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# Pallet and apparatus for forming a pallet with deep drawn legs

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# United States Patent [19]

Sandberg et al.

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[54] **PALLET AND APPARATUS FOR FORMING A PALLET WITH DEEP DRAWN LEGS**

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[73] Assignee: **Board of Control of Michigan Technological University**, Houghton, Mich.

[21] Appl. No.: **799,018**

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**Related U.S. Application Data**

[60] Continuation of Ser. No. 456,050, Dec. 26, 1989, which is a continuation of Ser. No. 227,007, Aug. 1, 1988, which is a division of Ser. No. 879,737, Jun. 30, 1986, Pat. No. 4,790,966.

[51] **Int. Cl.**[5] ..... **B65D 19/24**

[52] **U.S. Cl.** ..... **108/53.3**; 108/51.1; 108/901; 428/106

[58] **Field of Search** ..... 108/51.1, 53.1, 901; 428/541, 106, 107, 112; 156/62.2

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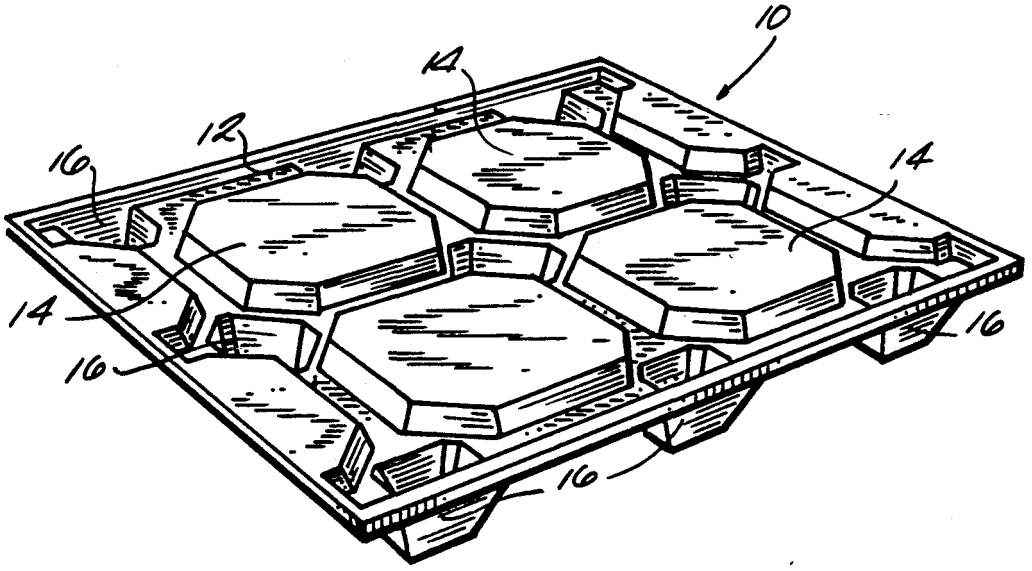
*Primary Examiner*—Peter A. Aschenbrenner
*Attorney, Agent, or Firm*—Michael, Best & Friedrich

[57] **ABSTRACT**

A method and apparatus for molding articles such as pallets from flake-like wood particles mixed with binder, the pallets housing a deck and integral molding legs. A loosly fitted mat of wood flakes is formed by depositing a first plurality of layers of wood flakes onto a supporting surface with a flake aligners provided for causing alignment of those flakes which will form legs of the pallet. A second plurality of layers are formed with a flake aligner provided for causing alignment of flakes which will form the legs of the pallet and in a direction transverse to the direction of alignment of the flakes of the first layers.

**1 Claim, 4 Drawing Sheets**



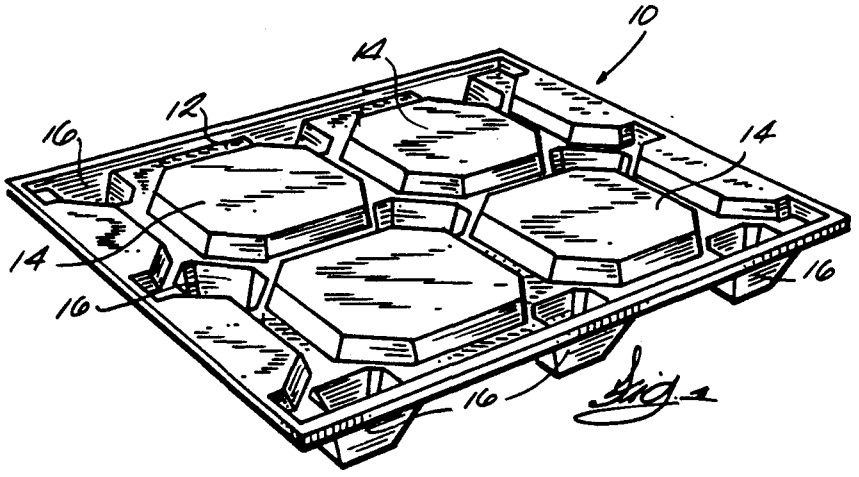



Fig. 1

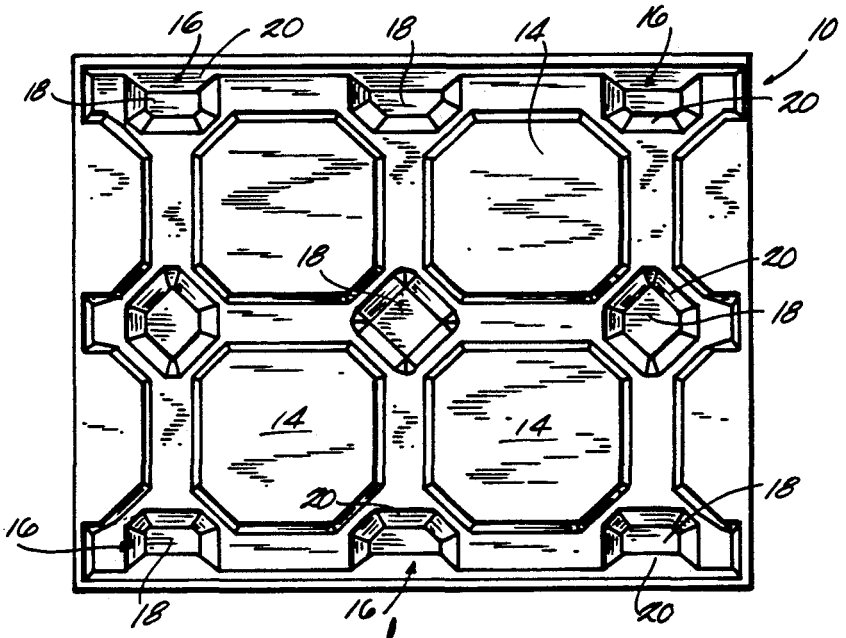



Fig. 2

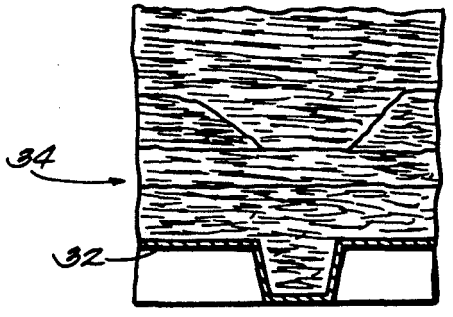



Fig. 3

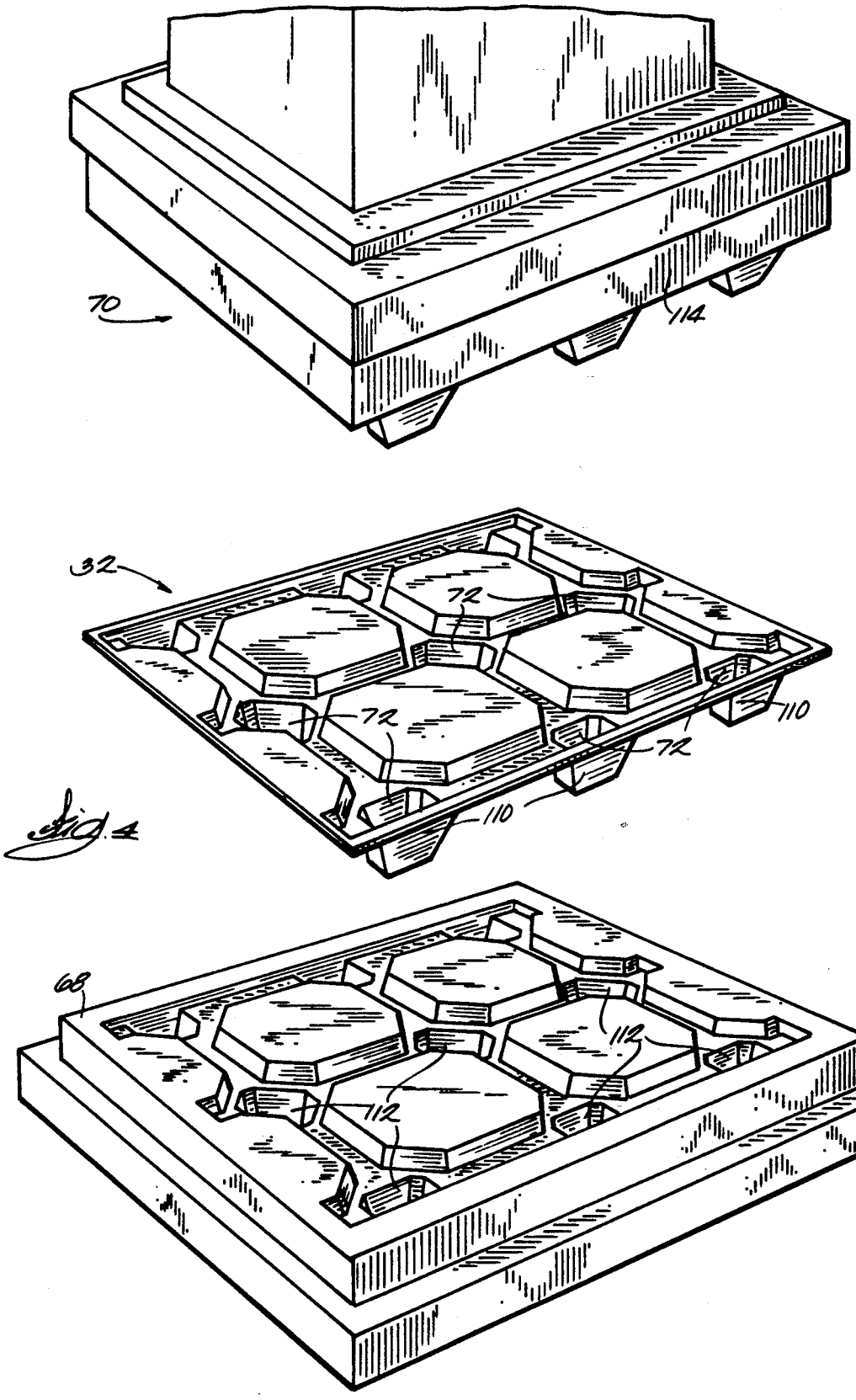
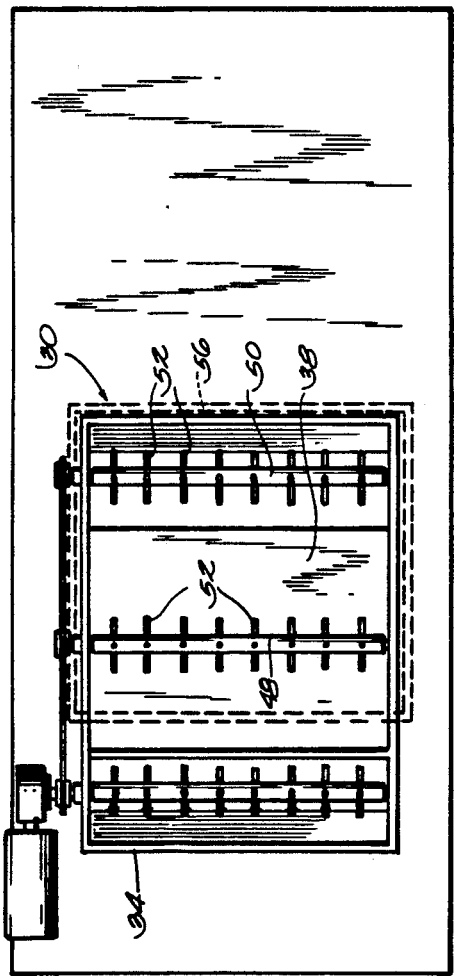



Fig. 4

Fig. 6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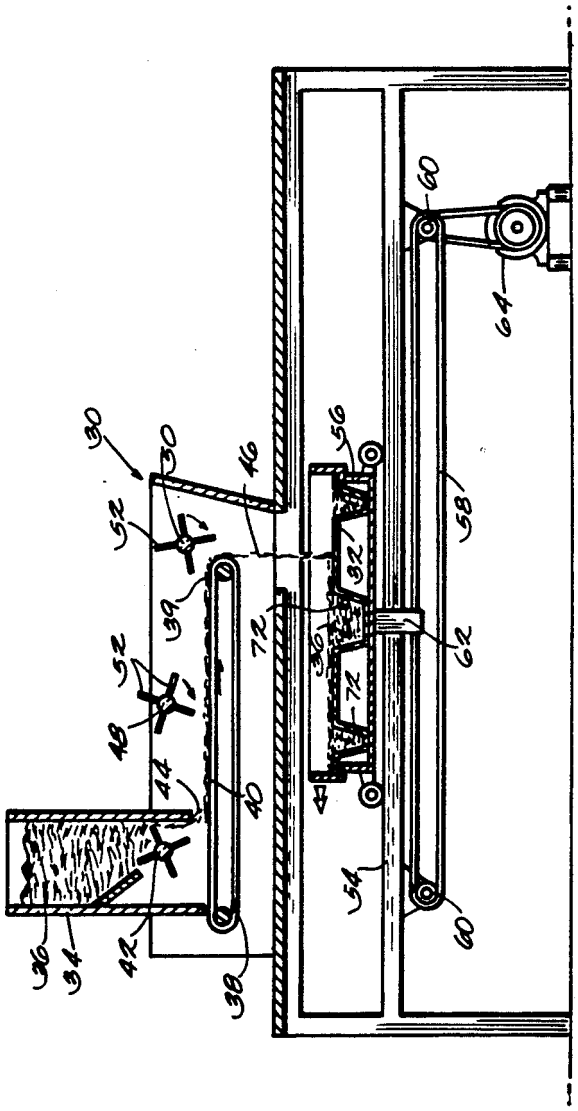
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Fig. 5

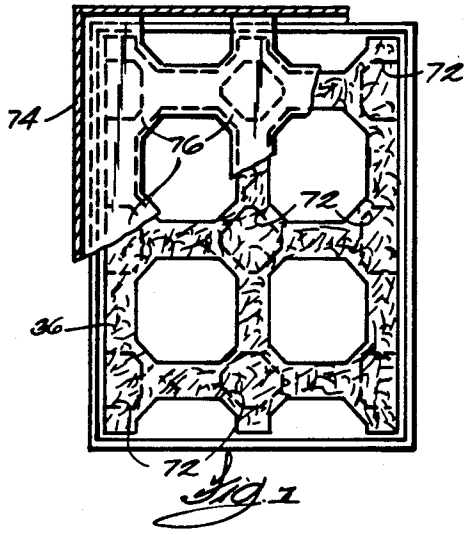


Fig. 1

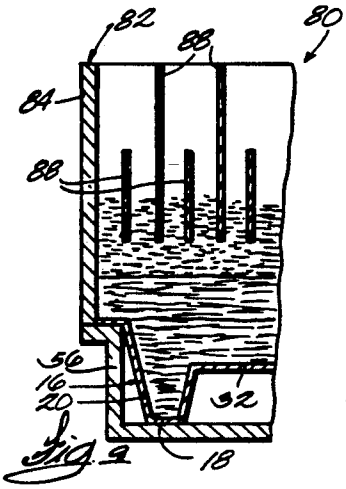


Fig. 9

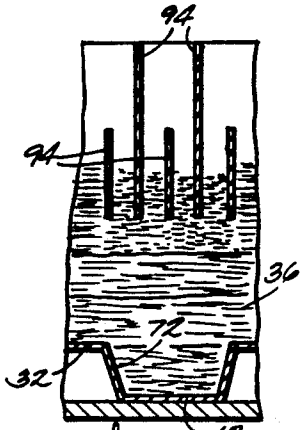


Fig. 11

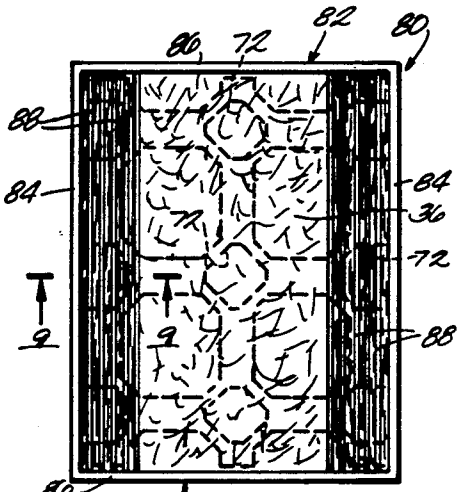


Fig. 8

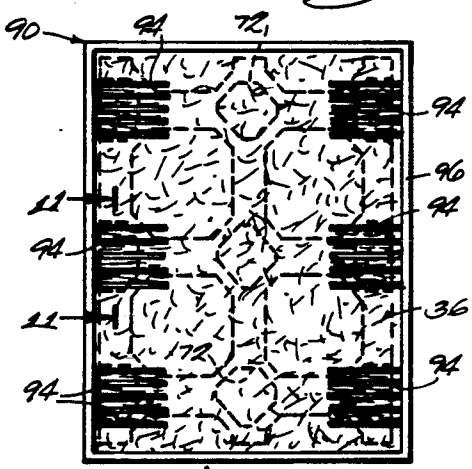


Fig. 10

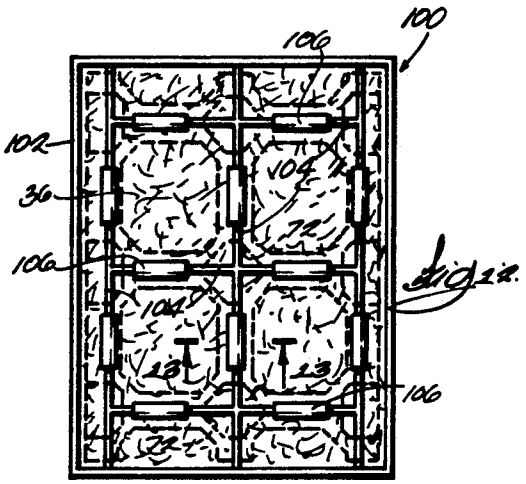


Fig. 12

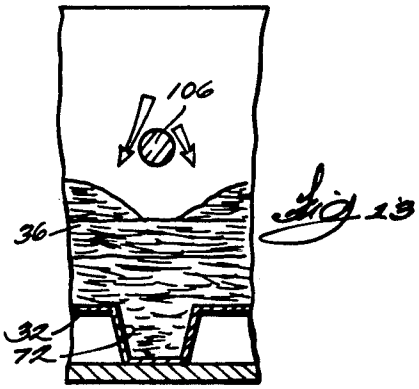


Fig. 13

# PALLET AND APPARATUS FOR FORMING A PALLET WITH DEEP DRAWN LEGS

This is a continuation of U.S. patent application Ser. No. 456,050, filed Dec. 26, 1989 which is a continuation of U.S. patent application Ser. No. 227,007, filed Aug. 1, 1988, which is a division of U.S. patent application Ser. No. 879,737, filed Jun. 30, 1986 now U.S. Pat. No. 4,790,966.

## FIELD OF THE INVENTION

The present invention relates to construction of molded wood particle products such as pallets used for material handling and to methods and apparatus for use in making such molded wood products.

## BACKGROUND PRIOR ART

Due to the increasing expense of wood and lumber, efforts have been made to construct a pallet of the type for use in material handling from alternative materials such as wood chips, wood pulp and wood particles.

Examples of pallets comprised of composite wood material are illustrated in the Coughey et al. U.S. Pat. No. 4,248,163 issued Feb. 3, 1981; and the Haataja U.S. Pat. No. 4,408,544 issued Oct. 11, 1983, assigned to the assignee of the present invention.

A method for molding articles such as wood pallets from loosely felted mats of wood flakes is also illustrated in the Haataja U.S. Pat. No. 4,440,708, issued Apr. 3, 1984 and in the Haataja U.S. Pat. No. 4,337,710, issued Jul. 6, 1982. Those patents illustrate a method and apparatus for molding composite wood flake pallets wherein a loosely felted mat of wood flakes is positioned on a lower press die. The loosely felted mat is comprised of elongated thin wood flakes with the flakes lying in horizontal planes and with the flakes having a random orientation in those planes. The die includes a plurality of cavities which form the integral downwardly extending legs of the pallet. Male die members of an upper die extrude the mat material down into the cavities in the lower die during compression of the mat to form the legs of the pallet.

During the compression of the mat, the wood flake material in the area of the die cavities forming the legs is extruded downwardly into the cavities. In applications where the legs are relatively long, there is substantial extrusion of the mat material into the die cavities, and in some applications, the mat material may be pulled apart to form voids in the compressed mat, and in some applications these voids result in localized weaknesses in the pallet.

## SUMMARY OF THE INVENTION

The present invention is directed to an improved method and apparatus for forming a pallet comprised of compressed wood particles of the type wherein a loosely felted mat of wood flakes mixed with a binder is placed between dies in a press and compressed to form a load supporting deck and hollow legs extending downwardly from the deck, the legs being formed integrally with the deck. The method and apparatus of the invention provides an improved means for forming the legs of the pallet, particularly where the legs are sufficiently long that a relatively deep draw of the mat material is required to form the legs.

In one embodiment of the invention, the method includes the steps of providing a caul sheet having a configuration conforming to the desired configuration of the lower press die and being adapted to be placed in the press and supported by the lower press die during compression of the pallet. The method includes a first step of filling the cavities of the caul sheet with wood flakes. A first layer of the loosely felted mat is then deposited onto the caul sheet, with the wood flakes of at least these portions of the first layer locate above the leg cavities being aligned generally parallel to one another. A second layer of the mat is then formed with at least the wood flakes of these portions of the second layer located above the leg cavities being aligned in generally parallel relation with respect to one another and extending generally transversely to the aligned wood flakes of the first layer.

When the wood flakes comprising the mat are aligned in this manner, during the pressing operation wherein the wood flakes are forced into the die cavities to form the pallet legs, the formation of voids is prevented.

In one embodiment of the invention wood flakes can be deposited directly into the die cavities of the lower die plate. The remainder of the loosely felted mat, and including the layers of the aligned wood flakes, can be formed on a flat caul sheet and can then be transferred onto the lower die plate.

In one preferred embodiment of the invention, the apparatus for use in forming the mats includes a conventional mat former adapted to drop uniform loosely felted layers of wood flakes onto a supporting surface or caul sheet. A structure is provided for positioning the caul sheet beneath the mat former and for causing reciprocal movement of the caul sheet beneath the mat former. During each pass of the caul sheet beneath the mat former a thin layer of wood flakes is deposited onto the caul sheet. During the initial formation of the mat, a first alignment structure is placed on the caul sheet and is moved with the caul sheet beneath the mat former. This alignment structure includes a rectangular frame of approximately the same size as the caul sheet and includes a plurality of parallel baffle plates positioned in vertical orientation and in parallel spaced apart side-by-side relation. The baffle plates are aligned with the direction of movement of the caul sheet and are positioned at opposite sides of the caul sheet and above the areas of the mat which will form the legs of the pallet. This flake aligner is positioned on the caul sheet during a first predetermined number of passes of the caul sheet beneath the former. The first flake aligner is then removed, and a second flake aligner is positioned on the caul sheet. This second flake aligner includes a plurality of baffle plates supported above the openings of the caul sheet to define the leg cavities. This second flake aligner includes baffles which are vertically oriented and supported in spaced apart relation and defining planes perpendicular to the direction of alignment of the first set of baffle plates of the first flake aligner. The second flake aligner is supported on the caul sheet for a second predetermined number of passes beneath the mat former. Subsequently, the second flake aligner is removed from the caul sheet and then the caul sheet is moved back and forth beneath the mat former to form the remaining layers of wood flake material forming the mat.

Various features and advantages of the invention will be apparent by reference to the following description of a preferred embodiment, from the drawings and from the claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a molded wood flake pallet manufactured using a method and apparatus embodying the invention.

FIG. 2 is a plan view of the pallet illustrated in FIG. 1.

FIG. 3 is a partial cross section view of a caul sheet supporting a loosely felted mat of wood flakes to be compressed to form the pallet illustrated in FIG. 1.

FIG. 4 is an exploded perspective view of a press and caul sheet used in manufacturing the pallet illustrated in FIG. 1.

FIG. 5 is a side elevation view partially in section illustrating a mat former employed in the method embodying the invention.

FIG. 6 is a plan view of the mat former illustrated in FIG. 5.

FIG. 7 is a plan view of a caul sheet of the type illustrated in FIG. 4 and having flakes deposited in the leg cacities of the caul sheet.

FIG. 8 is a view similar to FIG. 7 and showing a first flake aligner positioned on the caul sheet illustrated in FIG. 7.

FIG. 9 is a cross section view taken along line 9—9 in FIG. 8.

FIG. 10 is a view similar to FIG. 8 and showing a second flake aligner positioned on the caul sheet.

FIG. 11 is a cross section view taken along line 11—11 in FIG. 10.

FIG. 12 is a view similar to FIGS. 8 and 10 and showing a flake diverter positioned on the caul sheet.

FIG. 13 is a cross section view taken along line 13—13 in FIG. 12.

Before describing the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangement of the components set forth in the following description or illustrated in the drawings The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

Illustrated in FIG. 1 is a pallet 10 including a rectangular deck 12 having a substantially uniform thickness and flat upper surfaces 14 which serve as supporting planes for a load to be placed on the pallet. Projecting downwardly from the deck 12 are a plurality, e g. nine, hollow leg members 16 adapted to serve as supporting pads for the pallet 10. In the specific construction illustrated, each of the leg members 16 includes a bottom wall 18 having a flat bottom surface and two opposed pairs of flat sidewalls 20. The bottom surface of the bottom wall 18 is spaced from the underneath surface of the deck 12 a sufficient distance to permit entry of tines of a forklift beneath the deck 12.

The deck 12 and legs 16 are molded as a one-piece unit from a mixture of a suitable resinous particle board binder and flakelike wood particles as will be described below. The sidewalls 20 of the legs 16 are inclined or tapered to facilitate molding and also to permit nesting of several pallets 10 into a compact stack so as to minimize the space required for shipment and storage. In the specific construction illustrated, the sidewalls 20 are substantially flat, and the legs have the general form of an inverted truncated hollow pyramid.

Manufacturing a pallet from wood particles includes the steps of comminuting small logs, branches or rough pulp wood 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 into a loosely felted, layered mat, 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.

In a preferred form of the invention the wood flakes will comprise aspen species, Populus Tremuloides or Grandidentata. The wood should be purchased in pulp wood log form, commonly four inches in diameter and larger than 100 inches long or longer.

Suitable wood flakes can be prepared by various conventional techniques In a preferred form of the invention, pulp wood grade logs are converted into wood flakes by a conventional round wood flaker.

The size distribution of the flakes is important, particularly the length and thickness. The wood flakes should have a target or mean flake size of approximately 0.20 inches thick by 0.50 inches wide by 2.0 to 3.0 inches long. In any given batch, some of the flakes can be shorter or longer than the target flake size so long as the overall average length is within the above range. The same is true for the thickness.

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 undesirable particles, both undersized and oversized, and thereby insure the average length, thickness and width of the flakes within the desired ranges.

Flakes from some green wood can contain up to 90% moisture content. The moisture content of the mat must be substantially less than this 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 dryer, such as a tunnel dryer, to the moisture content desired for the blending step. The moisture content to which the flakes

are dried usually is on the order of about seven weight percent or less based on the dry weight of the flakes.

A known amount of the dried classified flakes is introduced into a conventional blender, such as a drum type 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." In one form of the invention an adhesive binder comprising Modur E441 Polyisocyanate, manufactured by Mobay Chemical Co., is applied at a rate of 8 percent and wax comprising Casco Wax EW 403-E, manufactured by Borden Chemical Co., is applied at a rate of 2 percent of the oven dry wood weight.

The furnish or blended wood flakes and binder is deposited by a mat former or dispensing system **30** (FIG. **5**) onto a caul plate **32** to form a loosely felted mat of wood flake material. In the illustrated arrangement, the mat former **30** includes a hopper **34** adapted to contain a quantity of furnish **36** comprised of the wood flakes mixed with binder. A conveyor belt **38** having a horizontal upper flight **40** is positioned beneath the hopper **34** and one or more picker wheels **42** are provided at the bottom of the hopper **34** to cause furnish to be metered through an opening **44** in the bottom of the hopper in a loosely dispersed state onto the upper flight **40** of the conveyor belt. The furnish is conveyed by the conveyor belt **38** from the hopper to the discharge end **39** of the conveyor belt where it is deposited as a thin curtain **46** of loosely blended wood flakes.

A plurality of picker wheels **48** and **50** are also provided between the hopper **34** and the discharge end **39** of the conveyor belt for maintaining the furnish in a loosely dispersed state on the upper belt flight **40** and to provide for an even distribution of the flakes in a thin uniform layer across the width of the belt. The picker wheels **48** and **50** are positioned immediately above the upper flight of the belt and include radially extending fingers **52** adapted to engage the furnish as the picker wheels **48** and **50** are rotated. The picker wheels are rotated in a clockwise direction as seen in FIG. **5** such that the downwardly extending ends of the fingers **52** move in a direction opposite to the direction of the upper flight **40** of the conveyor **38**.

In the illustrated arrangement, means are also provided for supporting the caul plate **32** beneath the discharge end **39** of the conveyor belt **38** such that the caul plate **32** can be reciprocated back and forth beneath the discharge end **39** of the conveyor and such that uniform thin layers of wood flakes will be deposited on the caul plate **32** as it is moved back and forth. As the flakes drop onto the caul plate, they will become oriented such that they will lie in horizontal planes and in interweaved loosely felted relation.

While various means could be provided for supporting the caul plate **32** for movement back and forth beneath the end of the conveyor, in the illustrated arrangement a track **54** is provided for supporting a wheeled cart **56**, and the cart **56** in turn supports the caul plate **32** in horizontal relation. Means are also provided for causing reciprocal movement of the cart **56**. While various means could be used to cause movement of the cart beneath the end **39** of the conveyor, in the illustrated construction that means includes a cable **58** reeved over a pair of pulleys **60** and connected to the cart **56** by a connecting structure **62**, the connecting structure **62** being fixed to the cart **56** and being fixed to the cable **58**. The cable **58** is driven by a reversing electric motor **64**.

In one embodiment of the invention, the loosely felted mat is built up by passing the caul plate **32** at a uniform rate beneath the discharge end **39** of the conveyor a total of 16 passes, and the furnish is deposited on the caul sheet **16** in even layers at the rate of three pounds per pass to form a mat having a thickness of approximately 6 inches.

In the illustrated arrangement, the caul plate **32** will have a configuration as illustrated in FIG. **4** and defining the bottom of the pallet **10** to be formed, and the lower die **68** of the press **70** is constructed such that it can house the caul plate **32**, with the caul plate **32** positioned directly in the lower die **68** during the pressing operation.

In one embodiment of the invention, the caul plate **32** can be moved back and forth beneath the discharge end **39** of the conveyor **38** until the leg cavities **72** of the caul plate **32** are filled with furnish. The caul plate **32** can then be removed from the carriage **56**, and a vacuum mask **74** (FIG. **7**) is positioned over the caul plate **32**. The vacuum mask **74** includes a rectangular chamber or housing adapted to fit over the caul plate, and the housing is provided with a plurality of fixed plates **76** adapted to engage the upper surface of the caul plate to cover the leg cavities **72**. The fixed plates **76** function to hold the wood flakes in the leg cavities in place. A vacuum hose (not shown) is connected to the housing **74** and functions to remove any wood flakes on the caul sheet **72** not secured in place by the fixed plates **76**.

After the leg cavities **72** are filled with furnish, and the excess furnish is removed from the surface of the caul plate, the caul plate **32** is again placed on the carriage **56** for movement back and forth beneath the discharge end **39** of the conveyor belt.

Means are also provided for causing a first portion of the wood flakes deposited on the caul plate **32** to be aligned in parallel relation to each other, this first portion of the wood flakes being those flakes forming the portion of the loosely felted mat which will become the legs **16** of the molded pallet **10**.

In the illustrated construction this means for causing the flakes to be aligned includes a flake aligner **80** (FIGS. **8** and **9**) supported above the caul plate **32** as the caul plate **32** moves back and forth under the mat former **30**. The flake aligner **80** is comprised of a rigid rectangular frame **82** including side members **84** and end members **86**, the frame **82** being open at the top and bottom. The frame **82** is positionable on the caul plate **32** or carriage **56** such that furnish can fall through the frame **82** onto the caul plate. The frame includes two sets of planar baffle plates **88** housed in the opening defined by the frame **82**, one of the sets of baffle plates **88** being positioned over one row of leg cavities **72** of the caul sheet and the other set of baffle plates **88** being positioned above a second row of leg cavities **72** of the caul sheet. Each set of baffle plates **88** is comprised of a plurality of spaced apart thin sheet metal plates supported at their opposite ends by the end walls **86** of frame **82**. The plates are spaced apart by a distance greater than the width of the widest flakes to be deposited on the caul sheet **32** but substantially less than the length of most of the flakes such that as the flakes fall from the discharge end **39** of the conveyor belt onto the moving caul sheet **32**, the baffle plates will result in

alignment of the flakes falling onto that area of the caul sheet **32** including the leg cavities **72**. In one form of the invention, the baffle plates are spaced apart by approximately 1.5 inches.

As seen in FIG. **9**, in a preferred form of the invention, the height of the baffle plates **88** is varied or staggered to prevent the flakes from lying across the baffle plates **88** and for causing the flakes to fall between the baffle plates so that they become aligned.

In a preferred form of the invention the caul plate **32** having the flake aligner **80** positioned thereon will be moved beneath the mat former four times to form a first layer of wood flakes. The flake aligner **80** is then removed and a second flake aligner **90** (FIG. **10**) is positioned above the caul plate **32**. The second flake aligner **90** is intended to provide a means for causing a portion of the loosely felted flakes forming the next layers to be aligned in directions transverse to the direction of alignment of the wood flakes of the first layer. More particularly, the second flake aligner **90** includes a rectangular frame **92** similar to frame **82** and adapted to be positioned above the caul sheet **32** and to be supported by the carriage **56**. The second flake aligner **90** also includes a plurality of sets of baffle plates **94**, each set of baffle plates **94** including a plurality of baffle plates positioned in side-by-side spaced apart relation and extending inwardly from the sides **96** of the frame **92**. The sets of baffle plates **94** are intended to be positioned above the leg cavities **72** of the caul sheet **32**, and the aligned flakes of the first layer of flakes. In a preferred arrangement, the baffle plates **94** of the second flake aligner **90** have a staggered height to facilitate alignment of the flakes and to prevent the flakes from lying across two or more baffle plates. In a preferred form of the invention, the baffle plates **94** of the second flake aligner will be spaced apart approximately 1.5 inches.

In one embodiment of the invention, the caul plate **32** having the second flake aligner **90** thereon is moved back and forth beneath discharge end **39** Of the conveyor belt **38** for eight passes to build up additional layers of wood flakes on the caul sheet **32**.

The second flake aligner **90** is then removed and a third frame structure **100** is placed above the caul sheet **32** for the remainder of the passes under the mat former and until a mat having a thickness of approximately **6** inches is formed on the caul sheet. The third frame structure **100** includes a rectangular frame **102** like those of the first and second flake aligners, and further includes a plurality of intersecting rods **104** supported by the rectangular frame **102**, the intersecting rods **104** supporting a plurality of cylinders **106** provided to cause the flakes falling onto the mat to be diverted away from areas of the mat. Diversion of flakes from these areas during formation of the top layers of the mat aids in molding of channels during the pressing operation.

Once the mat has been formed on the caul sheet **32**, the caul sheet is positioned on the lower die plate **68** of the press with the legs **110** of the caul sheet **32** nested in complementary cavities **112** of the lower die plate **68**. The loosely felted mat is compressed between the heated die plates **68** and **114** to form a densified product. The compressed pallet **10** is then removed from the press, and the edges of the pallet are trimmed as required to form straight sides on the pallet and to meet the dimensional requirements of the pallet.

In one preferred form of the invention, the dies are maintained at a temperature of approximately 350° or more during the pressing operation to provide for proper cure of the binder.

Due to the alignment of the layers of wood flakes used to form the pallet legs and by filling the caul plate cavities with additional furnish material, during the initial steps of depositing wood flakes onto the caul plate, during the pressing operation, a pallet having relatively long legs can be formed in a single stage compressing operation and without formation of tears or voids in the mat material during the pressing operation.

While in the illustrated arrangement the caul plate has a configuration complementing the configuration of the lower die plate, and is adapted to be inserted into the press during the molding operation, in other arrangements, furnish can be placed directly in the die cavities of the lower die plate and then the remainder of the loosely felted mat can be formed on a flat caul sheet with the wood flakes forming the mat being aligned in the same manner as described above. The caul sheet and mat are then placed between the dies of the press, and the caul sheet is stripped from the mat leaving the mat on the lower die plate.

In another embodiment of the invention, during the formation of the mat, a first layer or portion of the mat can contain aligned wood flakes in the areas to form the legs of the pallet. This portion of the mat can comprise approximately 25% of the mat thickness. The remainder of the mat can then be formed with randomly oriented wood flakes.

Various features of the invention are set forth in the following claims.

We claim:

**1**. A pallet comprising:

a generally flat rectangular deck having a major plane and a flat upper surface,

a plurality of spaced apart hollow leg members integral with said deck and projecting downwardly from said deck to support said deck,

said deck and said leg members being molded as a one-piece unit from a mixture of a resinous particle board binder and thin elongated wood flakes, said thin elongated wood flakes being deposited in a loosely felted layered mat onto a supporting surface such that said thin elongated wood flakes lie in horizontal planes, the loosely felted layered mat being formed by depositing a first layer of thin elongated wood flakes onto a supporting surface and then depositing a second layer of thin elongated wood flakes onto the first layer, the first layer of thin elongated wood flakes of said loosely felted mat having selected portions, the thin elongated wood flakes of said selected portions being aligned in a first direction substantially parallel to one another, and the remainder of the thin elongated wood flakes forming said first layer lying in horizontal relation but in random orientation with resect to one another, and the second layer of said loosely felted mat having selected portions overlying said selected portions of said first layer and said selected portions of said second layer being comprised of thin elongated wood flakes aligned in substantially parallel relation to one another in a direction substantially perpendicular to the direction of alignment of the elongated wood flakes of said selected portions of said first layer, and the remainder of the thin elongated wood flakes forming said second layer lying in horizontal relation but in random orientation with respect on one another, said loosely felted mat being compressed in a mold to form said one-piece unit, and said hollow leg members being molded from said selected portions of said first layer and said selected portion of second said layer.

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