiberization. Fiberboard is a product composed of separated wood fibers and lignin, formed from a water or air suspension into a mat. The mat after treatment has interlaced fibers bonded principally by plasticizing the lignin in the presence of heat and pressure. The adhesion of the interlaced fibers may be augmented by resins, waxes, and asphalt compounds.

Fiberboard also includes hardboard and softboard. Hardboard has a high density with a specific gravity of 0.80 or greater, while softboard which retains its porosity

is of low density and has a specific gravity of from about 0.20 to 0.50.

Generally speaking, the process and apparatus of this invention relates to the production of particle boards wherein the dimensions of the wood particles from woodworking equipment have been at least partially controlled. The length and thickness of the particles can normally be controlled by the primary wood cutting operation, and a secondary reduction of them will produce the desired shape by regulating the particle width and by further modifying the length thereof. Some of the particles are made from standard woodworking equipment, normally after screening to remove fines and oversized material without further reduction. However, other wood particles, when using a mixture of wood shavings and wood flakes, are sometimes subjected to a secondary reduction, especially in order to reduce the width of the particles by the use of hammer mills. Additionally, hammer mills are used to prepare the wood particles from small sized solid pieces of wood by grinding, breaking or tearing the wood, in which case the resulting chips are mostly coarse and splintered. Preliminary reduction of the wood is sometimes carried on in knife hogs. Particle size from hammer mills will depend upon the peripheral speed, the clearance of impellers, and the clearance between breaker plates or impellers.

Engineered particles may be produced by special cutting machines in order to produce particles with their grain axes parallel to their length. Wood particle manufacturing equipment will cut the particles to a predetermined length and thickness either by using disc type cutters, cup or ring type cutters, or cylindrical cutters. A secondary reduction of the wood particles to a predetermined width and sometimes length, although the latter is not usually resorted to, is normally accomplished in hammer mills or in wing beater mills.

While this invention is not concerned with a particular type of particle or flaking machines, it may be stated that particle thickness can normally be controlled by both knife protrusion and the forward speed of the raw material.

It will be appreciated that the type of cutting machinery best suited to a particular particle board process is, of course, dependent upon the raw material available, the type of process, the desired properties in the finished board, and the allowable manufacturing costs.

It will be further understood that the hereinafter described apparatus and method may be used in the production of various finished products, such as furniture, corestock for plastic overlaid material, corestock for veneer, decorative interior panelling for housing, doors, board to take the place of plaster board in housing constructions or dwellings, structural construction members, etc. In fact, the residential building industry, which consumes about 70% of all the lumber manufacturing in the United States, is the greatest potential market for particle boards produced in accordance with this invention. Such particle boards are equivalent to or are in most cases superior to previously used materials, and additionally show an over-all economic advantage. Such particle boards, as produced by the present apparatus and method, exhibit all of the better characteristics of more expensive materials used in the residential building industry today, i.e., greater strength, better adaptation for receiving nails, screws or other metal objects, and the ability to retain the same in place.

Particle boards have been shown in the prefabricated field, where gypsum, plywood, and other products are popularly used in stressed strain construction, to reduce shipping costs. It is possible when using particle boards of the type noted above to provide full wall sections that have been treated for decay, water, vermin, and to be fire resistant.

Raw material such as logs cut to size or pieces of wood refuse products, as indicated above, may be used. In a typical installation, however, raw material consisting of small logs, say from 6 to 10 inches in diameter, and about 3 feet long, are initially processed by being subjected in such apparatus to an automatic cut-off saw. It is then fed to a flaker where the cut off pieces or chunks are cut into particles, such as flakes. These particles are then sent to a surge bin, thence to a hammer mill, thence to a jet dryer, thence to a screen, thence to a surge bin for dry material. These machines have not been shown, but are known in the art. From the surge bin for dry material the wood particles are deposited on a movable conveyor shown in FIG. 1 by the numeral **10** from which they are deposited through an opening or hopper **12** to the separating chamber **14**. Here they are subjected to a blast of air issuing from the fan **16** through the screen **18** to the column of particles which fall by gravity into the interior **20** of the separating chamber **14**. The very light material and excess air is withdrawn through the exit **22**.

The wood particles A according to their density, i.e. weight and size, fall into one of the three bins **24**, **26** or **28**. It will be noted that in accordance with FIG. 1 these bins may be of different size, or vanes or valves (not shown) may be mounted in the upper inlet portions of each to permit entrance of material in regulated amounts, the bin size being in accordance with the amount of material to be received.

From the bins the material gravitates to the automatic gluing machine indicated by the numeral **30**. Adhesive of any suitable type, in either solid or liquid form, is deposited on the material within the gluing machine, although it is preferred to spray the glue in liquid form on the material. The sprayers are indicated diagrammatically by the numerals **32**, **34**, **36**. The purpose of separating the flakes according to size is to enable them to be sprayed with varying amounts of glue. For instance, the smallest wood particles as they move from the bin **24** to the glue machine **30** are directly sprayed with the smallest quantity of glue or other adhesive; the sprayer **34** at the same time spraying a larger amount of glue on the flakes which emerge from chute **26**, while simultaneously the greatest amount of glue is sprayed by sprayer **36** on the largest wood particles in the bin **28**.

The particles with glue on them are continually turned and fed by a worm, shown in dotted lines by the reference numeral **38**, that rotates within the gluing machine **30** that is rotated by shaft **40** from a suitable source of power (not shown) until the material reaches the left end of the gluing machine, whereupon it finds its way through the exit **42** to the conveyor **44**. At this time the several grades of material have been re-mixed with each other.

As distinguished from the fiberboard specific gravity noted above, the particle boards can be produced with from 0.50 to 0.70 specific gravity, although the density will be in higher ranges if a high proportion of hardwoods is used in the manufacture.

Actually, there may be two structures of the type shown in FIG. 1, or a single combined separator and gluing machine may be used which feeds onto separate conveyors **44**. Inasmuch as the present invention is not concerned with the number of separators and glue machines used, or the manner of conveying the glued material after it leaves the gluing machine, one such machine has been shown in FIG. 1, but parts of two gluing machines as well as two conveyors have been shown for illustrative purposes at **44** in FIG. 3, merely as examples of the different ways in which the material may be conveyed from the gluing machine or machines to the air laid mat forming mechanism. It will be understood that one or more conveyors are optional, and that other means such as a gravity feed (not shown) may be used.

As the material, i.e., the glued impregnated wood particles reach the end of the conveyors **44**, as indicated in FIG. 3, they drop by gravity through chutes **46** and **48** into the mat forming mechanism or chamber **50**. This

mat forming mechanism, as shown in FIGS. 3 and 4, is an elongated generally rectangular chamber. As the material drops by gravity, the lightest particles, indicated at A^1, fall by gravity at opposite ends of the chamber onto the moving belt 52, which occupies the lower open or bottom portion 54 of the chamber 50. The texture of the mat gradually becomes more coarse toward the center or core, although no distinct layers are formed, the finer flakes being shown at A^1, the less coarse wood particles at A^2, and the coarsest or heaviest wood particles at A^3. However, as stated heretofore, there are no distinct layers, the wood particles gradually becoming heavier and larger towards the center or core of the mat, whereby the innermost or core portion of the mat contains the coarsest particles, the lightest particles being deposited to form the upper and lower surfaces of the mat.

This distribution of the wood particles on the travelling belt 52 which moves from left to right is brought about by forcing streams of air from the fan 56, which is mounted on the casing by any suitable supporting means, not shown. This fan may be of various types, but preferably is of the centrifugal type, the air being discharged downwardly through the conduit 58. Adjacent the lower end of this conduit is a sleeved conduit 60 which is adjustable vertically, as indicated in FIG. 5. Conduit 60 is provided with slots 62 and with a bolt 64 having a nut 66 on each end thereof, which latter may be tightened in order to hold the conduit 60 in adjusted vertical positions. However, any other suitable means may be provided by adjusting the lower sleeved conduit 60. The latter is preferably provided with vanes for directing the material in divergent paths through horizontal conduit portions 70 and 72. These portions preferably extend the entire width of the mat forming chamber 50, and each of them may be provided with adjustable valves shown at 74 and 76, respectively. The air stream issuing from the exits 78 and 80 engages the glue impregnated particles as they fall by gravity and forces them to be deposited on conveyor 52 in accordance with the weights of the individual particles, so that the initially deposited particles A^1 at the left of FIG. 3 form the lowest portion of the mat. As the conveyor belt 52 moves to the right, heavier and heavier particles are added to the initially deposited particles until the heaviest particles A^3 are deposited as they fall from the chute 46. As the belt continues its rightward movement, the heaviest flakes which fall from chute 48 form the remainder of the core of the mat, following which less heavy particles A^2 are deposited in graduated amounts until the lightest particles, or those corresponding to the particles in engagement with the belt, form the top surface of the air laid mat A^4.

By reference to FIG. 4 it will be noted that the ends of the mat forming chamber 50 are provided with converging walls indicated at 82 and 84 to which pairs of conduits 86, 88 and 90, 92, respectively, are connected. These conduits are provided with valve means indicated by reference numeral 94 by which the amount of return air in each of them may be individually regulated. It will be understood, however, that these valves may be placed anywhere in these conduits or they may be omitted entirely. The pairs of return conduits are connected to the fan 56, preferably to the eye thereof, as shown in FIGS. 3 and 4, whereby air is drawn from chamber 50 to fan 56. The air system, therefore, becomes a substantially closed system. If necessary, a suitable air inlet may be provided either in the fan or in the casing 50, but it is believed that such will not be necessary, as I prefer a substantially closed air system, and for the additional reason that some air will find its way between the conveyor 52 and the lower end of the casing 50 and in chutes 46 and 48.

As indicated in FIGS. 3 and 4, the main body of the air issues from the horizontal conduit portions 70 and 72 and moves horizontally, as shown by the arrows B in FIG. 3, due to the return conduits 86, 88, 90 and 92. This air carries the finer particles which are too light to drop onto the belt. These finer particles are then mixed with the downwardly falling flakes as they fall through the chutes 46, 48, and some of them adhere to these flakes. The principal reason for recirculation, however, is to cut down turbulence in the casing 50, as only about 1% or less of the material is recirculated.

The mat A^4 which is produced by this system and method prevents telegraphing through the face veneer, plastic overlay, or paper covers, if one of them is used, even though the same is only $\frac{1}{32}$ inch thick.

The term "telegraphing" in this art indicates the protrusion through the veneer, plastic overlay, or paper of one or more of the wood particles. The particles as laid in accordance with the above described invention tend to lie on the belt 52 with their longitudinal axes in alignment with the direction of movement of the belt.

The mat, such as that shown at A^4, after being subjected to a pressing operation, is cut transversely to proper length, to form panels, and may then be subjected to a veneering machine and finished with a lacquer coating step involving a pigmented toner and a low built mat finish of the type used by furniture manufacturers.

Panels reserved for plastic overlaying, of three-ply construction as described herein, may be supplied to a commercial fabricator who supplies the plastic overlay face, such as $\frac{1}{16}$ inch, more or less, of a Formica overlay, and about 0.020 inch thick phenolic backing using a urea glue. Low pressures were used, in accordance with normal procedure, to reduce the possibility of the core particles telegraphing through the plastic overlay face or paper covers.

It is the usual practice in the manufacture of panels of the type herein described, after the steps of compressing and cutting, to follow with plastic overlaying, veneering, or paper covers, and then to apply tests in accordance with the end use for which the panels have been manufactured, i.e., furniture core stock, or plastic overlay corestock, or corestock to be used in the building industry. The initial moisture content of all boards to be so used should range from 5% to 7%.

Building test strength depends upon variations in thicknesses of the cores and faces, i.e. the portion indicated by A^3 and faces A^1, A^1, respectively, and different species of wood used. There are many other variations which must be considered also that will determine strength, such as the amount of compression used, and the amount of adhesive used.

The term "wood particles" includes in major proportions wood products, but may also include in minor proportions various amounts of various mineral, vegetable, or animal particles mixed with a major proportion of wood particles.

The size of wood particles has been shown larger than actual size in the drawings for illustrative purposes. Generally speaking, the particle size will be controlled in accordance with the use to be made of the boards, as well as by other variables, such as economy, source of supply, etc.

The above description and drawings disclose a single embodiment of the invention, and specific language has been employed in describing the several figures. It will, nevertheless, be understood that no limitations of the scope of the invention are thereby contemplated, and that various alterations and modifications may be made such as would occur to one skilled in the art to which the invention relates.

I claim:

Apparatus comprising a mat forming unit, means for delivering particles to said unit to fall by gravity therethrough, means for directing vertically spaced streams of air horizontally from adjacent the center of said unit toward each end thereof to effect size distribution of said particles, means for recirculating air from each end of said unit and means for adjusting the relationship of said

vertically spaced horizontal air streams with respect to the falling particles delivered to said unit.

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