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(54) **Articles, such as pallets, molded from wood flakes and a method of molding such articles.**

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Description

This invention relates to articles molded from flake-like wood particles and, more particularly, to such articles having non-planar portions, such as material handling pallets and the like. The invention also relates to the method of molding such articles.

It is well known to manufacture flat or substantially flat structural boards or so-called particle board from comminuted wood by mixing the wood particles with a suitable resinous binder, such as a synthetic thermosetting resin, forming the mixture into a multi-layered mat and then compressing the mat between heated platens to set the binder and bond the wood particles together.

Molding of pallets and other articles including non-planar portions presents problems of little or no concern in the manufacture of flat or substantially flat particle board. For instance, one difficulty involved in molding pallets is the necessity to pull or draw a plurality of hollow legs having acceptable crushing strengths from a substantially flat mat of wood particles without adversely affecting the strength of the deck member or the legs. Consequently, the above type process for manufacturing particle board heretofore has not been employed to manufacture pallets or other similar articles from wood particles.

Methods of molding a pallet from a material made up from dried, comminuted papermill sludge blended with fibrous reinforcing material in a resinous binder is shown in US—A—4221751. Other pallet molding methods are also shown in FR—A2 397 991, 2 039 258 and DE—A—2 845 704. These methods use finely comminuted wood. In these methods, which use fine starting materials, it is necessary to use a large amount of binder to hold the particles together.

According to one aspect of the invention, there is provided a molded article including a body portion having a major plane and at least one non-planar portion extending in a direction away from the major plane, said body and non-planar portions being formed as a one-piece unit characterised in that it comprises a layered mixture of a resinous particle board binder and flake-like wood particles having an average length of about 1-1/4 inch (3.18 cm) to about 6 inches (15.24 cm), an average thickness of about 0.005 inch (0.013 cm) to about 0.075 inch (0.191 cm), and an average width of about 3 inches (7.62 cm) or less and no greater than the length, each layer of said wood particles forming at least said body portion lying substantially flat in a plane generally parallel to the major plane with said wood particles therein being randomly oriented.

The present invention also provides a molded article in the form of a pallet comprising a deck member having a major plane, and a plurality of hollow leg members projecting from said deck member, said deck member and leg members forming a one-piece unit, each of said leg members having a bottom wall spaced from said deck member and one or more side walls integrally connecting said bottom wall with said deck member and inclining outwardly from said bottom wall toward said deck member characterized in that said one-piece unit comprises a layered mixture of a resinous particle board binder and flake-like wood particles having an average length of about 1-1/4 inches (3.18 cm) to about 6 inches (15.24 cm), an average thickness of about 0.005 inch (0.013 cm) to about 0.075 inch (0.191 cm), and an average width of about 3 inches (7.62 cm) or less and no greater than the average length, each layer of said wood particles forming at least said deck member lying substantially flat in a plane generally parallel to the major plane with said wood particles therein being randomly oriented.

According to another aspect, the present invention provides a method for molding an article having a major plane and at least one non-planar portion extending in a direction away from the major plane, said method comprising the steps of

(a) providing particles;

(b) admixing a resinous particle board binder with the particles;

(c) depositing a loosely-felted, layered mat formed from said mixture on one open part of a mold including two separate parts defining a mold chamber having the shape of the article; and

(d) closing the mold and applying sufficient heat and pressure on said mat to compress it into substantially the desired shape and size of the article and to bond the particles together to form a unitary structure;

characterised in that the particles are flake-like wood particles having an average length of about 1-1/4 inch (3.18 cm) to about 6 inches (15.24 cm), an average thickness of about 0.005 inch (0.013 cm) to about 0.075 inch (0.191 cm), and an average width of about 3 inches (7.62 cm) or less and no greater than the length; and in that the wood particles in each layer of the mat are substantially flat in a plane generally parallel to the major plane and are randomly oriented.

The sidewalls of the leg members can extend at an angle of about 78° or less relative to the major plane of the deck member and can have an average thickness which is about 70 to 110%, preferably about 80—85%, of the average thickness of the deck member.

The pallet conveniently contains about 2 to about 15 weight % of the binder, and optionally about 0.5 to about 2 weight %, based on the dry weight of the wood flakes, of a wax to provide water proof protection. Organic polyisocyanates, either alone and in combination with urea-formaldehyde, are the preferred binder.

In a preferred method, the wood flakes are admixed with a resinous particle board binder, the resulting mixture or furnish is deposited as a loosed-felted, layered mat on one part of an open mold or press including two separable parts defining a mold chamber having the shape of the pallet, the mold is closed, and pressure is applied to the mat to compress it into substantially the desired shape and size of the pallet and to bond the wood flakes together.

In one embodiment, a mat of substantially uniform thickness is formed outside the mold in a manner whereby the flakes in each layer lie substantially flat and are randomly oriented and this mat is placed between the male and female dies of the mold.

In another embodiment, a mat is formed outside the mold as described in the previous paragraph and mounds of mixture are added on top of the mat at locations corresponding to the leg-forming cavities of the female die.

In a further embodiment, the leg-forming cavities of the female die are first substantially filled with furnish and the mat is then placed between the male and female dies.

In a still further embodiment, the mat is formed directly on the female die or a remote caul which has a shape conforming with the female die and is subsequently placed over the female die. This technique and those described in the two preceding paragraphs are particularly advantageous for molding leg members having a length or depth up to about 5 inches (12.7 cm) or more.

This invention will now be described in detail with reference to the accompanying drawings, in which:—

Figure 1 is perspective view of a pallet incorporating various features of the invention.

Figure 2 is a sectional view taken generally along line 2—2 in Figure 1.

Figure 3 is a schematic flow diagram illustrating the various steps of a preferred process for molding pallets of the invention from residue and surplus woods.

Figures 4—7 are simplified, schematic side views of the mold or press, illustrating various techniques for depositing a mat of the wood flakes on the female die prior to closing the mold.

The invention relates broadly to articles, particularly support members, including a main body having a major plane and non-planar portions spaced from that major plane, both molded as a one-piece unit from wood flakes. The invention is particularly adaptable to material handling pallets and will be described in connection therewith.

Illustrated in Figures 1 and 2 is pallet 10 including a generally flat, rectangular deck member 12 having a substantially uniform wall thickness and a flat upper surface 14 which serves as a supporting plane. Projecting downwardly from the deck member 12 is a plurality (e.g. 9) of hollow leg members 16 adapted to serve as supporting pads for the pallet. In the specific construction illustrated, each of the leg members 16 (Figure 2) includes a bottom wall 18 having a flat bottom surface 20 and two opposed pairs of flat side walls 22 and 24. The bottom surface 20 of the bottom wall 18 is spaced from the underneath surface of the deck member 12 a sufficient distance to permit entry of the tines of a fork lift beneath the deck member.

The deck member 12 and leg members 16 are molded as a one-piece unit from a mixture of a suitable resinous particle board binder and flake-like wood particles as described below. The side walls 22 and 24 of the leg members 16 are inclined or tapered to facilitate molding and to also permit nesting of several pallets into a compact stack so as to minimize the space required for shipment and storage. In the specific construction illustrated, the side walls 22 and 24 are substantially flat and the leg members 16 have the general form of an inverted, truncated hollow pyramid. If desired, the leg members 16 can be formed with other suitable cross-sectional shapes, e.g., in the form of an inverted, truncated hollow cone.

Figure 3 diagrammatically illustrates the various steps of the process of the invention for manufacturing the pallet 10 from inexpensive residue and surplus woods. The process broadly includes the steps of comminuting small logs, branches or rough pulpwood into flake-like particles, drying the wood flakes to a predetermined moisture content, classifying the dried flakes to obtain wood particles having a predetermined size, blending predetermined quantities of a suitable resinous particle board binder, and optionally a liquid wax composition, with the dried and sized flakes, forming the resultant mixture of binder, wax and wood flakes or furnish into a loosely-felted, layered mat (single or multi-layers), placing the mat in an open mold or press including separable male and female dies defining a mold chamber having the desired shape of the pallet, closing the mold and applying sufficient pressure to the mat to compress it into substantially the desired shape and size of the pallet, removing the molded pallet from the press, and trimming the peripheral edges of the pallet with a power saw or the like to the desired final dimensions.

The wood flakes used can be prepared from various species of suitable hardwoods and softwoods used in the manufacture of particle board. Representative examples of suitable woods include aspen, maple, oak, elm, balsam, fir, pine, cedar, spruce, locust, beech, birch, and mixtures thereof.

Suitable wood flakes can be prepared by various conventional techniques. In the specific process illustrated, the wood flakes are prepared by one of two different techniques. In the technique illustrated in the upper left hand portion of Figure 3, pulpwood grade logs, or so-called roundwood, are converted into flakes in

one operation with a conventional roundwood flaker. In the technique illustrated in the upper right hand portion of Figure 3, logs, logging residue or the total tree are first cut into fingerlings in the order of 2—6 inches (5.08—15.24 cm) long with a conventional device, such as the helical comminuting shear disclosed in U.S. Patent 4,053,004, and the fingerlings are flaked in a conventional ring-type flaker.

Roundwood flakes generally are higher quality and produce stronger pallets because the lengths and thickness can be more accurately controlled. Also, roundwood flakes tend to be somewhat flatter which facilitates more efficient blending and the logs can be debarked prior to flaking which reduces the amount of less desirable fines produced during flaking and handling. Acceptable flakes can be prepared by ring flaking fingerlings and this technique is more readily adaptable to accept wood in poorer form, thereby permitting more complete utilization of certain types of residue and surplus woods.

Irrespective of the particular technique employed for preparing the flakes, the size distribution of the flakes is quite important, particularly the length and thickness. The wood flakes should have an average length of about 1-1/4 inch (3.18 cm) to about 6 inches (15.24 cm) and an average thickness of about 0.005 inch (0.013 cm) to about 0.075 inch (0.191 cm). In any given batch, some of the flakes can be shorter than 1-1/4 inch (3.18 cm) and some can be longer than 6 inches (15.24 cm) so long as the overall average length is within the above range. The same is true for the thickness.

The presence of major quantities of flakes having a length shorter than about 1-1/4 inch (3.18 cm) tends to cause the mat to pull apart as the leg members are being drawn therefrom during the molding step. This undesirable condition is particularly prevalent at the corner junctures of the leg members and the deck member as described in more detail below. The presence of some fines in the mat produces a smoother surface and, thus, may be desirable for some applications so long as the majority of the wood flakes, preferably at least 75%, is longer than 1-1/8 inch (2.86 cm) and the overall average length is at least 1-1/4 inch (3.18 cm).

Substantial quantities of flakes longer than about 6 inches (15.24 cm) tend to cause interleaving or felting of the flakes during handling prior to formation of the mat and can complicate drawing of the leg members. For example, such interleaving can prevent adequate coating of the flakes with the binder during the blending step with a resultant inadequate bonding of the flakes during molding. The average length of the wood flakes preferably is about 2 to about 3 inches (5.08—7.62 cm).

Substantial quantities of flakes having a thickness of less than about 0.005 inch (0.013 cm) should be avoided because excessive amounts of binder are required to obtain adequate bonding. On the other hand, flakes having a thickness greater than about 0.075 inch (0.191 cm) are relatively stiff and tend to overlie each other with substantial inclination when formed into the mat. Consequently, excessively high mold pressures are required to compress the flakes into the desired intimate contact with each other. For flakes having a thickness falling within the above range, thinner ones produce a smoother surface while thicker ones require less binder. These two factors are balanced against each other for selecting the best average thickness for any particular application. The average thickness of the flakes preferably is about 0.015 to about 0.25 inch (0.038—0.64 cm), most preferably about 0.020 inch (0.051 cm).

The width of the flakes is less important. The flakes should be wide enough to insure that they lie substantially flat when felted during mat formation. The average width generally should be about 3 inches (7.62 cm) or less and no greater than the average length. For best results, the majority of the flakes should have a width of about 1/16 inch (0.16 cm) to about 3 inches (7.62 cm).

The thickness of the flakes can be controlled primarily by the blade setting on the flaker. The length and width of the flakes are also controlled to a large degree by the flaking operation. For example, when the flakes are being prepared by ring flaking fingerlings, the maximum lengths are generally set by the length of the fingerlings. Other factors, such as the moisture content of the wood and the amount of bark on the wood affect the amount of fines produced during flaking. Dry wood is more brittle and tends to produce more fines. Bark has a tendency to more readily break down into fines during flaking and subsequent handling than wood.

While the flake size can be controlled to a large degree during the flaking operation as described above, it usually is necessary to use some sort of classification in order to remove undesired particles, both undersized and oversized, and thereby ensure the average length, thickness and width of the flakes are within the desired ranges. When roundwood flaking is used, both screen and air classification usually is required to adequately remove both the undersize and oversize particles, whereas fingerling flakes usually can be properly sized with only screen classification.

Flakes from some green woods can contain up to 90% moisture. The moisture content of the mat must be substantially less for molding as discussed below. Also wet flakes tend to stick together and complicate classification and handling prior to blending. Accordingly, the flakes are preferably dried prior to classification in a conventional type drier, such as a tunnel drier, to the moisture content desired for the blending step. The moisture content to which the flakes are dried usually is in the order of

about 6 weight % or less, preferably about 2 to about 5 weight %, based on the dry weight of the flakes. If desired, the flakes can be dried to a moisture content in the order of 10 to 25 weight % prior to classification and then dried to the desired moisture content for blending after classification. This two-step drying may reduce the overall energy requirements for drying flakes prepared from green woods in a manner producing substantial quantities of particles which must be removed during classification and, thus, need not be as thoroughly dried.

A known amount of the dried, classified flakes is introduced into a conventional blender, such as a paddle-type batch blender, wherein predetermined amounts of a resinous particle binder, and optionally a wax and other additives, is applied to the flakes as they are tumbled or agitated in the blender. Suitable binders include those used in the manufacture of particle board and similar pressed fibrous products and, thus, are broadly referred to herein as "resinous particle board binders". Representative examples of suitable binders include thermosetting resins such as phenol-formaldehyde, resorcinol-formaldehyde, melamineformaldehyde, urea-formaldehyde, urea-furfural and condensed furfural alcohol resins, and organic polyisocyanates, either alone or combined with urea- or melamine-formaldehyde resins. Particularly suitable polyisocyanates are those containing at least two active isocyanate groups per molecule, including diphenylmethane diisocyanates, m- and p-phenylene diisocyanates, chlorophenylene diisocyanates, toluene di- and triisocyanates, triphenylmethane, triisocyanates, diphenyl-ether-2,4,4'-triisocyanate and polyphenyl-polyisocyanates, particularly diphenylmethane-4,4'-diisocyanate.

The particular type binder used depends primarily upon the intended use for the pallet. For instance, pallets employing urea-formaldehyde resins have sufficient moisture durability for many uses which involve minimal exposure to moisture, but generally cannot withstand extended outdoor exposure and reusability is quite limited. Phenol-formaldehyde and melamine-formaldehyde resins provide good moisture resistance but require substantially longer cure times. Polyisocyanates, even in lesser amounts, provide greater strengths and moisture resistance than the urea- or phenol-formaldehyde resins and the resultant pallets can be reused for an extended number of cycles. Polyisocyanates cure in about the same time as urea-formaldehyde resins. However, polyisocyanates are more expensive and require the use of a mold release agent because of their tendency to stick to metal parts. These factors are balanced against each other when selecting the specific binder to be used.

A binder system including both a urea-formaldehyde resin and a polyisocyanate, at a solids weight ratio of about 4:1 to about 1:1, is advantageous for many applications because, although less costly than polyisocyanate alone, it provides strength characteristics and moisture resistance which is superior to those obtainable from either urea- or phenol-formaldehyde resins alone and the pallets are reusable.

The amount of binder added to the flakes during the blending step depends primarily upon the specific binder used, size, moisture content and type of the flakes, and the desired characteristics of the pallet. Generally, the amount of binder added to the flakes is about 2 to about 15 weight %, preferably about 4 to about 10 weight %, as solids based on the dry weight of the flakes. When a polyisocyanate is used alone or in combination with a urea-formaldehyde resin, the amounts can be more toward the lower ends of these ranges.

The binder can be admixed with the flakes in either dry or liquid form. To maximize coverage of the flakes, the binder preferably is applied by spraying droplets of the binder in liquid to form onto the flakes as they are being tumbled or agitated in the blender. When polyisocyanates are used, a conventional mold release agent preferably is applied to the die or to the surfaces of the formed mat prior to pressing. To improve water resistance of the pallet, a conventional liquid wax emulsion preferably is also sprayed onto the flakes during the blending step. The amount of wax added generally is about 0.5 to about 2 weight %, as solids based on the dry weight of the flakes. Other additives, such as a coloring agent, fire retardant, insecticide, fungicide and the like may also be added to the flakes during the blending step. The binder, wax and other additives, can be added separately in any sequence or in combined form.

The moistened mixture of binder, wax and flakes or furnish from the blending step is formed into a loosely-felted, single or multi-layered mat which is compressed into a pallet. The moisture content of the flakes should be controlled within certain limits so as to obtain adequate coating by the binder during the blending step and to enhance binder curing and deformation of the flakes during molding.

The presence of moisture in the flakes facilitates their blending to make intimate contact with each other and to form the leg members and enhances uniform heat transfer throughout the mat during the molding step, thereby ensuring uniform curing. However, excessive amounts of water tends to degrade some binders, particularly urea-formaldehyde resins, and generates steam which can cause blisters. On the other hand, if the flakes are too dry, they tend to absorb excessive amounts of the binder, leaving an insufficient amount on the surface to obtain good bonding and the surfaces tend to case harden which inhibits the desired chemical reaction between the binder and cellulose in the wood. This latter condition is particularly true for polyisocyanate binders.

Generally, the moisture content of the furnish after completion of the blending, including the original moisture content of the flakes and the moisture added during blending with the binder, wax and other additives, should be about 5 to about 25 weight %, preferably about 8 to about 12 weight %. Generally, higher moisture contents within these ranges can be used for polyisocyanate binders because they do not produce condensation products upon reacting with cellulose in the wood.

The furnish is formed into a generally flat, loosely-felted mat, preferably as multiple layers, having a rectangular shape generally corresponding to the outer dimensions of the pallet. A conventional dispensing system, similar to those disclosed in U.S. Patents 3,391,223 and 3,824,058, can be used to form the mat. Generally, such a dispensing system includes a plate-like carriage carried on an endless belt or conveyor and one or more (e.g., 3) hoppers spaced along the belt in the direction of travel for receiving the furnish. When a multi-layered mat is formed in accordance with a preferred embodiment, a plurality of hoppers usually are used with each having a dispensing or forming head extending across the width of the carriage for successively depositing a separate layer of the furnish as the carriage is moved beneath the forming heads.

In order to produce pallets having the desired strength characteristics, the mat should have a substantially uniform thickness and the flakes should lie substantially flat in a horizontal plane parallel to the surface of the carriage and be randomly oriented relative to each other in that plane. The uniformity of the mat thickness can be controlled by depositing two or more layers of the furnish on the carriage and metering the flow of furnish from the forming heads.

The desired random orientation of the flakes can be enhanced by spacing the forming heads above the carriage so the flakes must drop about 1 to about 3 feet (30—90 cm) en route to the carriage. As the flat flakes fall from that height, they tend to spiral downwardly and land generally flat in a random pattern. Wider flakes within the range discussed above enhances this action. A scalper or similar device spaced above the carriage can be used to ensure uniform thickness or depth of the mat; however, such means usually tends to align the top layer of flakes, i.e., eliminate the desired random orientation. Accordingly, the thickness of the mat preferably is controlled by closely metering the flow of furnish from the forming heads.

The mat thickness used will vary depending upon such factors as the size and shape of the wood flakes, the particular technique used for forming the mat, the desired thickness and density of the pallet deck and leg members, the configuration of the pallet (particularly the size and shape of the leg members), and the molding pressure to be used. For example, if the pallet is to have a 1/2-inch (1.27 cm) thick deck member and a density of 45 pounds per cubic foot (721 kg/m^3), the mat usually will be about 3 inches (7.62 cm) thick when roundwood flakes are used and about 4 inches (10.2 cm) thick when flakes prepared by ring flaking fingerlings are used. Of all these variables, the final density of the pallet is the primary factor for determining the mat thickness.

Referring to Figure 4, the mat 30 is compressed in a heated press or mold 32 including a movable male die 34 and a stationary female die 36 which co-operate to define a mold chamber having the shape of the pallet. The female die 36 includes a plurality of cavities 40 (one shown), each defining the exterior of a leg member 16, and the male die 34 includes a plurality of corresponding protuberances 42 (one shown), each defining the interior of a leg member 16.

The mat 30 is removed from the forming carriage and deposited on the female die 36 as illustrated. When the male die 34 is closed, portions of the mat 30 are drawn or pulled down into the female die cavities 40 to form the leg members 16 as contrasted to the material flowing into the mold cavities as is the case with plastic materials and finely comminuted fibrous molding compositions. Thus, the corner junctures between the leg members 16 and the deck member 12 are particularly vulnerable to structural weakening resulting from a tendency for the flakes to be pulled apart during the molding operation.

The process of the invention minimizes this tendency, in a large part, by using wood flakes having dimensions within the ranges noted above and forming the mat 30 so that the layers of wood flakes lie substantially flat and are randomly oriented. Instead of pulling apart at the corner junctures, a number of the flakes more or less are bent or deformed around the corners and thereby provide joints having substantial structural integrity.

Because of this drawing or pulling action on the mat during molding, there are some practical limitations for the pallet configuration. Referring to Figure 2, the slope of the side walls 22 and 24 with respect to the major horizontal plane of the deck member 16, designated by angle A, should not exceed about 78°. If relatively tight corners are desired between the bottom of the deck member 12 and the leg member 16, the outer radii, designated as R_1, should be substantially larger than the inner radii, designated as R_2. Larger leg members (e.g., 7 inches×9 inches (i.e. 17.8×22.9 cm) generally are easier to mold than smaller leg members (e.g. 5 inch (12.7 cm) diameter) when the side walls have the same slope. As a general rule, the slope and depth is less for smaller leg members. The leg member side walls 22 and 24 generally are provided with a thickness which is 70 to 110%, preferably about 80—85%, of the deck member thick-

ness. The bottom wall thickness can be about 60—100% the deck member thickness.

The leg members should not be closer than about 6 inches (15.24 cm) from each other. Even at this distance, an additional quantity of the flakes may be required to compensate for those pulled or drawn down into the female die cavities during the molding operation, particularly when deeper or longer leg members are formed. For example, when a mat formed outside the mold and placed between the male and female dies as illustrated in Figure 4 is used in the production of a 40 inch×48 inch (102×122 cm) pallet having 9 legs, leg members having a depth (designated by dimension D in Figure 2) up to about 1-3/4 inches (4.45 cm) can be conveniently drawn from such a mat.

Figures 5—7 illustrate alternate techniques for depositing the flakes in the mold so as to permit drawing of longer or deeper leg members. In the technique illustrated in Figure 5, the cavities 40 of the female die 36 are first substantially filled with furnish 44 and a loosely-felted mat 46, having a substantially uniform thickness and formed outside the mold similar to mat 30 in Figure 4, is deposited on the female die 36 over the filled cavities prior to closing the mold.

In the technique illustrated in Figure 6, a loosely-felted mat 48 of substantially uniform thickness is formed outside the mold, similar to the mat 30 in Figure 4, and mounds 50 of additional furnish required for a deep draw are deposited on top of the mat 48 at locations corresponding to the locations of the female die cavities 40 prior to placing the mat 48 in the mold. The technique illustrated in Figures 5 and 6 have been successfully employed to form pallets having leg members of depths up to 5 inches (12.7 cm) or more and sidewall slopes between 56° and 77°.

In the technique illustrated in Figure 7, the mat 52 is loosely felted directly onto the female die 36 by passing the female die 36 beneath the forming heads (not shown). Alternatively, the mat can be deposited on a remote caul or pan which conforms to the female die and is subsequently placed over the female die. The additional furnish required for a deep draw is provided by the tendency for the cavities 40 of the female die 36 of the caul to absorb extra furnish during the felting operation.

Molding temperatures, pressures and times vary widely depending upon the thickness and desired density of the pallet, size and type of wood flakes, moisture content of the flakes, and the type of binder used. The molding temperature used is sufficient to at least partially cure the binder and expel water from the mat within a reasonable time period and without charring the wood. Generally, a molding temperature ranging from ambient up to about 450° F (232°C) can be used. Temperatures above about 450°F (232°C) can cause charring of the wood. When a binder system including a urea-formaldehyde resin and a polyisocyanate is used, a molding temperature of about 250° to about 375°F (121°—190°C) is preferred while a molding temperature of about 300° to about 425°F (149°—218°C) is preferred for phenol-formaldehyde resin binders.

The molding pressure used should be sufficient to press the wood flakes into intimate contact with each other without crushing them to the point where lignin starts to exude, causing a breakdown in the fibers with a resultant degradation in structural integrity. The molding pressure on the net die area typically is about 300 to about 700 psi (2.07—4.83 MPa).

The time of the molding or press cycle is sufficient to at least partially cure the binder to a point where the pallet has adequate structural integrity for handling. The press cycle typically is about 2 to about 10 minutes (120—600 sec); however, shorter or longer times can be used when pressure-curing binders are employed to when more complete curing of certain thermosetting binders is desired.

After the pallet is removed from the mold, the peripheral edges are trimmed to the desired final dimensions, e.g., 40 inches×48 inches (102×122 cm). The molding apparatus can include means which provides built-in trimming during pressing. A typical pallet will contain about 9 weight % resin, about 1 weight % wax and about 92 weight % wood when a thermosetting resin type binder is used. The resin content typically is about 5 weight % when a polyisocyanate resin is used and about 7 weight % when the binder is a combination of a urea-formaldehyde resin and a polyisocyanate.

Without further elaboration, it is believed that one skilled in the art can, using the preceding description, utilize the present invention to its fullest extent. The following examples are presented to illustrate the invention and are not to be construed as limitations thereof.

Example I

Various strength tests were run on sample pallets made in accordance with the invention using aspen roundwood flakes (average length of 1-3/4 inch (4.45 cm) and average thickness of 0.21 inch (0.53 cm), 9 weight % urea-formaldehyde resin, and 1 weight % wax. The sample pallets had an average density of 39 pounds per cubic inch (0.27 MPa). A pressure of 300—350 psi (2.07—2.42 MPa), a temperature of 300—325°F (149°—163°C) and a press time of 4.5 to 7 minutes were used for molding.

Leg crushing tests were conducted on a Tinius Olson testing machine using 16 leg sections in a dry condition and 18 leg sections which had been soaked for 24 hours and then dried to a constant weight at 15% relative humidity and 70°F (37°C). The average crushing strength to a maximum load was 3548 pounds (1609 kg) for the first group and 2727

pounds (1237 kg) for the second group. On the basis of these test results, a 9-leg pallet theoretically can support a maximum of 24,543 pounds (11,132 kg) after being soaked and re-dried.

Deck strength was determined by testing 3 inch×14 inch (7.62×35.6 cm) specimens cut from the decks of sample pallets. The average modulus of rupture was 2435 pounds per square inch (16.8 MPa). Other samples soaked for 48 hours and tested when wet had an average modulus of rupture of 1000 pounds per square inch (6.9 MPa).

Example II

Pallets having different size and shape legs were molded from a variety of wood flakes and binders. Leg sections from these pallets were tested for crushing strength. The pallet legs, conditioned at 50% relative humidity and 70°F (37°C) were loaded in compression perpendicular to the pallet deck surface with a load rate of 0.10 inches (0.25 cm) per minute to a maximum of 1/2 inch (1.27 cm) deflection. The results from these tests are summarized in Table I.

TABLE I
Crushing strengths of pallet legs

Wood type	Binder	Leg configuration				Avg. density, lbs/ft^3 (kg/m^3)	Crushing strength	
		Depth, in. (cm)	Side wall Slope, deg.	Opening Size, in. (cm)	Deck thickness, in. (cm)		Load to proportional limit, lbs. (kg)	Max load at 1/2-inch (1.27 cm) deflection, lbs. (kg)
Elm	Urea-formaldehyde	3-1/4 (8.3)	56	6-1/2×9-1/2 (16.5×24.1)	.613 (1.56)	48.9 (784)	4320 (1960)	7160 (3248)
Aspen	Urea-formaldehyde	3-1/4 (8.3)	56	6-1/2×9-1/2 (16.5×24.1)	.497 (1.26)	46.5 (745)	3060 (1388)	6200 (2813)
Aspen	Urea-formaldehyde	3-1/2 (8.9)	70	6×9 (15.2×22.9)	.610 (1.55)	59.1 (947)	5040 (2286)	6480 (2939)
Aspen	Urea-formaldehyde	3-1/2 (8.9)	75	5-1/2×8 (14×20.3)	.449 (1.14)	—	4080 (1851)	5018 (2276)
Aspen	Polyisocyanate	3-1/2 (8.9)	75	5-1/2×8 (14×20.3)	.504 (1.28)	—	4500 (2041)	7400 (3357)

Claims

1. A molded article (10) including a body portion (12) having a major plane and at least one non-planar portion (16) extending in a direction away from the major plane, said body (10) and non-planar portions (16) being formed as a one-piece unit, characterized in that it comprises a layered mixture of a resinous particle board binder and flake-like wood particles having an average length of about 1-1/4 inch (3.18 cm) to about 6 inches (15.24 cm), an average thickness of about 0.005 inch (0.013 cm) to about 0.075 inch (0.191 cm), and an average width of about 3 inches (7.62 cm) or less and no greater than the length, each layer of said wood particles forming at least said body portion lying substantially flat in a plane generally parallel to the major plane with said wood particles therein being randomly oriented.

2. A molded article in the form of a pallet (10) comprising a deck member (12) having a major plane, and a plurality of hollow leg members (16) projecting from said deck member of the deck member (12) and leg members (16) forming a one-piece unit (10), each of said leg members (16) having a bottom wall (18) spaced from said deck member (12) and one or more side walls (22, 24) integrally connecting said bottom wall (18) with said deck member (12) and inclining outwardly from said bottom wall (18) toward said deck member (12), characterized in that said one-piece unit (10) comprises a layered mixture of a resinous particle board binder and flake-like wood particles having an average length of about 1-1/4 (3.18 cm) to about 6 inches (15.24 cm), an average thickness of about 0.005 inch (0.013 cm) to about 0.075 inch (0.191 cm), and an average width of about 3 inches (7.62 cm) or less and no greater than the average length, each layer of said wood particles forming at least said deck member (12) lying substantially flat in a plane generally parallel to the major plane with said wood particles therein being randomly oriented.

3. A pallet according to Claim 2, characterized in that said side walls (22, 24) extend at an angle of about 78° or less relative to the major plane of said deck member (12), and the average thickness of said side walls (22, 24) is about 70—110% of the average thickness of said deck member (12).

4. A method for molding an article (10) having a major plane (12) and at least one non-planar portion (16) extending in a direction away from the major plane, said method comprising the steps of

(a) providing particles;

(b) admixing a resinous particle board binder with the particles;

(c) depositing a loosely-felted, layered mat (30) formed from said mixture on one open part (36) of a mold (32) including two separate parts (34, 36) defining a mold chamber having the shape of the article (10); and

(d) closing the mold (32) and applying sufficient heat and pressure on said mat (30) to compress it into substantially the desired shape and size of the article (10) and to bond the particles together to form a unitary structure;

characterized in that the particles are flake-like wood particles having an average length of about 1-1/4 inch (3.18 cm) to about 6 inches (15.24 cm) an average thickness of about 0.005 inch (0.013 cm) to about 0.075 inch (0.191 cm), and an average width of about 3 inches (7.62 cm) or less and no greater than the length; and in that the wood particles in each layer of the mat (30) are substantially flat in a plane generally parallel to the major plane and are randomly oriented.

5. A method according to Claim 4, characterized in that said article is a pallet (10) having a deck member (12) including a major plane and a non-planar portion comprising a plurality of hollow leg members (16) projecting integrally from said deck member (12), each of said leg members (16) having a bottom wall (18) spaced from said deck member (12) and side walls (22, 24) integrally connecting said bottom wall (18) to said deck member (12) and inclining outwardly from said deck member (12) toward said bottom wall (18), and that said pallet (10) is molded between male and female dies (34, 36), each hollow leg member (16) being formed in a separate cavity (40) of the female die (36).

6. A method according to Claim 5, characterized by forming said loosely-felted mat (30) with a substantially uniform thickness outside the mold (32), depositing a mound (50) of said mixture atop said mat (30) at locations corresponding to locations of each female die cavity (40), and placing said mat (30) between the male and female dies (34, 36) with the mounds (50) generally aligned with respective female die cavities (40).

7. A method according to Claim 5, characterized by substantially filling each of the female die cavities (40) with said mixture, forming said loosely-felted mat (30) with a substantially uniform thickness outside the mold (32), and placing said mat (30) between the male and female dies (34, 36).

8. An article according to any one of the Claims 1 to 3 or a method according to any one of Claims 4 to 7, characterized in that the average thickness of the wood particles is about 0.015 inch (0.038 cm) to about 0.025 inch (0.064 cm), the average length of the particles is about 2 inches (5.1 cm) to about 3 inches (7.6 cm), the average width of the particles is about 1/16 inch (0.16 cm) to about 3 inches (7.6 cm).

9. A method according to any one of Claims 4 to 8, characterized in that the pressure applied to the mat (30) in step (d) is within the

range of about 300 to about 700 psi (2.09—4.83 MPa), the temperature applied to the mat (30) during step (d) ranges from ambient up to about 450°F (232°C).

10. A method according to any one of Claims 4 to 9, characterized in that the wood particles are dried to a moisture content of about 6% or less prior to step (b), and the amount of binder admixed with the wood particles during step (b) is within the range of about 2 to about 15 weight %, as solids based on the dry weight of the wood particles, the binder including an organic polyisocyanate having at least two active isocyanate groups per molecule, and that a liquid wax composition is also admixed with the wood particles during step (b).

Revendications

1. Article moulé (10) comprenant une partie (12) formant un corps ayant un plan principal et au moins une partie non plane (16) dépassant d'un côté du plan principal, le corps (10) et les parties non planes (16) étant formés en une seule pièce, caractérisé en ce qu'il comprend un mélange en couches d'un liant résineux pour panneaux de particules et de particules de bois analogues à des copeaux ayant une longueur moyenne d'environ 3,18 à 15,24 cm, une épaisseur moyenne d'environ 0,013 à 0,191 cm, et une largeur moyenne d'environ 7,62 cm ou moins et ne dépassant pas la longueur, chaque couche des particules de bois formant au moins la partie du corps étant disposée sensiblement à plat dans un plane parallèle de façon générale au plan principal, les particules de bois incorporées ayant une orientation aléatoire.

2. Article moulé sous forme d'une palette (10) comprenant un organe d'appui (12) ayant un plan principal et plusieurs pieds creux (16) dépassant de l'organe d'appui, ce dernier (12) et les pieds (16) formant un ensemble en une seule pièce (10), chacun des pieds (16) ayant une paroi inférieure (18) distante de l'organe d'appui (12), et une ou plusieurs parois latérales (22, 24) raccordant en une seule pièce la paroi inférieure (18) à l'organe d'appui (12) et s'inclinant vers l'extérieur depuis la paroi inférieure (18) vers l'organe d'appui (12), caractérisé en ce que l'ensemble en une seule pièce (10) est un mélange en couches d'un liant résineux pour panneaux de particules et de particules de bois analogues à des copeaux ayant une longueur moyenne d'environ 3,18 à 15,24 cm une épaisseur moyenne d'environ 0,013 à 0,191 cm, et une largeur moyenne d'environ 7,62 cm ou moins et ne dépassant pas la longueur moyenne, chaque couche des particules de bois formant au moins l'organe d'appui (12) étant disposée sensiblement à plat dans un plan parallèle de façon générale au plan principal, les particules de bois incorporées ayant une orientation aléatoire.

3. Palette selon la revendication 2, caractérisée en ce que lesdites parois latérales (22, 24) ont un angle d'environ 78° ou moins avec le plan principal de l'organe d'appui (12), et l'épaisseur moyenne des parois latérales (22, 24) est comprise entre 70 et 110% environ de l'épaisseur moyenne de l'organe d'appui (12).

4. Procédé de moulage d'un article (10) ayant un plan principal (12) et au moins une partie non plane (16) dépassant à distance du plan principal, ledit procédé comprenant les étapes de:

(a) fourniture de particules,

(b) mélange d'un liant résineux pour panneaux de particules aux particules,

(c) dépôt d'une nappe en couches, feutrée librement (30) formée à partir dudit mélange sur une partie ouverte (36) d'un moule (32) comprenant deux parties séparées (34, 36) délimitant une chambre de moulage ayant la configuration de l'article (10), et

(d) fermeture du moule (32) et application de chaleur et de pression à la nappe (30) en quantité suffisante pour qu'elle soit comprimée à la dimension et à la configuration voulues pratiquement pour l'objet (10) et pour que les particules se lient en formant une structure unitaire,

caractérisé en ce que les particules sont des particules de bois analogues à des copeaux ayant une longueur moyenne d'environ 3,18 à 15,24 cm, une épaisseur moyenne d'environ 0,013 à 0,191 cm, et une largeur moyenne d'environ 7,62 cm ou moins et ne dépassant pas la longueur, et en ce que les particules de bois de chaque couche de la nappe (30) sont pratiquement à plat dans un plan parallèle de façon générale au plan principal et ont une orientation aléatoire.

5. Procédé selon la revendication 4, caractérisé en ce que l'article est une palette (10) ayant un organe d'appui (12) comprenant un plan principal et une partie non plane comprenant plusieurs pieds creux (16) dépassant de l'organe d'appui (12) étant solidaires, chaque pied (16) ayant une paroi inférieure (18) distante de l'organe d'appui (12) et des parois latérales (22, 24) raccordant sous forme solidaire la paroi inférieure (18) à l'organe d'appui (12) et s'inclinant vers l'extérieur à partir de l'organe d'appui (12) vers la paroi inférieure (18), et en ce que la palette (10) est moulée entre des organes mâle et femelle (34, 36), chaque pied creux (16) étant formé dans une cavité séparée (40) de l'organe femelle (36).

6. Procédé selon la revendication 5, caractérisé par la formation de la nappe (30) feutrée librement avec une épaisseur sensiblement uniforme en dehors du moule (32), le dépôt d'un monticule (50) du mélange sur la nappe (30) à des emplacements correspondant à ceux de chaque cavité (40) de l'organe femelle, et la disposition de la nappe (30) entre les organes mâle et femelle (34, 36), les monticules (50)

étant alignés de façon générale sur les cavités respectives (40) de l'organe femelle.

7. Procédé selon la revendication 5, caractérisé par le remplissage pratiquement complet de chacune des cavités (40) de l'organe femelle avec ledit mélange, la formation de la nappe feutrée librement (30) avec une épaisseur sensiblement uniforme, en dehors du moule (32), et la disposition de la nappe entre les organes mâle et femelle (34, 36).

8. Article selon l'une quelconque des revendications 1 à 3 ou procédé selon l'une quelconque des revendications 4 à 7, caractérisé en ce que l'épaisseur moyenne des particules de bois est d'environ 0,038 à 0,64 cm, la longueur moyenne des particules est d'environ 5,1 à 7,6 cm, et la largeur moyenne des particules est d'environ 0,16 à 7,6 cm.

9. Procédé selon l'une quelconque des revendications 4 à 8, caractérisé en ce que la pression appliquée à la nappe (30) dans l'étape (b) est comprise entre environ 2,09 et 4,83 MPa, la température apliquée à la nappe (30) pendant l'étape (b) est comprise entre la température ambiante et 232°C.

10. Procédé selon l'une quelconque des revendications 4 à 9, caractérisé en ce que les particules de bois sont séchées à une teneur en humidité d'environ 6% ou moins avant l'étape (b), et la quantité de liant mélangé aux particules de bois pendant l'étape (b) est comprise entre environ 2 et 15% en poids, sous forme de matières solides d'après le poids à sec des particules de bois, le liant contenant un polyisocyanate organique ayant au moins deux groupes isocyanates actifs par molécule, et en ce qu'une composition de cire liquide est aussi mélangée aux particules de bois dans l'étape (b).

Patentansprüche

1. Formartikel (10), der einen eine Hauptebene umfassenden Körperteil (12) und wenigstens einen sich in einer von der Hauptebene entfernenden Richtung erstreckenden nicht-ebenen Teil (16) aufweist, wobei der genannte Körper (10) und die nicht-ebenen Teile (16) als eine einteilige Einheit geformt sind, dadurch gekennzeichnet, daß der Formartikel ein geschichtetes Gemisch aus einem harzigen Spanplattenbindemittel und schnitzelartigen Holzteilchen mit einer durchschnittlichen Länge von ungefähr 1-1/4 Zoll (3,18 cm) bis ungefähr 6 Zoll (15,24 cm), einer durchschnittlichen Dicke von ungefähr 0,005 Zoll (0,013 cm) bis ungefähr 0,075 Zoll (0,191 cm) und einer durchschnittlichen Breite von ungefähr 3 Zoll (7,62 cm) oder weniger und nicht größer als die Länge aufweist, wobei jede Schicht der genannten Holzteilchen, die zumindest den genannten Körperteil bilden, im wesentlichen flach in einer zur Hauptebene allgemein parallelen Ebene liegt und die darin befindlichen genannten Holzteilchen regellos orientiert sind.

2. Formartikel in Form einer Palette (10), die einen Deckteil (12) mit einer Hauptebene und eine Mehrzahl von vom genannten Deckteil vorspringenden hohlen Fußteilen (16) umfaßt, wobei der Deckteil (12) und die Fußteile (16) eine einteilige Einheit (10) bilden und jeder der genannten Fußteile (16) eine mit Abstand vom genannten Deckteil (12) angeordnete Bodenwandung (18) und eine oder mehrere, die genannte Bodenwandung (18) mit dem genannten Deckteil (12) einteilig verbindende und von der genannten Bodenwandung (18) in Richtung auf den genannten Deckteil (12) schräg nach außen verlaufende Seitenwandungen (22, 24) aufweist, dadurch gekennzeichnet, daß die genannte einteilige Einheit (10) ein geschichtetes Gemisch aus einem harzigen Spanplattenbindemittel und schnitzelartigen Holzteilchen mit einer durchschnittlichen Länge von ungefähr 1-1/4 Zoll (3,18 cm) bis ungefähr 6 Zoll (15,24 cm), einer durchschnittlichen Dicke von ungefähr 0,005 Zoll (0,013 cm) bis ungefähr 0,075 Zoll (0,191 cm) und einer durchschnittlichen Breite von ungefähr 3 Zoll (7,62 cm) oder weniger und nicht größer als die Durchschnittlänge aufweist, wobei jede Schicht der genannten Holzteilchen, die zumindest den genannten Deckteil (12) bilden, im wesentlichen flach in einer zur Hauptebene allgemein parallelen Ebene liegt und die darin befindlichen genannten Holzteilchen regellos orientiert sind.

3. Palette nach Anspruch 2, dadurch gekennzeichnet, daß die genannten Seitenwandungen (22, 24) unter einem Winkel von ungefähr 78° oder weniger relativ zur Hauptebene des genannten Deckteils (12) verlaufen, und daß die durchschnittliche Dicke der genannten Seitenwandungen (22, 24) ungefähr 70 bis 110% der durchschnittlichen Dicke des genannten Deckteils (12) beträgt.

4. Verfahren zum Formen eines Artikels (10) mit einem Hauptebenenteil (12) und wenigstens einem nichtebenen Teil (16), der sich in einer von der Hauptebene entfernenden Richtung erstreckt, mit den Schritten des

(a) Bereitstellens von Teilchen,

(b) Mischens eines harzigen Spanplattenbindemittels mit den Teilchen,

(c) Auflegens einer aus dem genannten Gemisch geformten lockerfilzigen, geschichteten Matte (30) auf einen offenen Teil (36) einer Form (32) mit zwei getrennten Teilen (34, 36), die eine Formkammer mit der Form des Artikels (10) definieren,

(d) Schließens der Form (32) und des Anwendens ausreichender Wärme und Druckes auf die genannte Matte (30), um diese im wesentlichen in die gewünschte Form und Größe des Artikels (10) zu pressen und um die Teilchen miteinander zur Bildung einer einheitlichen Struktur zu verbinden,

dadurch gekennzeichnet, daß die Teilchen schnitzelähnliche Holzteilchen mit einer durchschnittlichen Länge von ungefähr 1-1/4 Zoll

(3,18 cm) bis ungefähr 6 Zoll (15,24 cm), einer durchschnittlichen Dicke von ungefähr 0,005 Zoll (0,013 cm) bis ungefähr 0,075 Zoll (0,191 cm) und einer durchschnittlichen Breite von ungefähr 3 Zoll (7,62 cm) oder weniger und nicht größer als die Länge sind, und daß die Holzteilchen in jeder Schicht der Matte (30) im wesentlichen flach in einer zur Hauptebene allgemein parallelen Ebene liegen und regellos orientiert sind.

5. Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß der genannte Artikel eine Palette (10) mit einem eine Hauptebene umfassenden Deckteil (12) und einem eine Mehrzahl von einteilig vom genannten Deckteil (12) vorspringenden hohlen Fußteilen (16) umfassenden nicht-ebenen Teil ist, wobei jeder der genannten Fußteille (16) eine mit Abstand vom genannten Deckteil (12) angeordnete Bodenwandung (18) und die genannte Bodenwandung (18) einteilig mit dem genannten Deckteil (12) verbindende und vom genannten Deckteil (12) in Richtung auf die genannte Bodenwandung (18) schräg nach außen verlaufende Seitenwandungen (22, 24) aufweist, und daß die genannte Palette (10) zwischen positiven und negativen Matrizen (34, 36) geformt wird, wobei jeder hohle Fußteil (16) in einer getrennten Mulde (40) der negativen Matrize (36) geformt wird.

6. Verfahren nach Anspruch 5, dadurch gekennzeichnet, durch Formen der genannten lockerfilzigen Matte (30) mit einer im wesentlichen gleichmäßigen Dicke außerhalb der Form (32), durch Aufbringen einer Erhebung (50) des genannten Gemischs oben auf die genannte Matte (30) an Stellen, die den Positionen jeder Negativmatrizen-Mulde (40) entsprechen, und durch Plazieren der genannten Matte (30) zwischen die positive und negative Matrize (34, 36), wobei die Erhebungen (50) allgemein auf die entsprechenden Negativmatrizen-Mulden (40) ausgerichtet sind.

7. Verfahren nach Anspruch 5, gekennzeichnet, durch weitgehendes Füllen jeder der Negativmatrizen-Mulden (40) mit dem genannten Gemisch, durch Formen der genannten lockerfilzigen Matte (30) mit einer im wesentlichen gleichmäßigen Dicke außerhalb der Form (32), und durch Plazieren der genannten Matte (30) zwischen die positive und negative Matrize (34, 36).

8. Artikel nach irgendeinem der Ansprüche 1 bis 3 oder Verfahren nach irgendeinem der Ansprüche 4 bis 7, dadurch gekennzeichnet, daß die durchschnittliche Dicke der Holzteilchen ungefähr 0,015 Zoll (0,038 cm) bis ungefähr 0,025 Zoll (0,064 cm), die durchschnittliche Länge der Teilchen ungefähr 2 Zoll (5,1 cm) bis ungefähr 3 Zoll (7,6 cm) und die durchschnittliche Breite der Teilchen ungefähr 1/16 Zoll (0,16 cm) bis ungefähr 3 Zoll (7,6 cm) beträgt.

9. Verfahren nach irgendeinmen der Ansprüche 4 bis 8, dadurch gekennzeichnet, daß der während des Schrittes (d) auf die Matte (30) ausgeübte Druck von ungefähr 300 bis ungefähr 700 psi (2,09 bis 4,83 MPa) und die auf die Matte (30) während des Schrittes (d) aufgebrachte Temperatur von Umgebungstemperatur bis ungefähr 450°F (232°C) reichen.

10. Verfahren nach irgendeinem der Ansprüche 4 bis 9, dadurch gekennzeichnet, daß die Holzteilchen vor dem Schritt (b) auf einen Feuchtigkeitsgehalt von ungefähr 6% oder weniger getrocknet werden und die Menge des mit den Holzteilchen während des Schrittes (b) gemischten Bindemittels ungefähr 2 bis ungefähr 15 Gew-%e als Trockensubstanz basierend auf dem Trockengewicht der Holzteilchen beträgt, daß das Bindemittel ein organisches Polyisocyanat mit wenigstens zwei aktiven Isocyanatgruppen pro Molekül umfaßt, und daß eine Flüssigwachskomposition ebenfalls mit den Holzteilchen während des Schrittes (b) vermischt wird.

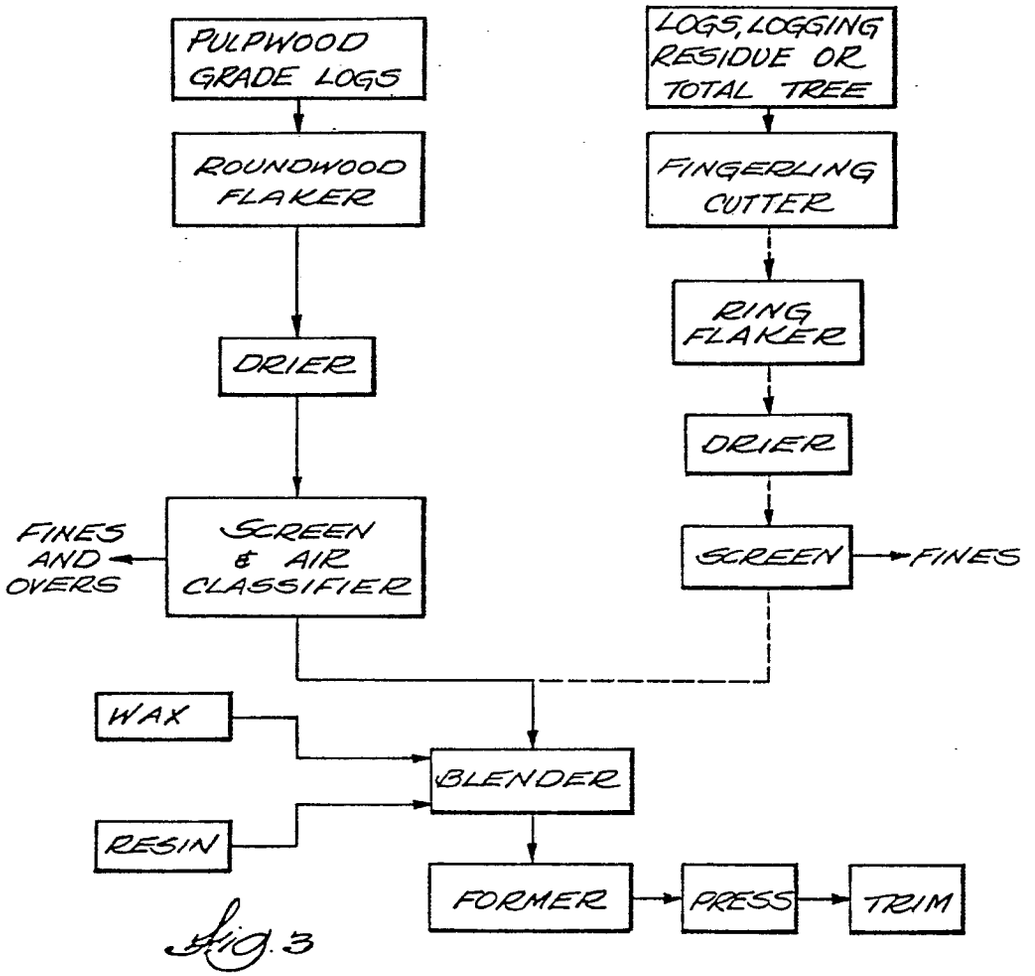
PULPWOOD GRADE LOGS
LOGS, LOGGING RESIDUE OR TOTAL TREE
ROUNDWOOD FLAKER
FINGERLING CUTTER
RING FLAKER
DRIER
DRIER
FINES AND OVERS
SCREEN & AIR CLASSIFIER
SCREEN
FINES
WAX
BLENDER
RESIN
FORMER
PRESS
TRIM

Fig. 3

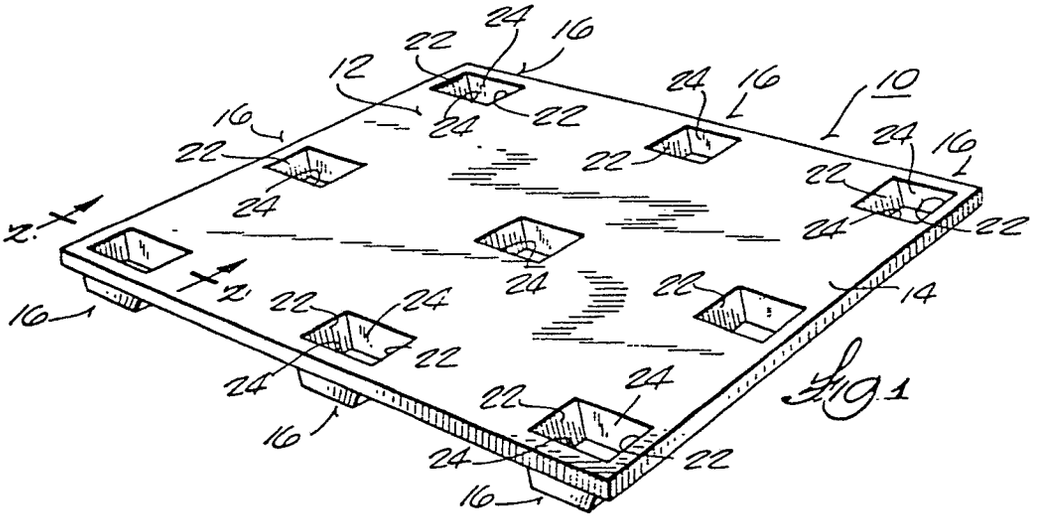
10
12
14
16
22
24
x
y

Fig. 1

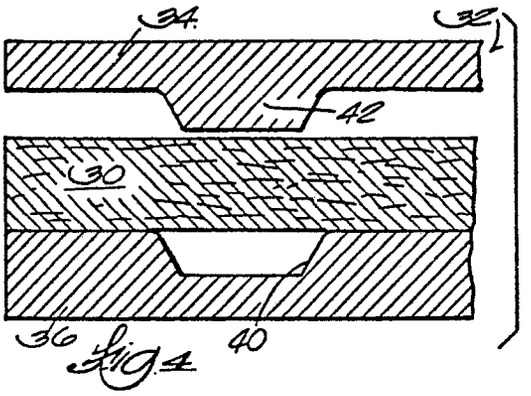

Fig. 4

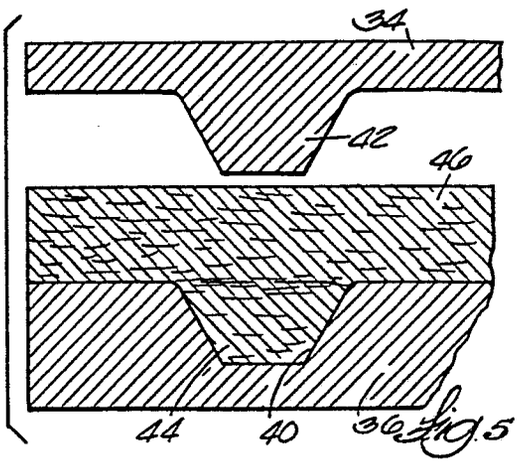

Fig. 5

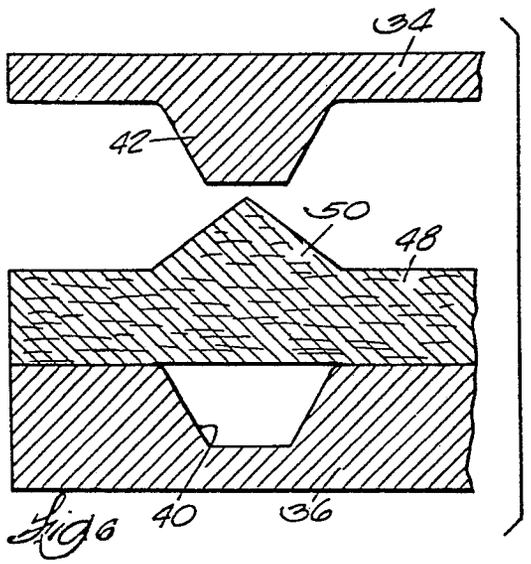

Fig. 6

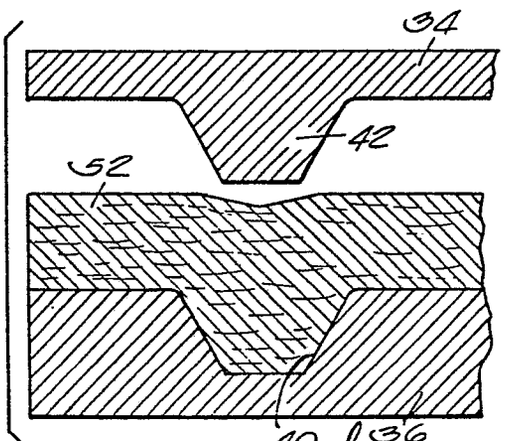

Fig. 7

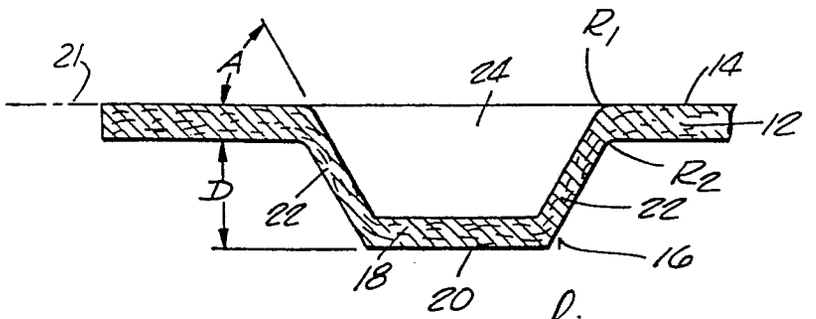

Fig. 2