Jan. 24, 1967 W. M. GAITTEN 3,299,478

APPARATUS FOR FORMING PARTICLE BOARDS

Filed July 9, 1963 3 Sheets-Sheet 1

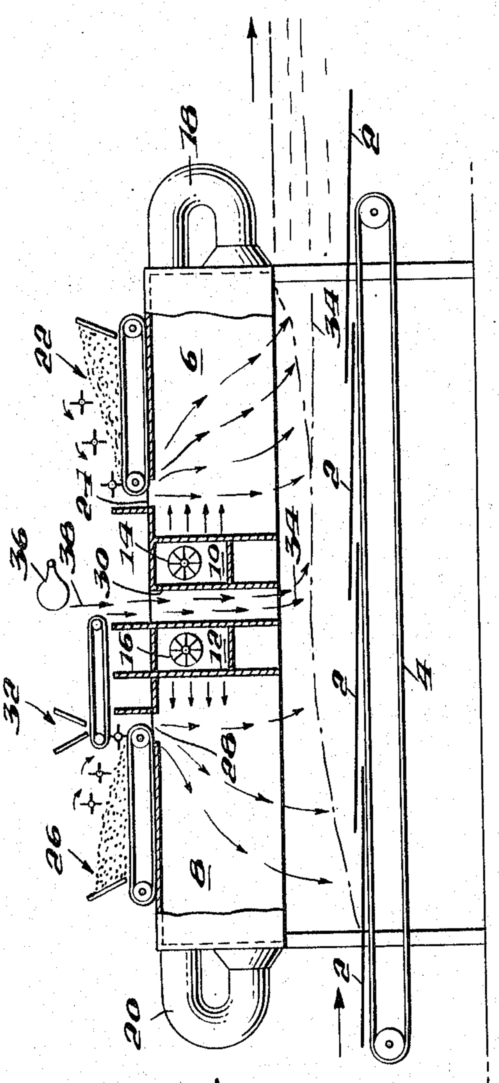

Fig. 1.

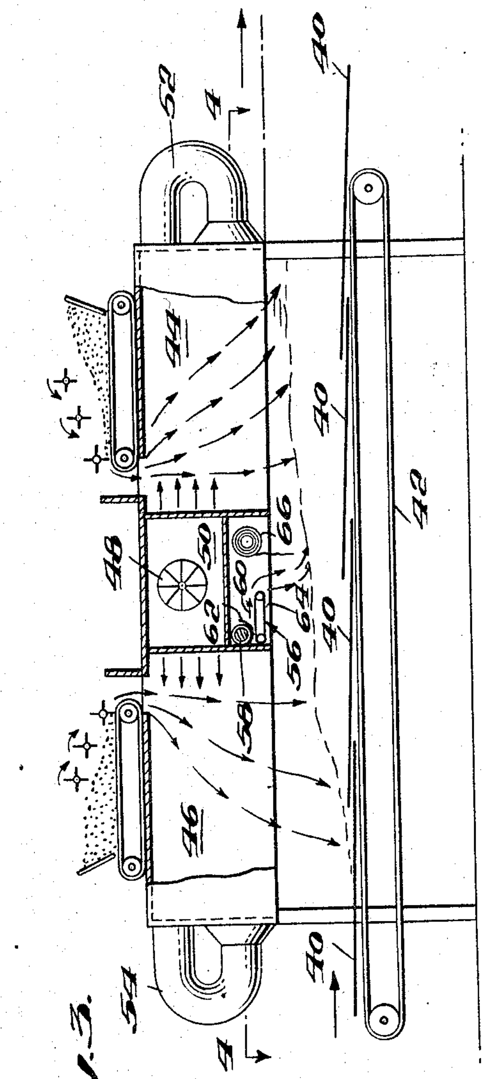

Fig. 3.

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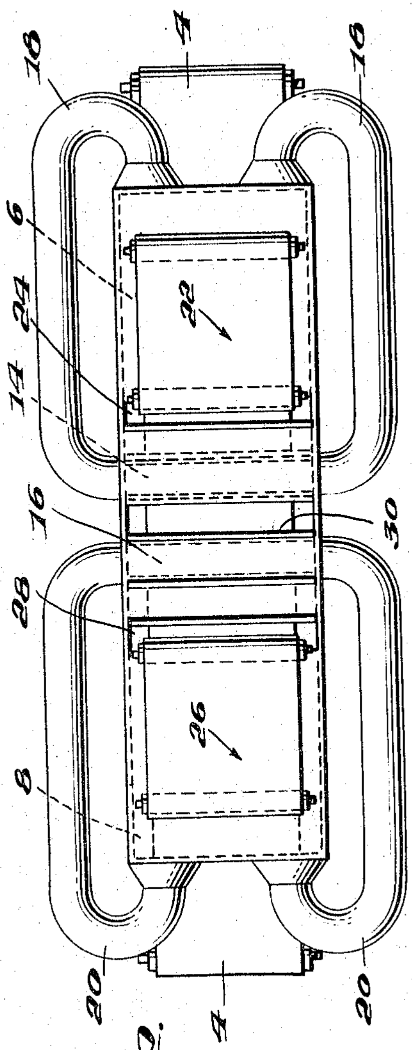

Fig. 2.

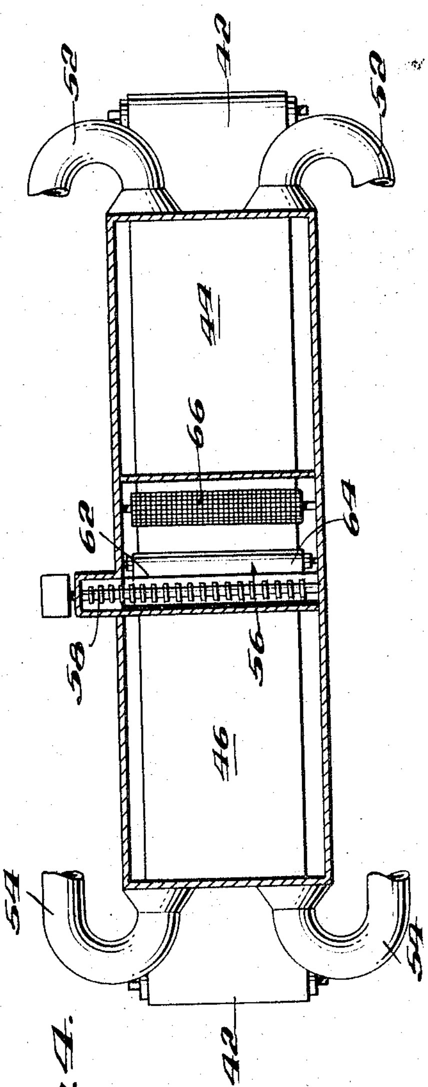

Fig. 4.

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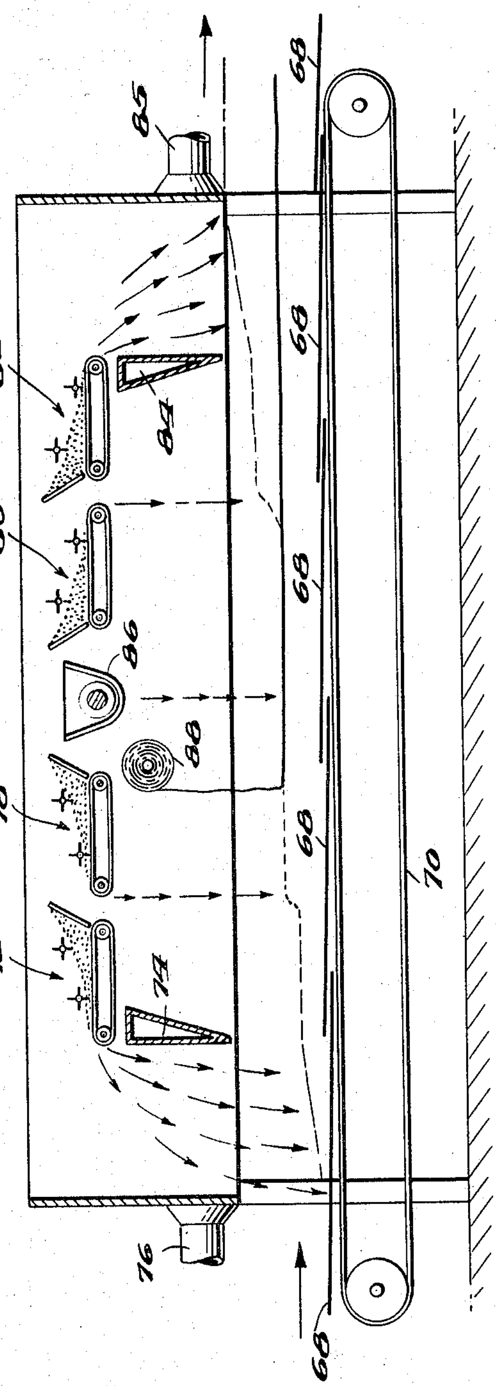
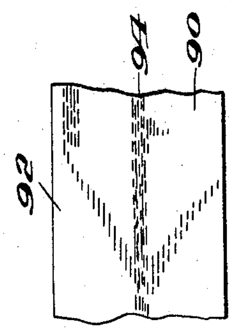


Fig. 5.

Fig. 6.



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APPARATUS FOR FORMING PARTICLE BOARDS

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This invention relates to particle board manufacture and more particularly to a method and apparatus for forming a mat of particles having a filled core, and to articles formed thereby.

An improved known type of particle board is formed of two half mats. The particles in the board are graduated in size from large particles at the center of the board to small particles adjacent the exposed surfaces of the board. This improved type of board has smoother surfaces, greater strength and better insulating properties than the more conventional particle boards in which the particles are of random size distribution. Apparatus and method for producing particle boards of this type are described in Greten Patent No. 3,028,287.

The size distribution of the particles is accomplished by delivering particles of various sizes into the top of a chamber in which a current of gas, such as air, is directed along the length of the chamber, so that the larger, heavier particles fall a shorter distance to the mat surface under the chamber and the smaller, lighter particles are carried along by the current of air a greater distance from the point of insertion of the particles in the chamber. A mat disposition surface moves longitudinally of the chamber in the opposite direction of the air flow, so that the smaller particles are deposited first and the larger particles fall on top of the smaller particles to form a half mat graduated from smaller to larger particles toward the top of the mat. A similar mat forming chamber facing oppositely from the first chamber deposits another half mat on top of the first half mat, with the particles graduated in size from large particles on the bottom of the half mat to small particles on the top of the half mat.

Particle boards of this type may be used as a core material for veneer furniture, and during the fabrication of furniture it is often necessary to cut into the board, such as by routing or sawing. It may be necessary to apply veneer to a severed edge of the particle board. The chips at the center of the mat are of a relatively large size, however, and a large percentage of the volume of the center portion of the mat is made up of voids. Consequently, the bonding between the individual particles is not as effective as it is between the smaller particles near the surfaces of the mat. Also, because of the openness of the center of the particle board, thin veneers are not bonded uniformly when they are applied along the severed edge of a mat. Additionally, there is a danger of splitting the veneer due to the inadequate support provided by the large particles at the center of the board. Further, the openness of the board allows it to absorb moisture or water, causing it to swell and lose dimensional stability. Still further, since the large particles are randomly oriented, the particle boards may have a low bending strength because of insufficient bonded area between particles. This is true even when the customary small amounts of conventional binder are used, whereas it is uneconomical to use high binder concentrations such as would be necessary materially to alleviate this core porosity problem.

In view of these defects, it is an object of this invention to provide a method and apparatus for producing double graduated particle size, or 3 layer mats which have a substantially uniform density and porosity throughout their thickness.

It is another object of this invention to provide a particle board which is easily machined.

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It is yet another object to provide a particle board possessing improved dimensional stability even in the presence of moisture.

It is a further object to provide a particle board which is mechanically strong yet light in weight.

It is a still further object to provide a particle board which has a smooth exterior surface.

These objects are accomplished in accordance with a preferred embodiment of the invention by introducing a foamable resin composition between the half mats, while they are being formed. The foamable resin composition, or a resin composition with a foaming agent or additive mixed with or added separately thereto, is spread or poured on the surface of the first half mat in the region between the first mat forming chamber and the second mat forming chamber. The resulting mat has a layer of foamable resin composition between the two half mats which eventually, upon foaming, substantially uniformly penetrates the viods between the larger particles in the opposing faces of the mat. Subsequent to its formation, the resin impregnated mat is conveyed to a press where it is heated and compressed. Due to the pressure and heat applied to the mat in the press, the formable resin composition expands to fill the voids or form a closed cell structure between the large particles, flowing through the mat from the center toward the surfaces and substantially closing or filling the voids between the particles. In cooperation with the caul boards on opposite faces of the mat, the excess resin fills irregularities in the surface of the mat.

A board made in accordance with this invention should have a dimensional tolerance at least 15 percent better than a conventional board.

This preferred embodiment of the invention is illustrated in the accompanying drawings in which:

FIG. 1 is a side elevational view, partially cross-sectional, of a mat forming unit of this invention;

FIG. 2 is a top plan view of the mat forming unit of FIG. 1;

FIG. 3 is a side elevational view, partially cross-sectional, of a modified form of mat forming unit;

FIG. 4 is a cross-sectional view of the unit along the line 4—4 in FIG. 3;

FIG. 5 is a side elevational view, partially cross-sectional, of a second modified form of mat forming unit; and

FIG. 6 is an enlarged cross-sectional view of an unpressed mat in accordance with this invention.

One form of mat forming unit is shown schematically in FIGS. 1 and 2. A plurality of cauls **2** are supported in end-to-end overlapping relation on an endless conveyor **4**. Fiber deposition chambers **6** and **8** are provided at their adjacent ends with individual plenum chambers **10** and **12**. Air is circulated through the chambers **6** and **8** by blowers **14** and **16**, respectively. The air flows from the blower **14** through the chamber **6** and into ducts **18** which return the air to the plenum chamber **10** for recirculation. Similarly, ducts **20** return the air to the plenum chamber **12** for recirculation. A particle dispenser **22** is mounted on top of the chamber **6** and dispenses particles of a variety of sizes which have been mixed in a previously known manner with a small amount of adhesive through an opening **24** in the top of the chamber **6**. A corresponding particle dispenser **26** is mounted on top of the chamber **8** and dispenses particles together with an adhesive through an opening **28** in the top of the chamber **8**. In this operation an adhesive is usually added in an amount which just wets the particles sufficiently to produce a firm bond therebetween when pressed.

The particles in the dispensers **22** and **26** are of various sizes and have been thoroughly mixed with up to about 10%, e.g. 6 to 10%, of an adhesive in such a manner that the various sizes of particles are properly wetted with the adhesive while still remaining substantially discrete to permit proper distribution in the mat laying step. As the particles are discharged through the openings 24 and 28, they fall into the current of air which flows between the plenum chambers 10 and 12 and their respective outlets to the ducts 18 and 20. The smaller, lighter particles are carried along by the air current a distance which is proportional to the size and weight of the particle. The larger, heavier particles are deflected to a lesser extent by the air current and therefore fall more directly to the mat. The smaller, lighter particles are deposited first on the cauls 2 under the chamber 8 and, since the upper run of the conveyor 4 moves toward the right as viewed in FIG. 1, the larger, heavier particles which fall more directly through the air stream are deposited on top of the previously deposited smaller particles to form the lower half mat.

Between the plenum chambers 10 and 12 is a vertical shaft 30, above which a resin dispenser 32 is mounted. Any suitable type of dispenser may be used, but since the resin composition 34 is ordinarily a somewhat viscous liquid. a dispenser which delivers a continuously flowing web of material is preferred. The resin composition 34 flows through the shaft 30 and is deposited on the surface of the first half mat. As the conveyor 4 advances, additional particles are deposited under the chamber 6, with the heavier particles being deposited directly over the resin composition 34 and the lighter particles being deposited on top of the heavier particles. The cauls 2 supporting the mat containing the resin composition are then transported to the press. If cauls 2 are not used, the mat is formed directly on the conveyor 4 and conveyed to a press. A rack 36 may be provided on the mat forming unit for mounting a roll of sheet material 38 in position over the shaft 30 so that the sheet material may be dispensed through the shaft 30 for insertion in the mat between the mat forming chambers 6 and 8.

In a modified form of the invention, as shown schematically in FIGS. 3 and 4, a plurality of cauls 40 are supported on a conveyor 42 beneath mat forming chambers 44 and 46. The air current is generated by a blower 48 in a plenum chamber 50 and the air is recirculated to the plenum chamber 50 by conduits 52 and 54. The plenum chamber 50 does not extend the full depth of the deposition chambers 44 and 46 and a resin composition dispensing unit 56 is mounted below the plenum 50. The dispenser 56 includes a feed-screw 58, as shown in FIG. 4, for conveying the resin 60 from a hopper 62 to the interior of the mat forming unit where it flows onto a moving belt conveyor 64. From the conveyor 64, the resin 60 flows onto the large particles adjacent the surface of the first half mat. A roll of sheet material 66, such as fabric or wire mesh, is also mounted under the plenum chamber 50 to be fed into the mat between the two half mats.

A second modified form of the invention is shown in FIG. 5. In this modified form, four layers of particles are deposited on cauls 68, which are on a moveable conveyor 70. The particles in the outer layers are air layed and the particles in the center layers are gravity layed. A particle dispenser 72 is mounted over a plenum chamber 74 having a plurality of openings which direct the air toward a recirculation duct 76 in the same manner as the apparatus shown in FIGS. 1 and 2. A second particle dispenser 78 deposits particles directly on the preceding graduated particle size layer. Since the particles fall directly downward from the dispenser 78, the second layer consists of a homogenous mixture of particles. Similarly, a homogenous layer particle dispenser 80 and a graduated layer particle dispenser 82 are mounted in the opposite end of the apparatus. A plenum chamber 84 directs a stream of air toward a recirculating duct 85. In the center of the apparatus, between the particle dispensers, a hopper 86 is provided for dispensing resin to the mat of particles between the center layers. If desired, a roll of screen material 88 may be mounted adjacent the hopper 86 for being inserted between the homogenous layers.

The two layer mat which is formed from the wood particles for example by the apparatus of FIGS. 1 to 4, in accordance with this invention is shown in FIG. 6. Before it is heated and compressed, the loose mat consists of three layers, a lower half mat 90 of particles mixed with an adhesive, an upper half mat 92 of particles mixed with an adhesive, both half mats being graduated in size from large particles at the center to small particles adjacent the outside surfaces, and an intermediate layer 94 of a foamable resin composition. When the mat is compressed in the press, sufficient heat is applied to the mat to cause the resin composition to foam and expand, filling the voids between the wood particles. As the mat is compressed, the resin also flows through the mat to the exterior surfaces, covering the irregularities in the surface of the mat to form a smooth surface. It is preferred that the resin composition contain a separate foaming or swelling agent and wood flour or other powder-like filler of minute particle size. The adhesive preferably sets in the hot press and bonds the expanded resin composition to the adjacent wood particles, thereby forming a pressed mat having improved strength characteristics and having a smooth surface and a filled interior with greatly reduced porosity. If the resin is also a suitable adhesive, as for example, urea-formaldehyde, the addition of a separate adhesive may be omitted.

Examples of suitable resins for use in the foamable compositions include polystyrene, polyurethane and urea-formaldehyde. Foaming or expanding agents for polystyrene, for example, include volatile aliphatic saturated hydrocarbons which may be incorporated in the polystyrene during or after polymerization. When formed, such polystyrene may have a density of about 8 to 16 or more pounds per cubic foot depending on amount of foaming agent, added powdered filler, etc. Typical foamable polystyrene and urea-formaldehyde compositions are described in Patent No. 3,023,136. Foaming agents for polyurethane are described in Patent No. 3,078,240. Wood flour or other suitable fillers may be used. The weight proportions of filler to resin are preferably about equal. It is also preferred that that the air voids in the mat as it comes from the mat forming machine be of the order of 10 percent to 25 percent of the volume of the mat. Sufficient resin composition is added to substantially fill the voids upon foaming. A thermoplastic resin filler, such as Vinsol resin, manufactured by Hercules Power Company, may be substituted for all or part of the wood flour. The fact that the added resin forms a foam within the mat upon heating has the advantage over the addition of non-foaming resin in that the former provides an increased driving force for the resin composition to penetrate the voids throughout the mat and also that the resulting somewhat porous resin fill is desirably light in weight and requires relatively little resin to obtain the desired effect.

As a specific example of the manufacture of a mat in accordance with this invention, 1½ parts of urea-formaldehyde resin, such as Borden's No. 5, are mixed with about 3% by weight of a suitable foaming agent, such as ammonium carbonate, and 1½ parts of wood flour of 42 to 90 mesh particle size to form a suitable resin composition which is capable of foaming. The resin composition is placed in the dispenser 32 of the apparatus shown in FIGS. 1 and 2, for example. Cauls 2 are placed on the moving conveyor 4. Air is circulated through the particle dispensing chambers 6 and 8 by the fans 14 and 16, respectively, in substantially the same manner as described in Patent No. 3,028,287.

Wood chips or other particles of various sizes are deposited in the dispensers 22 and 26 and as they fall through the chambers 6 and 8 they are separated according to size, with the large size particles near the center of the mat and the small size particles near the outer surface of the mat. While the wood chips are being dispensed to form the mat, the resin composition dispenser **32** causes a stream of resin composition **34** to fall through the shaft **30** and onto the mat on top of the layer deposited by the chamber **8**. If desired, a screen or sheet material **38** may be fed into the mat through the shaft **30**. Subsequently an upper layer of wood chips is deposited by the chamber **6** to form a complete mat.

The loose mat which leaves the mat forming machine preferably contains about 15 percent by volume of voids between the wood chips. The mat is then compressed in a heated press under sufficient pressure to reduce the thickness of the mat to about 25 percent of its original thickness. During the compression of the mat, the resin composition foams to provide a substantially uniform and light weight filling in the voids in the mat to improve the structural characteristics of the resulting board.

While this invention has been illustrated and described in several embodiments, it is recognized that variations and changes may be made therein without departing from the invention as set forth in the claims.

I claim:

1. Apparatus for forming a particle mat comprising means for supporting the mat, a first chamber, a second chamber, said mat supporting means extending under said first and second chambers, means for dispensing particles of varied sizes into each chamber, means directing a stream of air through each of said chambers, the direction of air flow in said first chamber being opposite and away from the direction of air flow in the second chamber, said chambers having openings adjacent said mat-supporting means to allow said particles to pass from said chambers to said mat supporting means, means for effecting relative motion between the chambers and the mat supporting means, means for dispensing a resin composition in a continuous stream, said dispensing means including a screw conveyor and a belt conveyor, said belt conveyor being interposed between said screw conveyor and the mat supporting means, means for feeding a web of material onto the mat between the first and second chambers, and means mounting the dispensing means and feeding means in position for directing the composition stream and the web of material to the mat between said first and second chambers.

2. Apparatus for forming a particle mat comprising means for supporting the mat, a first chamber, a second chamber, said mat supporting means extending continuously under said chambers, each of said chambers having means for dispensing particles onto the mat supporting means, plenum chambers adjacent said first and second chambers, said plenum chambers including means for directing a stream of air through said first and second chambers, first and second auxiliary dispensers, means mounting said auxiliary dispensers over said mat supporting means and between said chambers, each of said plenum chambers directing a stream of air away from the other plenum chamber, a hopper between said first and second auxiliary dispensers for dispensing resin composition onto said mat supporting means, means between said first and second auxiliary dispensers for feeding a web of material onto said mat supporting means, and means for effecting relative motion of the mat supporting means with respect to said chambers and said dispensers, whereby particles of non-uniform size are distributed according to size in the first and second chambers while uniform particles are distributed in intermediate, homogenous layers by said first and second dispensers and a layer of resin composition and a web of material is applied to the surface of the mat between said first and second auxiliary dispensers.

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