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(54) LOAD BEARING STRUCTURE WITH INSERTS

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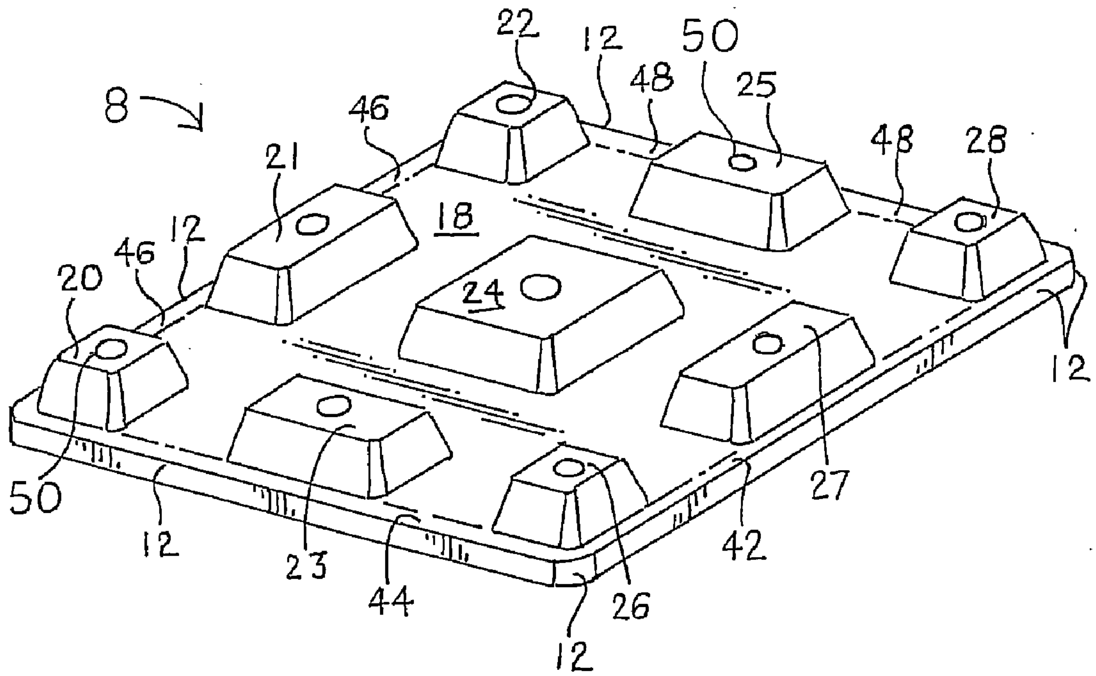
(57) **ABSTRACT**

A load-bearing platform that includes an expandable polymer matrix core and a skin disposed over a bottom side of the core. The core includes a base and a plurality of legs extending from one side of the base, the legs having one or more core insert openings in a bottom surface of the legs. The skin includes a plurality of legs, each adapted to accept a leg of the core and one or more skin insert openings corresponding to a core insert opening, where at least one leg insert per leg is inserted into an insert opening. The load bearing platform can be used for shipping articles.



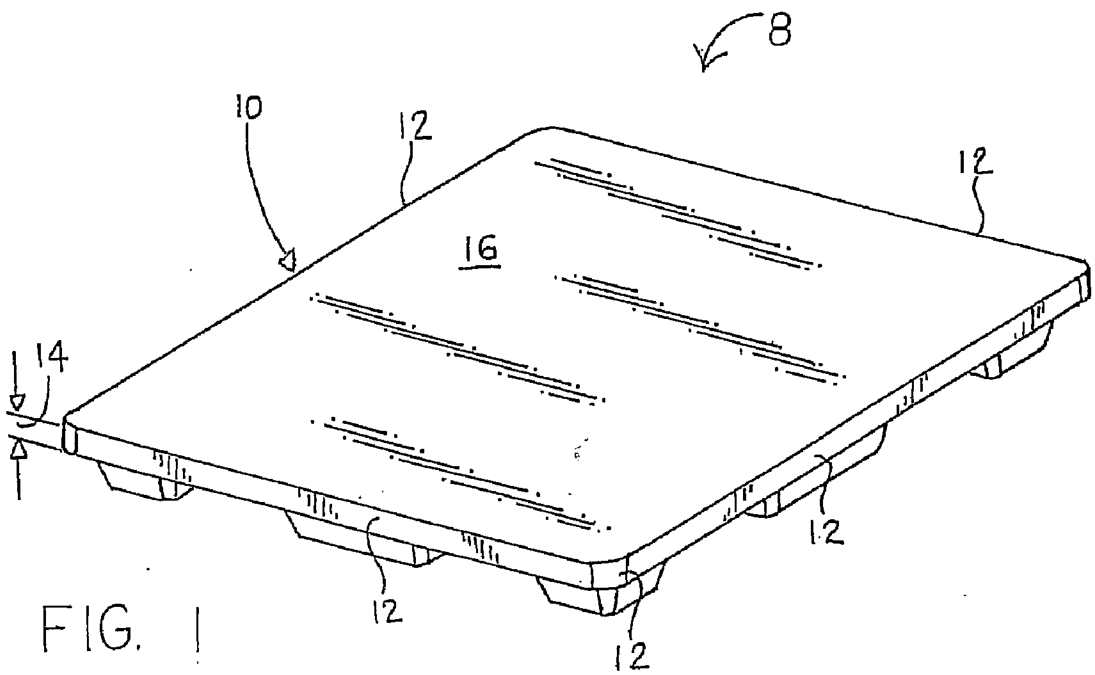

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FIG. 1

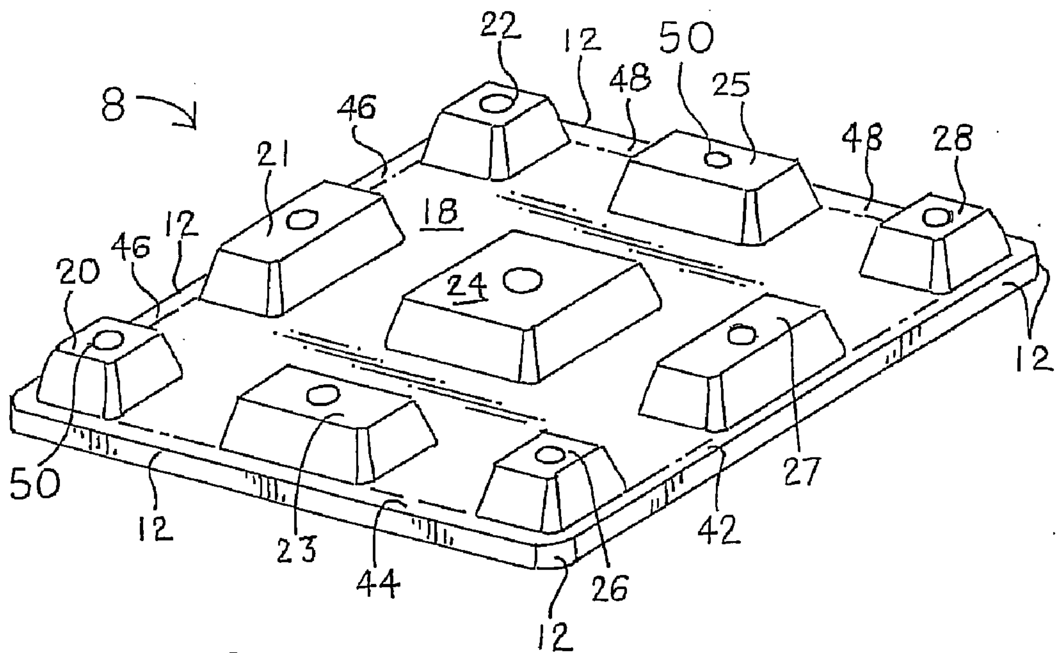
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FIG. 2

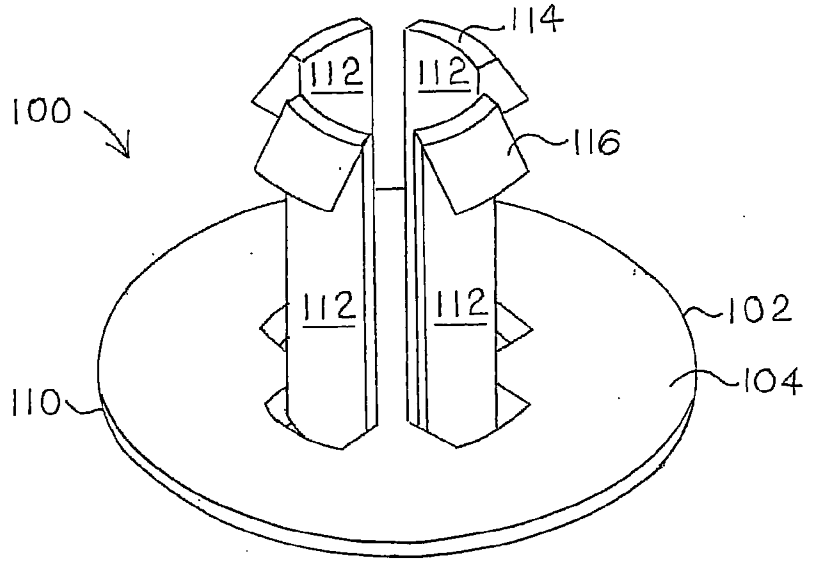

FIG. 3

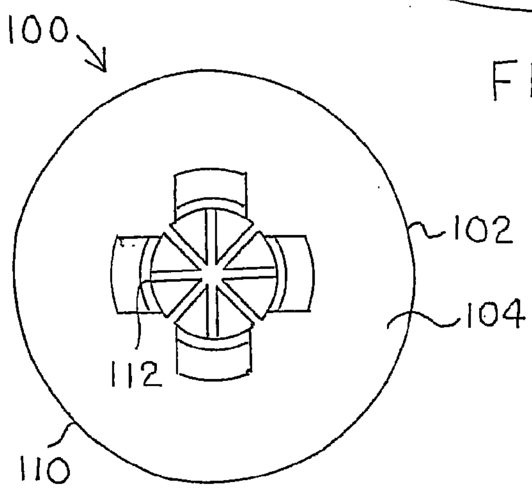

FIG. 4

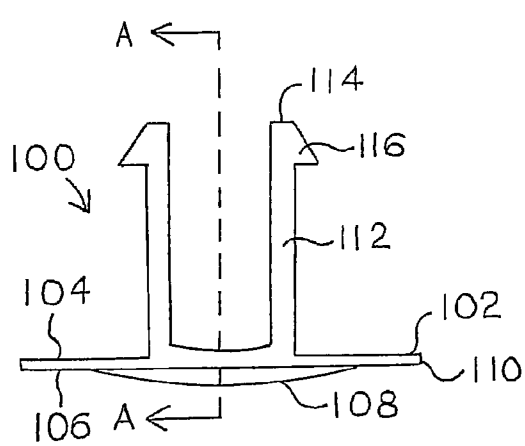

FIG. 5

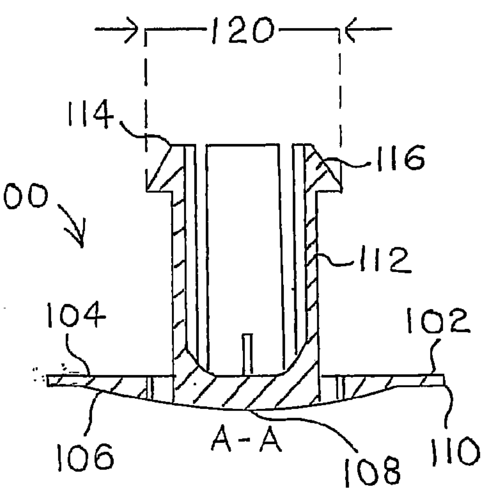

FIG. 6

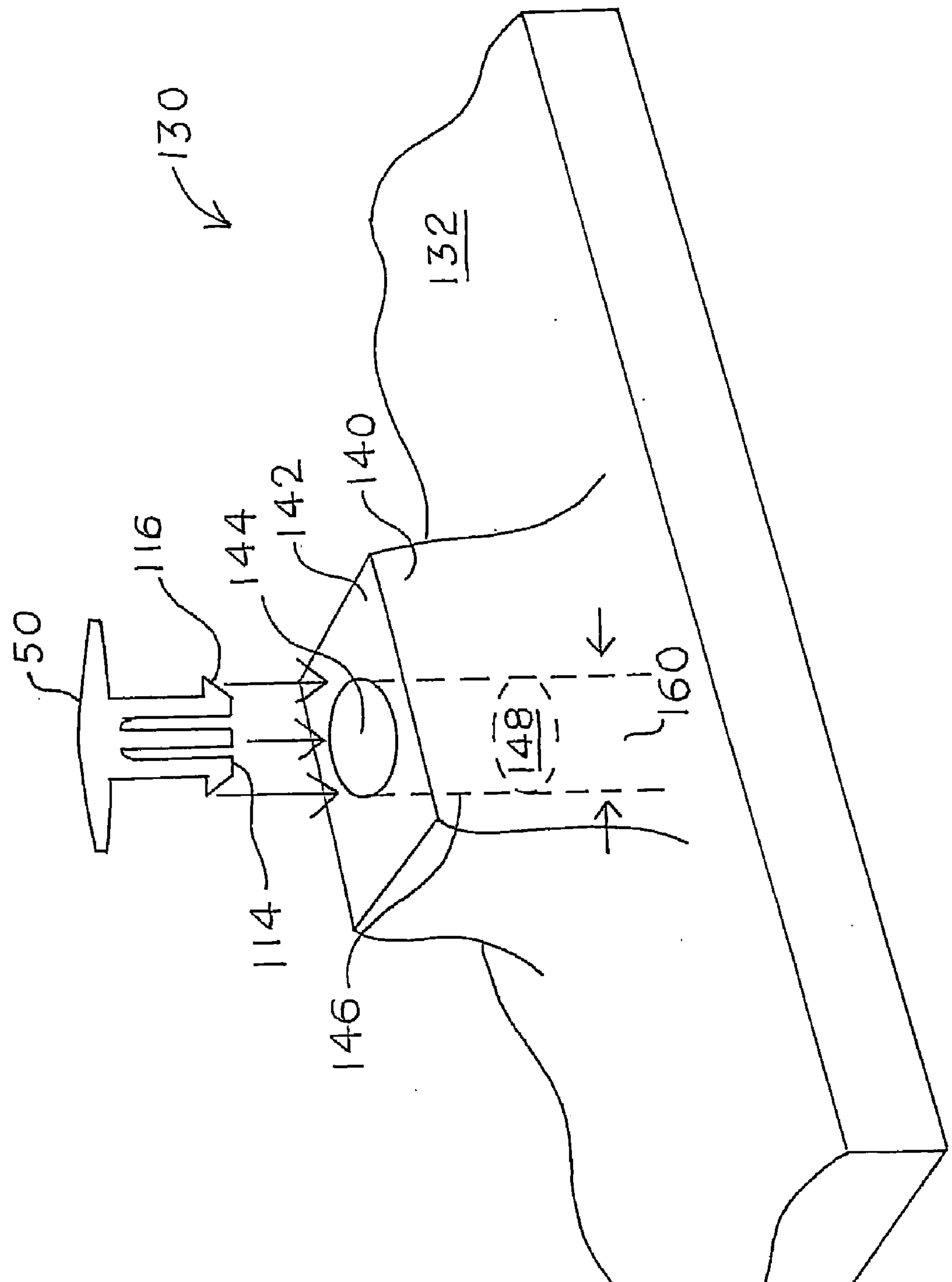

FIG. 7

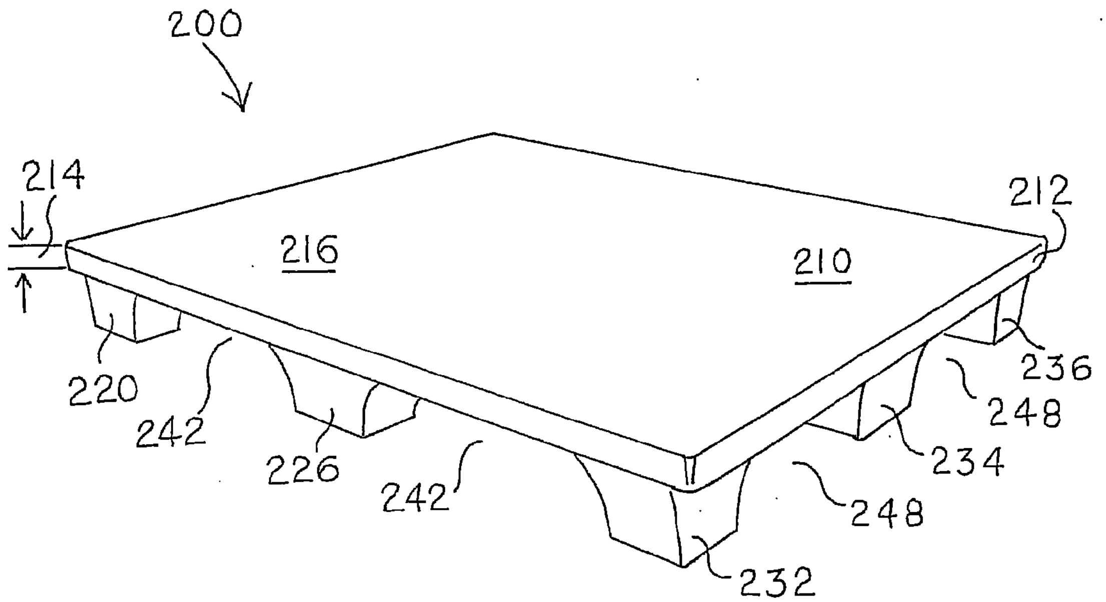
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FIG. 8

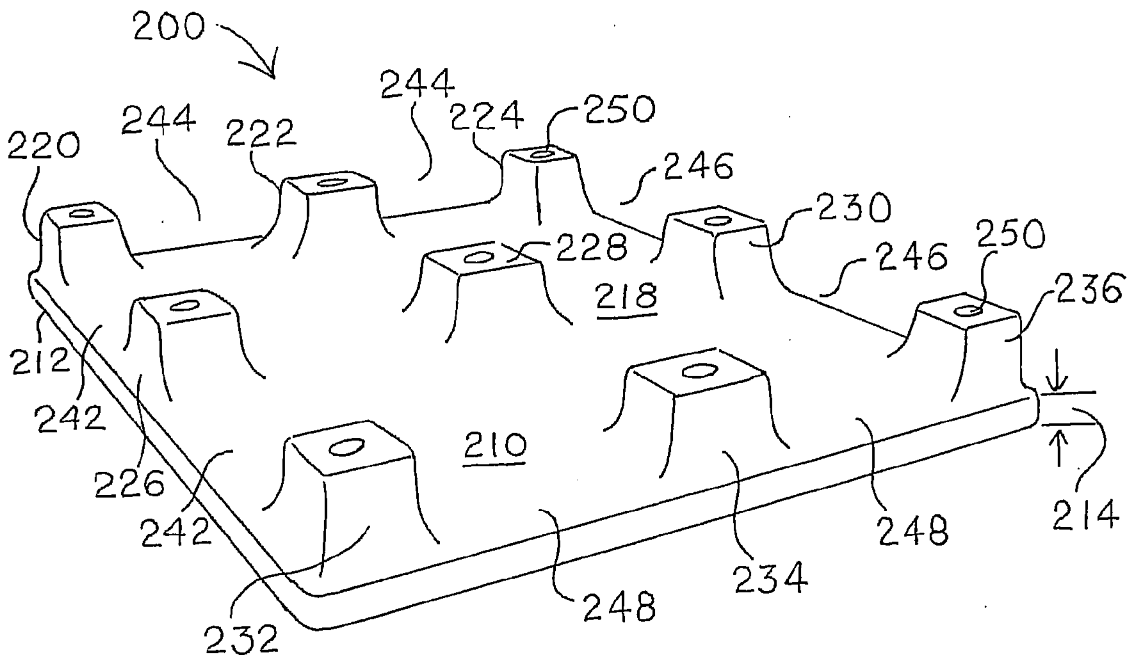
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FIG. 9

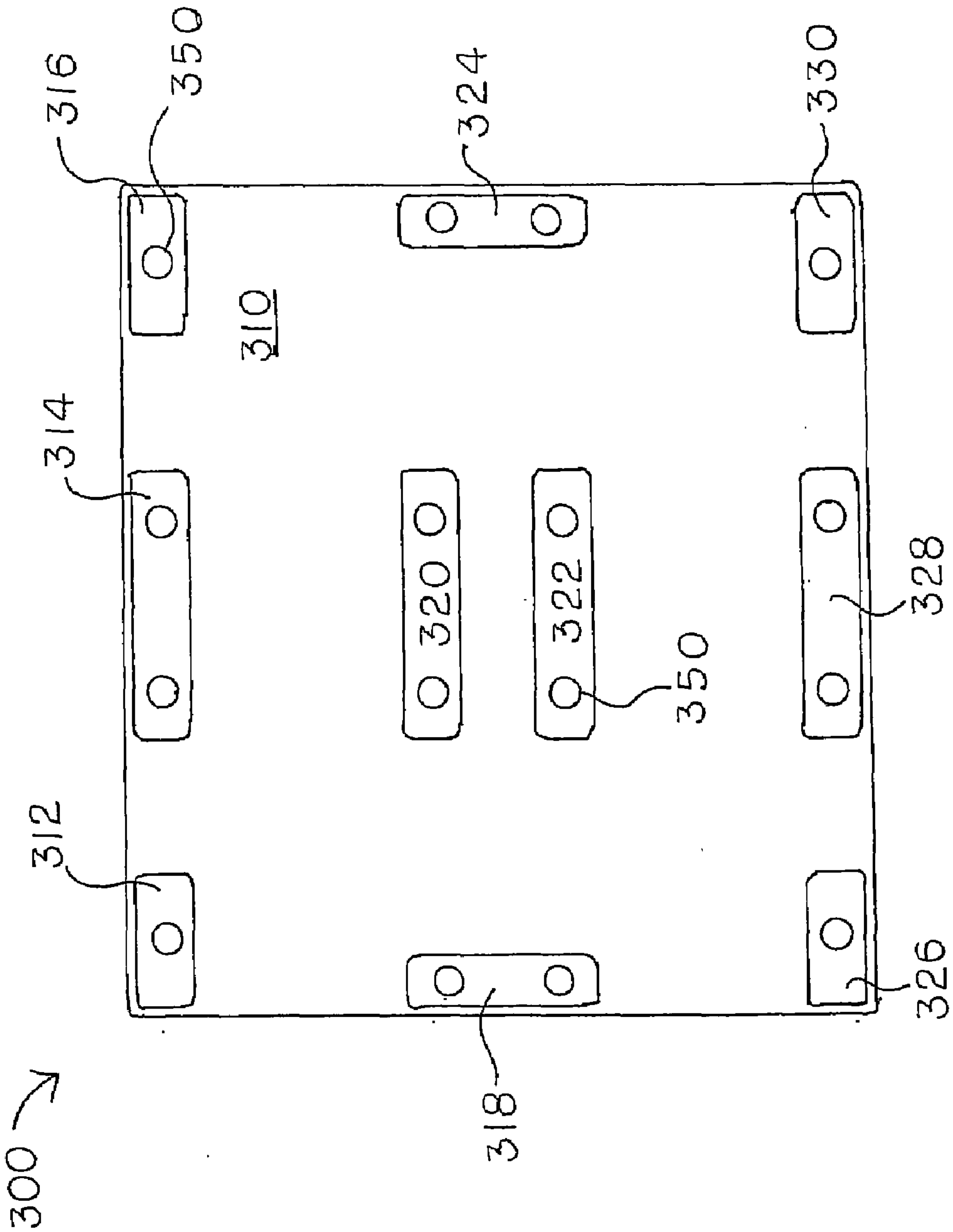

FIG. 10

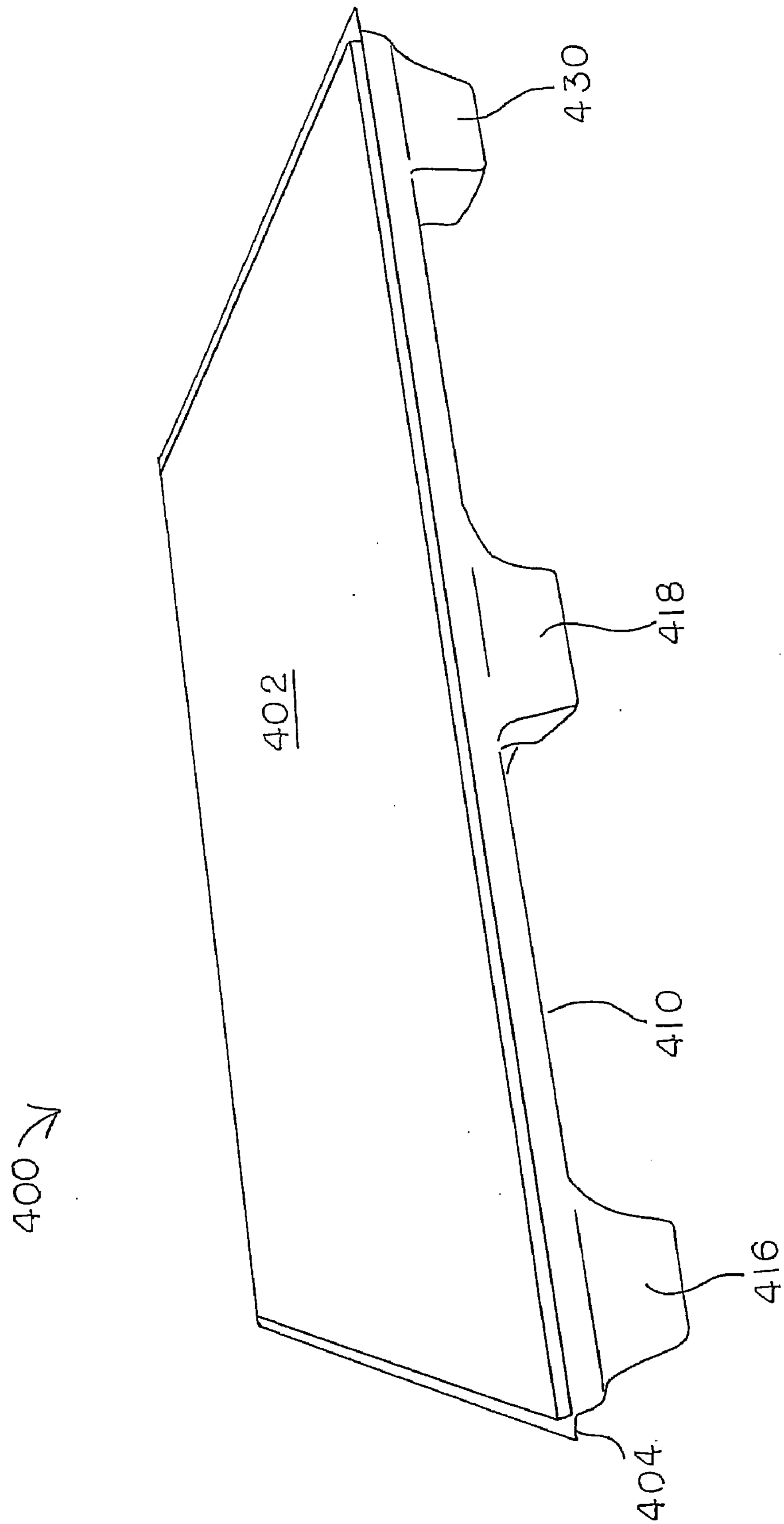

FIG. 11

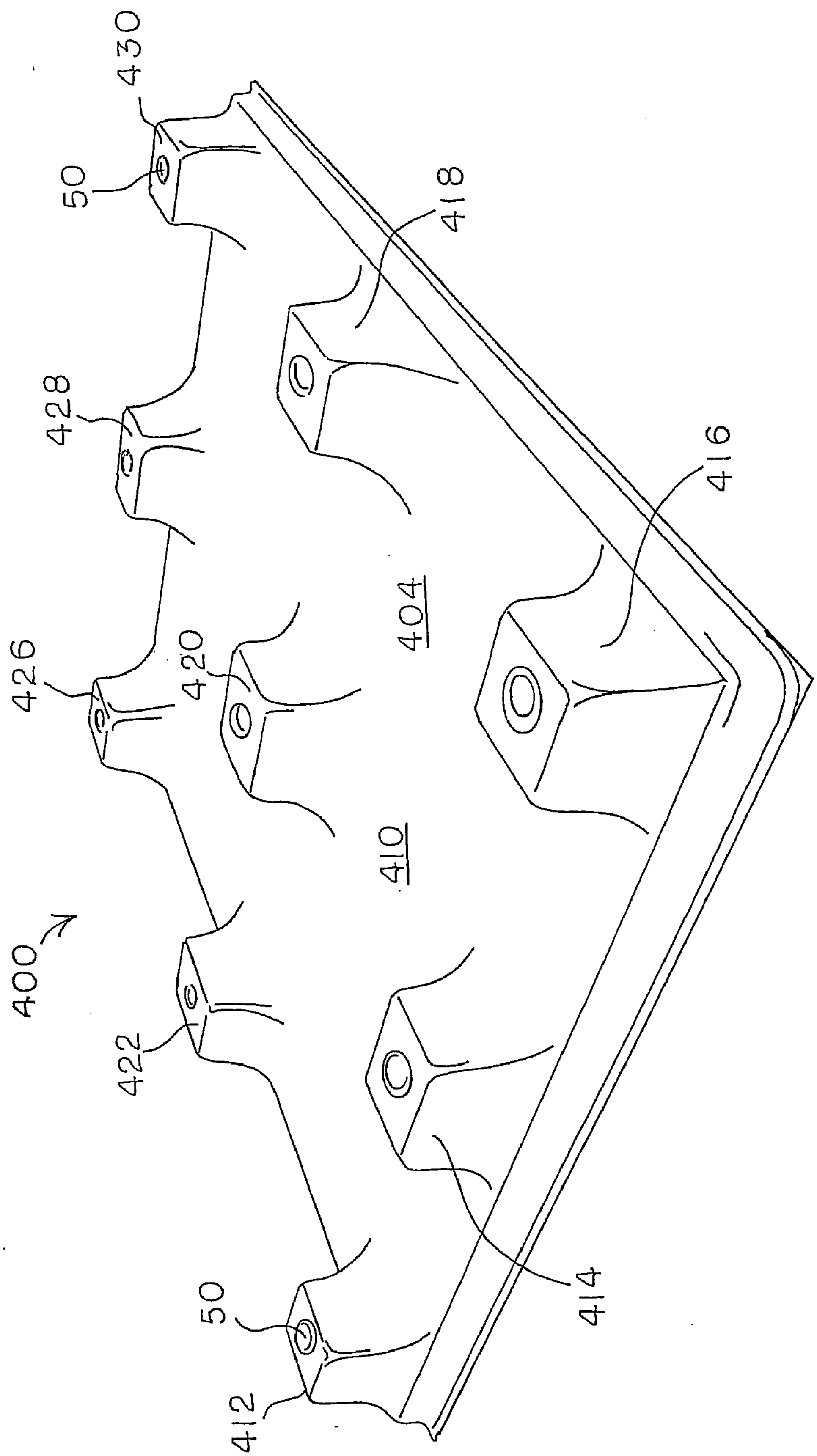

FIG. 12

LOAD BEARING STRUCTURE WITH INSERTS

[0001] This application claims the benefit of priority of U.S. Provisional Application Ser. No. 60/809,913, filed Jun. 1, 2006, and 60/844,836, filed Sep. 15, 2006, both entitled "Load Bearing Structure With Inserts" which are both herein incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention is directed to novel load-bearing structures, such as pallets, generally used for stacking articles on for storage and/or shipping.

[0004] 2. Description of the Prior Art

[0005] A shipping pallet is a well known load-bearing, moveable platform whereon articles are placed for storage and/or shipment. The pallet usually is loaded with a multiplicity of items, such as cartons or boxes. The loaded pallet is movable, usually with the aid of either a pallet truck or a forklift. Generally, pallets are made from wood.

[0006] The weight of the wood pallet is in the range of from forty to seventy pounds. Therefore, the weight of cargo shipped on the wood pallet is reduced by from forty to seventy pounds to provide for the weight of the wood pallet. This severely limits the amount of goods that can be shipped, especially by air.

[0007] Further, numerous injuries caused by wood splinters and nails are frequent occurrences among people who handle wood pallets. Additionally, disposal of wood pallets is a frequent concern.

[0008] There has been concern among nations about the use of the wood pallet causing an import of wood-boring insects, including the Asian Longhorned Beetle, the Asian Cerambycid Beetle, the Pine Wood Nematode, the Pine Wilt Nematode and the Anoplophora Glapripwnnis. Exemplary of damage caused by imported insects is the fate of the Chestnut Tree in the United States. There was a time when it was said that a squirrel could cross the United States on Chestnut Tree limbs without ever touching the ground. Insect infestation has caused the extinction of the Chestnut Tree in the United States.

[0009] Efforts to overcome the disadvantages of wood pallets have lead to molded foam plastic pallets. For example, U.S. Pat. No. 6,786,992 discloses a pallet having an expanded polystyrene core and a layer of high impact polystyrene covering a portion of the core.

[0010] U.S. Patent Application Publication No. 2005/0263044 discloses a pallet that includes a shape defining compressible core member, having at least one surface including a convex feature and a core member perimeter; and a thermoplastic shell having a shell interior and a shell edge, where the shell includes a first pliable thermoplastic sheet having an interior shaped by the convex surface of the core member and a first sheet edge extending outside of the core member perimeter, and a second pliable thermoplastic sheet having a second sheet interior and second sheet edge extending outside of the core member perimeter.

[0011] Generally, pallets made from plastics, especially foamed plastics, are not as strong as traditional wood pallets and, therefore, break under the load-bearing stress applied during use. Additionally, pallets made of foamed plastics tend to stick to the floor and/or generally resist sliding when being manipulated with a forklift truck resulting in the pallet breaking at its weakest point. The inability of foamed plastic pallets to stand up to these handling stresses have made them undesirable.

[0012] Therefore, there is a need in the art to provide a lightweight pallet that can withstand the load-bearing stress of repeated use and handling for shipping and/or storing articles traditionally found in wood pallets weight.

SUMMARY OF THE INVENTION

[0013] The present invention is directed to a load-bearing platform that includes an expandable polymer matrix core and a skin disposed over a bottom side of the core. The core includes a base and a plurality of legs extending from one side of the base, the legs having one or more core insert openings in a bottom surface of the legs. The skin includes a plurality of legs, each adapted to accept a leg of the core and one or more skin insert openings corresponding to a core insert opening, where at least one leg insert per leg is inserted into an insert opening.

[0014] The present invention also provides a method of shipping articles that includes loading articles onto a top surface of the above-described load bearing platform.

DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a top perspective view of a load bearing platform according to the invention;

[0016] FIG. **2** is a bottom perspective view of a load bearing platform according to the invention;

[0017] FIG. **3** is a perspective view of a leg insert according to the invention;

[0018] FIG. **4** is a top plan view of a leg insert according to the invention;

[0019] FIG. **5** is a side elevation view of a leg insert according to the invention;

[0020] FIG. **6** is a cross-sectional view of a leg insert according to the invention;

[0021] FIG. **7** is a perspective view of a leg part of a load bearing platform and a leg insert according to the invention;

[0022] FIG. **8** is a top perspective view of a load bearing platform according to the invention;

[0023] FIG. **9** is a bottom perspective view of a load bearing platform according to the invention;

[0024] FIG. **10** is a bottom plan view of a load bearing platform according to the invention;

[0025] FIG. **11** is a top perspective view of a skinned load bearing platform according to the invention; and

[0026] FIG. **12** is a bottom perspective view of a skinned load bearing platform according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0027] For the purpose of the description hereinafter, the terms "upper", "lower", "inner", "outer", "right", "left", "vertical", "horizontal", "top", "bottom", and derivatives thereof, shall relate to the invention as oriented in the drawing Figures. However, it is to be understood that the invention may assume alternate variations and step sequences except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings and described in the following specification, is an exemplary embodiment of the present invention. Hence, specific dimensions and other physical characteristics related to the embodiment disclosed herein are not to be considered as limiting the invention. In describing the embodiments of the present invention, reference will be made herein to the drawings in which like numerals refer to like features of the invention.

[0028] Other than in the operating examples or where otherwise indicated, all numbers or expressions referring to quantities of ingredients, reaction conditions, etc. used in the specification and claims are to be understood as modified in all instances by the term "about". Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following specification and attached claims are approximations that can vary depending upon the desired properties, which the present invention desires to obtain. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

[0029] Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical values, however, inherently contain certain errors necessarily resulting from the standard deviation found in their respective testing measurements.

[0030] Also, it should be understood that any numerical range recited herein is intended to include all sub-ranges subsumed therein. For example, a range of "1 to 10" is intended to include all sub-ranges between and including the recited minimum value of 1 and the recited maximum value of 10; that is, having a minimum value equal to or greater than 1 and a maximum value of equal to or less than 10. Because the disclosed numerical ranges are continuous, they include every value between the minimum and maximum values. Unless expressly indicated otherwise, the various numerical ranges specified in this application are approximations.

[0031] As used herein, the term "expandable polymer matrix" refers to a polymeric material in particulate or bead form that is impregnated with a blowing agent such that when the particulates and/or beads are placed in a mold and heat is applied thereto, evaporation of the blowing agent (as described below) effects the formation of a cellular structure and/or an expanding cellular structure in the particulates and/or beads and the outer surfaces of the particulates and/or beads fuse together to form a continuous mass of polymeric material conforming to the shape of the mold.

[0032] As used herein, the terms "expanded plastics" and "expanded resin beads" refer to thermoplastic particles that have been impregnated with a blowing agent, at least some of which is subsequently removed (as a non-limiting example heated and expanded followed by evaporation and diffusion out of the bead) in a way that increases the volume of the particles and accordingly decreases their bulk density.

[0033] As used herein, the term "thermoplastic" refers to materials that are capable of softening, fusing, and/or modifying their shape when heated and of hardening again when cooled.

[0034] As used herein, the term "polymer" is meant to encompass, without limitation, homopolymers, copolymers and graft copolymers.

[0035] As used herein, the term "polyolefin" refers to a polymer prepared from at least one olefinic monomer, such as alpha unsaturated C_2-C_{32} linear or branched alkenes, non-limiting examples of which include ethylene, propylene, 1-butene, 1-hexene and 1-octene.

[0036] As used herein, the term "polyethylene" refers to and includes not only a homopolymer of ethylene, but also an ethylene copolymer containing units of at least 50 mole %, in some cases at least 70 mole %, and in other cases at least 80 mole % of an ethylene unit and a corresponding proportion of units from a monomer copolymerizable with ethylene, and blends containing at least 50% by weight, in some cases at least 60% by weight, and in other cases at least 75% by weight of an ethylene homopolymer or copolymer with another polymer.

[0037] Non-limiting examples of monomers that can be copolymerized with ethylene include vinyl acetate, vinyl chloride, propylene, 1-butene, 1-hexene, and (meth)acrylic acid and its esters.

[0038] Polymers that can be blended with ethylene homopolymers or copolymers include any polymer compatible with ethylene homopolymers or copolymers. Non-limiting examples of polymers that can be blended with ethylene homopolymers or copolymers include polypropylene, polybutadiene, polyisoprene, polychloroprene, chlorinated polyethylene, polyvinyl chloride, styrene/butadiene copolymers, vinyl acetate/ethylene copolymers, acrylonitrile/butadiene copolymers, styrene/butadiene/acrylonitrile copolymers, and vinyl chloride/vinyl acetate copolymer.

[0039] As used herein, the term "styrenic polymers" refers to homopolymers of styrenic monomers and copolymers of styrenic monomers and other copolymerizable monomers, where the styrenic monomers make up at least 50 mole percent of the monomeric units in the copolymer. Non-limiting examples of styrenic monomers include styrene, p-methyl styrene, α-methyl styrene, tertiary butyl styrene, dimethyl styrene, nuclear brominated or chlorinated derivatives thereof and combinations thereof. Non-limiting examples of suitable copolymerizable monomers include 1,3-butadiene, C_1-C_{32} linear, cyclic or branched alkyl (meth) acrylates (specific non-limiting examples include butyl (meth)acrylate, ethyl (meth)acrylate, methyl (meth)acrylate, and 2-ethylhexyl (meth)acrylate), acrylonitrile, vinyl acetate, alpha-methyl-ethylene, divinyl benzene, maleic anhydride, maleic acid, fumaric acid, C_1-C_{12} linear, branched or cyclic mono- and di-alkyl esters of maleic acid, C_1-C_{12} linear, branched or cyclic mono- and di-alkyl esters of fumaric acid, itaconic acid, C_1-C_{12} linear, branched or cyclic mono- and di-alkyl esters of itaconic acid, itaconic anhydride and combinations thereof.

[0040] As used herein, the terms "(meth)acrylic" and "(meth)acrylate" are meant to include both acrylic and methacrylic acid derivatives, such as the corresponding alkyl esters often referred to as acrylates and (meth)acrylates, which the term "(meth)acrylate" is meant to encompass.

[0041] As used herein, the term "molding" refers to the shaping of a pliable material to assume a new desired shape. Molding can involve the use of specific molding tools such as male and female molding tools, sculptured platens, and the like. It can also include the use of specifically shaped core members including compressible core members that are used to impart a desired shape to at least a portion of a thermoplastic material.

[0042] As used herein, the term "expansion factor" refers to the volume a given weight of expanded polymer bead occupies, typically expressed as cc/g.

[0043] The present invention provides a load-bearing platform that includes a base, a plurality of legs extending from one side of the base and one or more leg inserts inserted into a bottom surface of one or more of the legs.

[0044] The present load-bearing platform is made from an expandable polymer matrix, which can include one or more expandable plastics.

[0045] Suitable expandable plastics include, but are not limited to interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers, expandable polystyrene (EPS), expandable styrenic polymers, expandable polyolefins, rubber modified styrenic polymers where the styrenic polymer constitutes a continuous phase and the rubber constitutes a dispersed phase in the resin, rubber modified styrenic polymers where the rubber constitutes a continuous phase and the styrenic polymer constitutes a dispersed phase in the resin as described in copending U.S. Patent Application Publication No. 2006/0276558, the relevant portions of which are herein incorporated by reference, polyphenylene oxide, and combinations and blends thereof.

[0046] In an embodiment of the invention, the expandable plastics can include one or more polymers selected from homopolymers of vinyl aromatic monomers; copolymers of at least one vinyl aromatic monomer with one or more of divinylbenzene, conjugated dienes, alkyl methacrylates, alkyl acrylates, acrylonitrile, and/or maleic anhydride; polyolefins; polycarbonates; polyesters; polyamides; natural rubbers; synthetic rubbers; and combinations thereof.

[0047] In a particular embodiment of the invention, the expandable plastics include thermoplastic homopolymers or copolymers selected from homopolymers derived from vinyl aromatic monomers including styrene, isopropylstyrene, alpha-methylstyrene, nuclear methylstyrenes, chlorostyrene, tert-butylstyrene, and the like, as well as copolymers prepared by the copolymerization of at least one vinyl aromatic monomer as described above with one or more other monomers, non-limiting examples being divinylbenzene, conjugated dienes (non-limiting examples being butadiene, isoprene, 1,3- and 2,4-hexadiene), alkyl methacrylates, alkyl acrylates, acrylonitrile, and maleic anhydride, wherein the vinyl aromatic monomer is present in at least 50% by weight of the copolymer. In an embodiment of the invention, styrenic polymers are used, particularly polystyrene. However, other suitable polymers can be used, such as polyolefins (e.g. polyethylene, polypropylene), polycarbonates, polyphenylene oxides, and mixtures thereof.

[0048] In a more particular embodiment of the invention, the expandable plastics include expandable polystyrene (EPS) particles. These particles can be in the form of beads, granules, or other particles convenient for the expansion and molding operations.

[0049] In the present invention, the expandable plastics can be particles polymerized in a suspension process, which are essentially spherical resin beads useful for making expandable polymer particles. However, polymers derived from solution and bulk polymerization techniques that are extruded and cut into particle sized resin bead sections can also be used.

[0050] In an embodiment of the invention, resin beads (unexpanded) of expandable plastics containing any of polymers or polymer compositions described herein can have a particle size of at least 0.2, in some situations at least 0.33, in some cases at least 0.35, in other cases at least 0.4, in some instances at least 0.45 and in other instances at least 0.5 mm. Also, the resin beads can have a particle size of up to 3, in some instances up to 2, in other instances up to 2.5, in some cases up to 2.25, in other cases up to 2, in some situations up to 1.5 and in other situations up to 1 mm. The resin beads used in this embodiment can be any value or can range between any of the values recited above.

[0051] The expandable plastic particles or resin beads can optionally be impregnated using any conventional method with a suitable blowing agent. As a non-limiting example, the impregnation can be achieved by adding the blowing agent to the aqueous suspension during the polymerization of the polymer, or alternatively by re-suspending the polymer particles in an aqueous medium and then incorporating the blowing agent as taught in U.S. Pat. No. 2,983,692. Any gaseous material or material which will produce gases on heating can be used as the blowing agent. Conventional blowing agents include aliphatic hydrocarbons containing 4 to 6 carbon atoms in the molecule, such as butanes, pentanes, hexanes, and the halogenated hydrocarbons, e.g., CFC's and HCFC's, which boil at a temperature below the softening point of the polymer chosen. Mixtures of these aliphatic hydrocarbon blowing agents can also be used.

[0052] Alternatively, water can be blended with these aliphatic hydrocarbon blowing agents or water can be used as the sole blowing agent as taught in U.S. Pat. Nos. 6,127,439; 6,160,027; and 6,242,540, In these patents, water-retaining agents are used. The weight percentage of water for use as the blowing agent can range from 1 to 20%. The text of U.S. Pat. Nos. 6,127,439, 6,160,027 and 6,242,540 are incorporated herein by reference.

[0053] The impregnated resin beads are optionally expanded to a bulk density of at least 0.5 lb/ft^3 (0.008 g/cc), in some cases at least 1.25 lb/ft^3 (0.02 g/cc), in other cases at least 1.5 lb/ft^3 (0.024 g/cc), in some situations at least 1.75 lb/ft^3 (0.028 g/cc), in some circumstances at least 2 lb/ft^3 (0.032 g/cc), in other circumstances at least 3 lb/ft^3 (0.048 g/cc), and in particular circumstances at least 3.25 lb/ft^3 (0.052 g/cc) or 3.5 lb/ft^3 (0.056 g/cc). When non-expanded resin beads are used, higher bulk density beads can be used. As such, the bulk density can be as high as 40 lb/ft^3 (0.64 g/cc). The bulk density of the polymer particles can be any value or range between any of the values recited above.

[0054] The expansion step is conventionally carried out by heating the impregnated beads via any conventional heating medium, such as steam, hot air, hot water, or radiant heat. One generally accepted method for accomplishing the pre-expansion of impregnated thermoplastic particles is taught in U.S. Pat. No. 3,023,175.

[0055] The impregnated resin beads can be foamed cellular polymer particles as taught in U.S. Patent Application Publication No. 2002-0117769 A1, the teachings of which are incorporated herein by reference. The foamed cellular particles can be polystyrene that are expanded and contain a volatile blowing agent at a level of less than 14 wt. %, in some situations less than 6 wt. %, in some cases ranging from about 2 wt. % to about 5 wt. %, and in other cases ranging from about 2.5 wt. % to about 3.5 wt. % based on the weight of the polymer.

[0056] The expandable polymer matrix can include an interpolymer of a polyolefin and in situ polymerized vinyl aromatic monomers and optionally other expandable polymers.

[0057] In the embodiments of the invention, the interpolymer of a polyolefin and in situ polymerized vinyl aromatic monomers is one or more of those described in U.S. Pat. Nos. 3,959,189; 4,168,353; 4,303,756; 4,303,757 and 6,908,949, the relevant portions of which are herein incorporated by reference. A non-limiting example of such interpolymers that can be used in the present invention include those available under the trade name ARCEL®, available from NOVA Chemicals Inc., Pittsburgh, Pa. and PIOCELAN®, available from Sekisui Plastics Co., Ltd., Tokyo, Japan.

[0058] In the embodiments of the invention, the interpolymer of a polyolefin and in situ polymerized vinyl aromatic monomers is a particle or resin bead, which is subsequently processed to form the load bearing structures according to the present invention. The interpolymer particles used in the invention include a polyolefin and an in situ polymerized vinyl aromatic resin that form an interpenetrating network of polyolefin and vinyl aromatic resin particles. The interpolymer particles are impregnated with a blowing agent and optionally, a plasticizer.

[0059] Such interpolymer particles can be obtained by processes that include suspending polyolefin particles and vinyl aromatic monomer or monomer mixtures in an aqueous suspension and polymerizing the monomer or monomer mixtures inside the polyolefin particles. Non-limiting examples of such processes are disclosed in U.S. Pat. Nos. 3,959,189, 4,168,353 and 6,908,949.

[0060] In an embodiment of the invention, the polyolefin includes one or more polyethylene resins selected from low-, medium-, and high-density polyethylene, an ethylene vinyl acetate copolymer, an ethylene/propylene copolymer, a blend of polyethylene and polypropylene, a blend of polyethylene and an ethylene/vinyl acetate copolymer, and a blend of polyethylene and an ethylene/propylene copolymer. Ethylene-butyl acrylate copolymer and ethylene-methyl methacrylate copolymer can also be used.

[0061] The amount of polyolefin in the interpolymer resin particles of the invention can be at least 20%, in some cases at least 25%, and in other cases at least 30% and can be up to 80%, in some cases up to 70%, in other cases up to 60% and in some instances up to 55%, by weight based on the weight of the interpolymer resin particles. The amount of polyolefin in the interpolymer resin particles can be any value or range between any of the values recited above.

[0062] The amount of polymerized vinyl aromatic resin in the interpolymer resin particles of the invention ranges can be at least 20%, in some cases at least 30%, in other cases at least 40%, and in some instances at least 45%, and can be up to 80%, in some cases up to 75%, and in other cases up to 70%, by weight based on the weight of the interpolymer resin particles. The amount of polymerized vinyl aromatic resin in the interpolymer resin particles can be any value or range between any of the values recited above.

[0063] The vinyl aromatic resin can be made up of polymerized vinyl aromatic monomers or the resin can be a copolymer containing monomeric units from vinyl aromatic monomers and copolymerizable comonomers. Non-limiting examples of vinyl aromatic monomers that can be used in the invention include styrene, alpha-methylstyrene, ethylstyrene, chlorostyrene, bromostyrene, vinyltoluene, vinylbenzene, and isopropylxylene. These monomers may be used either alone or in admixture.

[0064] Non-limiting examples of copolymerizable comonomers include 1,3-butadiene, C_1-C_{32} linear, cyclic or branched alkyl (meth)acrylates (specific non-limiting examples include butyl (meth)acrylate, ethyl (meth)acrylate and 2-ethylhexyl (meth)acrylate), acrylonitrile, vinyl acetate, alpha-methylethylene, divinyl benzene, maleic anhydride, itaconic anhydride, dimethyl maleate and diethyl maleate.

[0065] Non-limiting examples of vinyl aromatic copolymers, that can be used in the invention, include those disclosed in U.S. Pat. No. 4,049,594. Specific non-limiting examples of suitable vinyl aromatic copolymers include copolymers containing repeat units from polymerizing styrene and repeat units from polymerizing one or monomers selected from 1,3-butadiene, C_1-C_{32} linear, cyclic or branched alkyl (meth)acrylates (specific non-limiting examples including butyl (meth)acrylate, ethyl (meth)acrylate and 2-ethylhexyl (meth)acrylate), acrylonitrile, vinyl acetate, alpha-methylethylene, divinyl benzene, maleic anhydride, itaconic anhydride, dimethyl maleate and diethyl maleate.

[0066] In particular embodiments of the invention, the vinyl aromatic resin includes polystyrene or styrene-butyl acrylate copolymers.

[0067] In general, the interpolymer resin particles are formed as follows: The polyolefin particles are dispersed in an aqueous medium prepared by adding 0.01 to 5%, in some cases 2 to 3%, by weight based on the weight of the water of a suspending agent such as water soluble high molecular weight materials, e.g., polyvinyl alcohol or methyl cellulose or slightly water soluble inorganic materials, e.g., calcium phosphate or magnesium pyrophosphate and soap, such as sodium dodecyl benzene sulfonate, and the vinyl aromatic monomers are added to the suspension and polymerized inside the polyolefin particles.

[0068] Any conventionally known and commonly used suspending agents for polymerization of vinyl aromatic monomers can be employed. These agents are well known in the art and can be freely selected by one skilled in the art. Initially, the water is in an amount generally from 0.7 to 5, preferably 3 to 5 times that of the starting polyolefin particles employed in the aqueous suspension, on a weight basis, and gradually the ratio of the polymer particles to the water may reach around 1:1.

[0069] The polymerization of the vinyl aromatic monomers, which is absorbed in the polyolefin particles, is carried out using initiators.

[0070] The initiators suitable for suspension polymerization of the vinyl aromatic monomers are generally used in an amount of about 0.05 to 2 percent by weight, in some cases 0.1 to 1 percent by weight, based on the weight of the vinyl aromatic monomer. Non-limiting examples of suitable initiators include organic peroxides such as benzoyl peroxide, lauroyl peroxide, t-butyl perbenzoate and t-butyl perpivalate and azo compounds such as azobisisobutylonitrile and azobisdimethylvaleronitrile.

[0071] These initiators can be used alone or two or more initiators can be used in combination. In many cases, the initiators are dissolved in the vinyl aromatic monomers, which are to be absorbed in the polyolefin particles. In other cases, the initiator can be dissolved in a solvent, such as toluene, benzene, and 1,2-dichloropropane.

[0072] When the in situ polymerization of the vinyl aromatic monomers is completed, the polymerized vinyl aromatic resin is uniformly dispersed inside the polyolefin particles.

[0073] In many cases, the polyolefin particles are cross-linked. The cross-linking can be accomplished simultaneously with the polymerization of the vinyl aromatic monomer in the polyolefin particles, and before impregnation of the blowing agent and/or plasticizer. For this purpose, cross-linking agents are used. Such cross-linking agents include, but are not limited to di-t-butyl-peroxide, t-butyl-cumylperoxide, dicumyl-peroxide, .alpha., .alpha.-bis-(t-butylperoxy)-p-diisopropylbenzene, 2,5-dimethyl-2,5-di-(t-butylperoxy)-hexyne-3,2,5-dimethyl-2,5-di-(benzoylperoxy)-hexane and t-butyl-peroxyisopropyl-carbonate. These cross-linking agents are absorbed in the polyolefin particles together with the vinyl aromatic monomers by dissolving the cross-linking agent in an amount of about 0.1 to 2 weight % and in some cases 0.5 to 1 weight %, based on the weight of the polyolefin particles suspended in water. Further details of the cross-linking agents and the manner for absorbing the cross-linking agents into the polyolefin particles are provided in U.S. Pat. No. 3,959,189.

[0074] In an embodiment of the invention, the interpolymer of a polyolefin and in situ polymerized vinyl aromatic monomers includes a rubber modified styrenic polymers where the rubber constitutes a continuous phase and the styrenic polymer constitutes a dispersed phase in the resin as described in copending U.S. Patent Application Publication No. 2006/0276558 the relevant portions of which are herein incorporated by reference.

[0075] The resulting expandable polymer matrix can be used as raw materials in producing foamed articles. The blowing agent and/or plasticizer are introduced into the expandable polymer matrix resin particles to form foamable or expandable particles or resin beads, which in turn, are used to mold foamed articles.

[0076] The blowing agent should have a boiling point lower than the softening point of the polyolefin and should be gaseous or liquid at room temperature (about 20 to 30° C.) and normal pressure (about atmospheric). Blowing agents are well known in the art and generally have boiling points ranging from −42° C. to 80° C., more generally, from −10° C. to 36° C. Suitable hydrocarbon blowing agents include, but are not limited to aliphatic hydrocarbons such as n-propane, n-butane, iso-butane, n-pentane, iso-pentane, n-hexane, and neopentane, cycloaliphatic hydrocarbons such as cyclobutane and cyclopentane, and halogenated hydrocarbons such as methyl chloride, ethyl chloride, methylene chloride, trichlorofluoromethane, dischlorofluoromethane, dichlorodifluormethane, chlorodifluoromethane and dichloroetetrafluoro-ethane, etc. These blowing agents can be used alone or as mixtures. If n-butane, ethyl chloride, and dichlorotetrafluoro-ethane, which are gaseous at room temperature and normal pressure, are used as a mixture, it is possible to achieve foaming to a low bulk density. Specific types of volatile blowing agents are taught in U.S. Pat. No. 3,959,180. In particular embodiments of the invention, the blowing agent is selected from n-pentane, iso-pentane, neopentane, cylcopentane, and mixtures thereof.

[0077] The amount of the blowing agent ranges from about 1.5% to about 20% by weight, in some cases about 1.5% to 15% by weight, and in other cases from 5% to 15% by weight, based on the weight of the expandable polymer matrix.

[0078] A plasticizer can be used in combination with the blowing agent and as stated herein above and acts as a blowing aid in the invention.

[0079] Suitable plasticizers include, but are not limited to benzene, toluene, limonene, linear, branched or cyclic C_5 to C_{20} alkanes, white oil, linear, branched or cyclic C_1 to C_{20} dialkylphthalates, styrene, oligomers of styrene, oligomers of (meth)acrylates having a glass transition temperature less than polystyrene, and combinations thereof.

[0080] In a particular embodiment of the invention, the plasticizer includes limonene, a mono-terpene hydrocarbon existing widely in the plant world. The known types are d-limonene, l-limonene, and dl-limonene. D-limonene is contained in the skin of citrus fruits and is used in food additives as a fragrant agent; its boiling point is about 176° C.; and its flammability is low. D-limonene is a colorless liquid, has a pleasant orange-like aroma, is approved as a food additive, and is widely used as a raw material of perfume. Limonene is not a hazardous air pollutant.

[0081] The amount of plasticizer can range from about 0.1 to 5 parts and in some cases from about 0.1 to about 1 part by weight per 100 parts by weight of the expandable polymer matrix.

[0082] In embodiments of the invention, the interpolymer particles can be produced as follows: In a first reactor, the polyolefin particles are suspended in an aqueous medium containing a dispersing agent. The dispersing agent can be polyvinyl alcohol, methylcellulose, calcium phosphate, magnesium pyrophosphate, calcium carbonate, tricalcium phosphate, etc. The amount of dispersing agent employed can be from 0.01 to 5% by weight based on the amount of water. A surfactant can be added to the aqueous medium. Generally, the surfactant is used to lower the surface tension of the suspension and helps to emulsify the water/vinyl aromatic monomer in mixture in the initiator and wax mixes, if used. Suitable waxes include polyethylene waxes and ethylene bistearamide. The aqueous medium is generally heated to a temperature at which the vinyl aromatic monomers can be polymerized, i.e., from about 60° C. to about 120° C. over a period of time, for example, 12 to 20 hours. Over this 12 to 20 hour period, the vinyl aromatic monomers, the vinyl aromatic polymerization initiator, and the cross-linking agent are added to the resulting suspension containing the polyolefin particles, which are dispersed in the aqueous medium. These materials may be added all at one time, or gradually in individual portions.

[0083] The interpolymer particles are acidified, dewatered, screened, and subsequently charged to a second reactor where the particles are impregnated with the blowing agent and/or plasticizer.

[0084] The impregnation step can be carried out by suspending the interpolymer particles in an aqueous medium, adding the blowing agent and/or plasticizer to the resulting suspension, and stirring at a temperature of, preferably, about 40° C. degrees to 80° C. The blowing agent and/or plasticizer can be blended together and then added to the interpolymer particles or can be added to the interpolymer particles separately.

[0085] Alternatively, the blowing agent and/or plasticizer can be added to the first reactor during or after the polymerization process.

[0086] The above processes describe a wet process for impregnation of the interpolymer particles. Alternatively, the interpolymer particles can be impregnated via an anhydrous process similar to that taught in Column 4, lines 20-36 of U.S. Pat. No. 4,429,059.

[0087] In an embodiment of the invention, the blowing agent can be dosed to the expandable polymer matrix in an extruder to produce resin pellets or beads. The extruder acts to mix the blowing agent into the expandable polymer matrix prior to extruding a strand of the mixture. The strand can be cut into bead or pellet lengths using an appropriate device, a non-limiting example being an underwater face cutter.

[0088] The particles and/or beads of the expandable polymer matrix according to the invention can also contain other additives known in the art, non-limiting examples including anti-static additives; flame retardants; colorants or dyes; filler materials and combinations thereof. Other additives can also include chain transfer agents, non-limiting examples including C_{2-15} alkyl mercaptans, such as n-dodecyl mercaptan, t-dodecyl mercaptan, t-butyl mercaptan and n-butyl mercaptan, and other agents such as pentaphenyl ethane and the dimer of alpha-methyl styrene. Other additives can further include nucleating agents, non-limiting examples including polyolefin waxes, i.e., polyethylene waxes.

[0089] The expandable polymer matrix can include interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers and optionally other expandable polymers. The other expandable polymers include those polymers that can provide desirable properties to the load bearing platform of the invention and that are compatible with the interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers. Non-limiting examples of other expandable polymers that can be used in the present invention include expandable polystyrene (EPS), expandable polyolefins, rubber modified styrenic polymers where the styrenic polymer constitutes a continuous phase and the rubber constitutes a dispersed phase in the resin, rubber modified styrenic polymers where the rubber constitutes a continuous phase and the styrenic polymer constitutes a dispersed phase in the resin as described in copending U.S. Patent Application publication No. 2006/0276558 the relevant portions of which are herein incorporated by reference, polyphenylene oxide, and combinations and blends thereof.

[0090] The expandable polymer matrix can contain 100% interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers, but can also contain up to 99%, in some cases up to 95%, in other cases up to 90%, in some instances up to 80% and in other instances up to 75% based on the weight of the expandable polymer matrix of interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers. Also, the expandable polymer matrix can contain at least 25%, in some cases at least 30%, in other cases at least 40% and in some instances at least 50% based on the weight of the expandable polymer matrix of interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers. The amount of interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers in the expandable polymer matrix can be any value or range between any of the values recited above.

[0091] When other expandable polymers are included in the expandable polymer matrix, the other expandable polymers can be present at a level of at least 1%, in some cases at least 5%, in other cases at least 10%, in some instances at least 20% and in other instances at least 25% based on the weight of the expandable polymer matrix. Also, the other expandable polymers can be present in the expandable polymer matrix at a level of up to 75%, in some cases up to 70%, in other cases up to 60% and in some instances up to 50% based on the weight of the expandable polymer matrix. The other expandable polymers can be included in the expandable polymer matrix at any level or range between any of the values recited above.

[0092] An embodiment of the load bearing structure according to the invention is shown in FIGS. **1** and **2**, where a load bearing structure **8** includes an expanded polymer matrix core **10**, which is in the general shape of a rectangular slab with an edge **12** that has a width **14** which can be from 1 to 25 cm, in some cases from 2 to 20 cm and in other cases from 2.5 to 15 cm. Core **10** has a topside **16** that can be from 75 to 150 cm, in some cases from 90 to 140 cm and in other cases from 100 to 130 cm long and from 65 to 140 cm, in some cases from 80 to 130 cm and in other cases from 90 to 120 cm wide. A bottom side **18** of core **10** includes legs **20-28** from 8 to 15 cm, in some cases from 9 to 13 cm long extending from bottom side **10**.

[0093] Legs **20-28** and bottom side **18** define spaces **42**, **44**, **46**, and **48** proximate to edge **12**. Spaces **42**, **44**, **46**, **48** separate legs **26-28**, legs **20**, **23**, **26**, legs **20-22** and legs **22**, **25**, **28**, respectively, from the edge **12**.

[0094] In an embodiment of the invention, spaces **42**, **44**, **46**, **48** are adapted to receive the tongues of a forklift truck. As a non-limiting example, a first tongue of a forklift can be placed under and along the length of bottom side **18** between leg **20** and leg **23**, leg **21** and leg **24** and/or between leg **22** and leg **25** and a second tongue of a forklift can be placed under and along the length of bottom side **18** between leg **26** and leg **23**, leg **27** and leg **24** and/or between leg **28** and leg **25**. When the forklift truck lifts the first and second tongues, a surface of each tongue contacts the surface of bottom side **18** and acts to lift load bearing structure **8** and any articles stacked on topside **16**.

[0095] Because core **10** is made from the above-described expanded polymer matrix, it has sufficient structural strength to be used as a load bearing platform.

[0096] Leg inserts **50** are inserted into openings in legs **20-28**. Leg inserts **50** have a raised portion and are made of a material that allows load bearing platform **8** to slide across surfaces when being moved and otherwise positioned using, as a non-limiting example, a forklift truck.

[0097] Leg inserts **50** can be made of any material that allows load bearing platform to move relatively easily across surfaces when being handled in ways that are typical for pallets and other load bearing platforms. As such, leg inserts **50** can be made of, as non-limiting examples, hard plastics, metals, ceramics, composite materials, and combinations of such materials and the like.

[0098] Suitable metals include, but are not limited to, aluminum, steel, stainless steel, tungsten, molybdenum, iron and alloys and combinations of such metals. In a particular embodiment of the invention, leg inserts **50** are made of a light gauge metal.

[0099] Suitable hard plastics include, but are not limited to reinforced thermoplastics, thermoset resins, and reinforced thermoset resins. Thermoplastics include polymers made up of materials that can be repeatedly softened by heating and hardened again on cooling. Suitable thermoplastic polymers include, but are not limited to homopolymers and copolymers of styrene, homopolymers and copolymers of C_2 to C_{20} olefins, C_4 to C_{20} dienes, polyesters, polyamides, homopolymers and copolymers of C_2 to C_{20} (meth)acrylate esters, polyetherimides, polycarbonates, polyphenylethers, polyvinylchlorides, polyurethanes, and combinations thereof.

[0100] Suitable thermoset resins are resins that when heated to their cure point, undergo a chemical cross-linking reaction causing them to solidify and hold their shape rigidly, even at elevated temperatures. Suitable thermoset resins include, but are not limited to alkyd resins, epoxy resins, diallyl phthalate resins, melamine resins, phenolic resins, polyester resins, urethane resins, and urea, which can be crosslinked by reaction, as non-limiting examples, with diols, triols, polyols, and/or formaldehyde.

[0101] Reinforcing materials and/or fillers that can be incorporated into the thermoplastics and/or thermoset resins include, but are not limited to carbon fibers, aramid fibers, glass fibers, metal fibers, woven fabric or structures of the mentioned fibers, fiberglass, carbon black, graphite, clays, calcium carbonate, titanium dioxide, woven fabric or structures of the above-referenced fibers, and combinations thereof.

[0102] The thermoplastics and thermoset resins can optionally include other additives, as non-limiting examples, ultraviolet (UV) stabilizers, heat stabilizers, flame retardants, structural enhancements, biocides, and combinations thereof.

[0103] In some embodiments of the invention, a wheel or other suitable device that provides a rolling mechanism is mounted on, molded into, or otherwise attached to inserts **50**. In this embodiment of the invention, load bearing platform **8** is able to roll along a surface to provide, in some cases, easier manipulation, either by hand, forklift, or other method, of a loaded load bearing platform according to the invention. In particular embodiments of the invention, inserts **50** are adapted to be removable to prevent movement during transport. In other embodiments, the wheel or other rolling device is equipped with a braking mechanism that can be set to minimize movement of load bearing platform **8** during transport.

[0104] In order to provide a desirable surface finish and/or texture and/or to minimize wear and tear from repeated use, a suitable layer material can be applied to topside **16** and optionally edge **12**.

[0105] Suitable layer materials that can be applied include rubber modified styrenic polymers, polyamides, such as nylon, polypropylene, polyethylene, and combinations thereof. Non-limiting examples of rubber modified styrenic polymers that can be used include the Dylark® and Zylar® resins available from NOVA Chemicals Inc., Pittsburgh, Pa.

[0106] The density of the expanded polymer matrix in core **10** can be at least 5, in some cases at least 10 and in other cases at least 15 kg/m^3 and can be up to 40, in some cases up to 35 and in other cases up to 30 kg/m^3.

[0107] In embodiments of the invention, the density of the expanded polymer matrix in core **10** corresponding to the portion's proximate spaces **42**, **44**, **46**, **48** is higher than the density of the expanded polymer matrix in the remainder of core **10**. This feature aids in preventing stress breakage at the thinnest portions of load bearing structure **8**.

[0108] The load bearing structure can be prepared by heating beads of the expandable polymer matrix using a heating medium such as steam. Depending on the desired density in any portion of the load bearing structure, the beads are expanded to an expansion ratio (the ratio of expanded bead volume/initial bead volume) of from 5 to 100, in some cases from 10 to 90, in other cases from 20 to 80, in some instances from 30 to 75 and in other instances from 40 to 70.

[0109] The beads of the expandable polymer matrix according to the invention can be formed into a load bearing structure of a desired configuration by pre-expanding the beads and further expanding and shaping them in a mold cavity. The resulting load bearing structure has superior thermal stability, chemical resistance (e.g., oil resistance), and flexural strength compared to EPS pallets.

[0110] In an embodiment of the invention (not shown), a groove or channel can be molded or cut into the surface of topside **16** such that the groove or channel follows the perimeter of topside **16** and a first edge of the groove or channel is spaced apart from edge **12**. The spacing of the groove or channel from edge **12** can be at least 1 cm, in some cases at least 2 cm and can be up to 10 cm, in some cases up to 8 cm. The groove or channel can be continuous or discontinuous.

[0111] In a particular embodiment of the invention, the groove or channel has a width and depth adapted to receive a foam panel. The foam panel can form an angle or arc to conform to a corner section of topside **16** directly above a portion of leg **20**, **22**, **28** and/or **26**. Alternatively, the foam panel can extend along the sides of topside **16** beginning above leg **20** and terminating above leg **22**, beginning above leg **22** and terminating above leg **28**, beginning above leg **28** and terminating above leg **26**, and/or beginning above leg **26** and terminating above leg **20**. The length of the panels will conform to the dimensions of load bearing platform **8** as described above. The height of the panels can be at least 5 cm, in some cases at least 10 cm and in other cases at least 15 cm and can be up to 450 cm, in some cases up to 400 cm, in other cases up to 350 cm and in some instances up to 310 cm. The height of the panels can be any value or range between any of the values recited above.

[0112] In a further embodiment, a top panel can be included that roughly matches the width and length of load bearing structure **8**. The top panel includes a groove or channel matching the groove or channel in topside **16** and is adapted to receive a top surface of the panels.

[0113] When assembled, the load bearing structure, panels and top panel form a box or open-box structure. Buckles or appropriate fasteners can be used to secure the panels and structure together. Alternatively, shrink wrap, duct tape, rope, string or other suitable binding materials can be applied around the outside perimeter of the box or open-box structure to secure the parts in position.

[0114] In an embodiment of the invention, the top panel can be a load bearing structure **8** that includes a groove or channel that passes along a corresponding bottom surface of legs **20**, **21**, **22**, **25**, **28**, **27**, **26**, and/or **23**.

[0115] In another embodiment of the invention, the panels and top panels are made from the expandable polymer matrix described herein.

[0116] In other embodiments of the invention, the panels and top panels are made of one or more other expandable polymers as described above.

[0117] The panels and/or top panels prevent articles placed or stacked on topside **16** from sliding or otherwise leaving the surface of topside **16** when load bearing structure **8** is moved.

[0118] Embodiments of the leg inserts according to the invention are shown in FIGS. **3-6**. Leg insert **100** includes base **102** that has a top surface **104** and bottom surface **106**. The thickness of base **102**, defined as the distance between top surface **104** and bottom surface **106**, is generally larger at center portion **108** than at edge **110**. Two or more or a plurality of fingers **112** extend generally perpendicularly from top surface **104**. Terminal end **114** of fingers **112** includes a gripping means **116** for holding leg insert **100** in an insert opening in a leg of a load bearing platform. Gripping means **116** can be selected from a shoulder (shown), knobs, buttons, ribs, teeth, a collar or other similar devise for applying pressure against the inner wall of an insert opening in a leg of a load bearing platform. The widest diameter **120** of the terminal ends **114** of fingers **112** are typically equal to or slightly larger than the diameter of the insert opening in a leg of a load bearing platform. Generally, when leg insert **100** is inserted into an insert opening in a leg of a load bearing platform, terminal ends **114** are movable and bend inward to facilitate insertion of leg insert **100** into an insert opening in a leg of a load bearing platform. Once inserted, fingers **112** attempt to return to their original configuration and provide pressure against the inner wall of the insert opening, which acts to hold leg insert **100** in place.

[0119] Referring to FIG. **7**, leg insert **50** can be inserted into leg insert opening **144** by pushing it into opening **144** until terminal end **114** contacts bottom **148** of opening **144**. When this is accomplished, gripping means **116** presses against inner wall **146** of opening **144**. As shown, opening **144** is in a top surface **142** and extends into leg **140** of load bearing platform **130**. Leg **140** extends from top surface **132** of load bearing platform **130**.

[0120] In a particular embodiment of the invention, the ratio of widest diameter **120** to the diameter **160** of insert opening **144** is at least 1, in some cases at least 1.001, in other cases at least 1.01, in some cases at least 1.025 and in other cases at least 1.05.

[0121] In some embodiments of the invention, a wheel or other suitable device that provides a rolling mechanism is mounted on, molded into, or otherwise attached to inserts **50** as described above. Another embodiment of the load bearing structure according to the invention is shown in FIGS. **8** and **9**, where a load bearing structure **200** includes an expanded polymer matrix core **210**, which is in the general shape of a rectangular slab with an edge **212** that has a width **214** which can be from 1 to 25 cm, in some cases from 2 to 20 cm and in other cases from 2.5 to 15 cm. Core **210** has a topside **216** that can be from 75 to 150 cm, in some cases from 90 to 140 cm and in other cases from 100 to 130 cm long and from 65 to 140 cm, in some cases from 80 to 130 cm and in other cases from 90 to 120 cm wide. A bottom side **218** of core **210** includes legs **220-236** from 8 to 15 cm, in some cases from 9 to 13 cm long extending from bottom side **10**.

[0122] Legs **220-236** and bottom side **218** define spaces **242**, **244**, **246**, and **248** proximate to edge **12**. Spaces **242**, **244**, **246**, **248** separate legs **220**, **226**, and **232**, legs **220**, **222**, and **224**, legs **224**, **230**, and **236** and legs **232**, **234**, and **236**, respectively.

[0123] In an embodiment of the invention, spaces **242**, **244**, **246**, **248** are adapted to receive the tongues of a forklift truck. As a non-limiting example, a first tongue of a forklift can be placed under and along the length of bottom side **218** between leg **220** and leg **226** and between leg **220** and leg **222** and/or between leg **232** and leg **234** and a second tongue of a forklift can be placed under and along the length of bottom side **18** between leg **226** and leg **232**, leg **222** and leg **224** and/or between leg **234** and leg **236**. When the forklift truck lifts the first and second tongues, a surface of each tongue contacts the surface of bottom side **218** and acts to lift load bearing structure **200** and any articles stacked on topside **216**.

[0124] Because core **210** is made from the above-described expanded polymer matrix, it has sufficient structural strength to be used as a load bearing platform.

[0125] Leg inserts **250** are inserted into openings in legs **220-236**. Leg inserts **250** have a raised portion and are made of a material that allows load bearing platform **200** to slide across surfaces when being moved and otherwise positioned using, as a non-limiting example, a forklift truck.

[0126] The load bearing platform according to the invention can have a number of configurations, especially regarding the number and placement of legs and leg inserts. FIG. **10** shows a non-limiting example where load bearing platform **300** includes legs **312**, **314**, **316**, **318**, **320**, **322**, **324**, **326**, **328**, and **330** extending from bottom surface **310** of load bearing platform **300**. In the configuration of load bearing platform **300**, the corner legs **312**, **316**, **326**, and **330** are not as long as legs **314**, **318**, **320**, **322**, **324**, or **328**. Legs **312**, **316**, **326**, and **330** have on leg insert **350** and legs **314**, **318**, **320**, **322**, **324**, and **328** have one or more leg inserts (two are shown although any suitable number of leg inserts can be used). As described above, the legs are spaced apart so that the space there between can accept the tongues of a forklift truck.

[0127] In embodiments of the invention, the load bearing platform includes a "bottom skin" to provide additional strength, ease of maneuvering with a fork-lift and aesthetic qualities. As shown in FIGS. **11** and **12**, skinned platform **400** includes expanded polymer matrix core **402** and skin **404**, which is adapted to receive the legs and bottom side of core **402**. In particular embodiments of the invention, core **402** can be any of load bearing structures or platforms **8**, **200**, or **300** as described above. As such, legs **412**, **414**, **416**, **418**, **420**, **422**, **424**, **426**, **428**, and **430** extending from bottom surface **410** of skin **404** and each accept a leg of core **402**.

[0128] In embodiments of the invention, leg inserts **50** can be inserted into leg insert openings (not shown) in skin **404** by pushing them into openings (not shown) in the legs as described above.

[0129] In some embodiments of the invention, a wheel or other suitable device that provides a rolling mechanism is mounted on, molded into, or otherwise attached to inserts **50** as described above.

[0130] Core **402** fits securely within skin **404** to form skinned platform **400**.

[0131] Skin **404** can be made by known thermoforming techniques, where a plastic sheet is heated and formed to desired shape through the use of one or more of a plug or air pressure pushing the plastic into the form, and/or vacuum drawing the plastic into the form.

[0132] Skin **404** can be made from any suitable thermoplastic material that maintains its strength and has a glass transition temperature higher than the conditions of use for the present load bearing structure or platform.

[0133] Suitable thermoplastic materials include polymers and polymer compositions made up of materials that can be repeatedly softened by heating and hardened again on cooling. Useful thermoplastic materials in the invention include, but are not limited to homopolymers and copolymers of styrene, homopolymers and copolymers of C_2 to C_{20} olefins, homopolymers and copolymers of C_4 to C_{20} dienes, polyesters, polyamides, homopolymers and copolymers of C_2 to C_{20} (meth)acrylate esters, polyetherimides, polycarbonates, polyphenylethers, polyvinylchlorides, copolymers of styrene, C_4 to C_{20} dienes and (meth)acrylonitrile, cured thermoset materials, a non-limiting example being polyurethanes, and combinations thereof.

[0134] Optionally, reinforcing materials and/or fillers can be incorporated into the thermoplastic materials including, but not limited to carbon fibers, aramid fibers, glass fibers, metal fibers, woven fabric or structures of the mentioned fibers, fiberglass, carbon black, graphite, clays, calcium carbonate, titanium dioxide, woven fabric or structures of the above-referenced fibers, and combinations thereof.

[0135] Skin **404** can have a thickness of at least 0.1 mm, in some cases at least 0.25 mm, and in other cases at least 0.5 mm and can have a thickness of up to 1.5 mm, in some cases up to 1 mm, and in other cases up to 0.75 mm. The thickness of skin **404** will depend on the intended use of the load bearing structure or platform.

[0136] Typically, skin **404** will have dimensions that mirror those of core **402**. As a non-limiting example, core **402** can have a shape and dimensions that correspond to edge **12** or **212** along with the legs of load bearing platforms or structures **8** or **200**.

[0137] In some embodiments of the invention, instead of covering the entire underside of core **402**, skin **404** comprises a plurality of sleeves, one for each leg of core **402** that is form fitting over the legs. In this embodiment, the sleeves can be made of the same materials as core **402** and can similarly be adapted to receive a leg insert.

[0138] Because the load bearing structures of the present invention are made from the above-described expanded polymer matrix, they are generally lighter in weight than conventional wood pallets, but can be handled in the same way because of the inclusion of the leg inserts as described above. As such, the present load bearing structures are ideally suited for air transport and other weight-limited transport situations allowing more goods to be shipped per trip than when traditional wood pallets are used.

[0139] The present invention has been described with reference to specific details of particular embodiments thereof. It is not intended that such details be regarded as limitations upon the scope of the invention.

What is claimed is:

1. A load-bearing platform comprising an expandable polymer matrix core and a skin disposed over a bottom side of the core wherein

the core comprises a base and a plurality of legs extending from one side of the base, the legs having one or more core insert openings in a bottom surface of the legs, and

the skin comprises a plurality of legs, each adapted to accept a leg of the core and one or more skin insert openings corresponding to a core insert opening;

and wherein at least one leg insert per leg is inserted into an insert opening.

2. The load-bearing platform according to claim **1**, wherein the expandable polymer matrix comprises one or more expandable plastics.

3. The load-bearing platform according to claim **1**, wherein the expandable plastics are one or more selected from the group consisting of interpolymers of one or more polyolefins and in situ polymerized vinyl aromatic monomers, expandable polystyrene, expandable styrenic polymers, expandable polyolefins, rubber modified styrenic polymers where the styrenic polymer constitutes a continuous phase and the rubber constitutes a dispersed phase in the resin, rubber modified styrenic polymers where the rubber constitutes a continuous phase and the styrenic polymerconstitutes a dispersed phase in the resin, polyphenylene oxide, and combinations and blends thereof.

4. The load-bearing platform according to claim **3**, wherein the polyolefins are selected from the group consisting of low density polyethylene, medium density polyethylene, high density polyethylene, an ethylene vinyl acetate copolymer, an ethylene/propylene copolymer, a blend of polyethylene and polypropylene, a blend of polyethylene and an ethylene/vinyl acetate copolymer, and a blend of polyethylene and an ethylene/propylene copolymer, ethylene-butyl acrylate copolymer, ethylene-methyl methacrylate copolymer and combinations thereof.

5. The load-bearing platform according to claim **3**, wherein the vinyl aromatic monomers are selected from the group consisting of styrene, alpha-methylstyrene, ethylstyrene, chlorostyrene, bromostyrene, vinyltoluene, vinylbenzene, and isopropylxylene and admixtures thereof.

6. The load-bearing platform according to claim **1**, wherein the expandable polymer matrix comprises a blowing agent and/or plasticizer.

7. The load-bearing platform according to claim **1**, wherein the expandable polymer matrix comprises polymers selected from the group consisting of expandable polystyrene, expandable polyolefins, rubber modified styrenic polymers where the styrenic polymer constitutes a continuous phase and the rubber constitutes a dispersed phase in the resin, rubber modified styrenic polymers where the rubber constitutes a continuous phase and the styrenic polymer constitutes a dispersed phase in the resin, polyphenylene oxide, and combinations and blends thereof.

8. The load-bearing platform according to claim **3**, wherein the expandable polymer contains from 25 to 99% based on the weight of the expandable polymer matrix of interpolymers of a polyolefin and in situ polymerized vinyl aromatic monomers and from 1 to 75% based on the weight of the expandable polymer matrix of other expandable polymers.

9. The load-bearing platform according to claim **1**, wherein the load bearing platform is in the shape of a rectangle and has an edge of from 1 to 25 cm, a length of from 75 to 150 cm and a width of from 65 to 140 cm.

10. The load-bearing platform according to claim **1** comprising a layer material applied to a topside of the platform.

11. The load-bearing platform according to claim **1**, wherein a continuous or discontinuous groove or channel is molded or cut into a surface of a topside of the base such that the groove or channel follows the perimeter of the topside and a first edge of the groove or channel is spaced apart from an outer edge of the base.

12. The load-bearing platform according to claim **11** comprising a plurality of panels adapted to fit into the groove or channel.

13. The load-bearing platform according to claim **12** comprising a top panel that matches the width and length of the load bearing structure and includes a groove or channel matching the groove or channel in the topside and is adapted to accept a top surface of the panels to form a box or open box structure.

14. The load-bearing platform according to claim **1**, wherein the leg inserts comprise

a base having a top surface and bottom surface;

a thickness defined as the distance between top surface and bottom surface that is larger at a center portion than at an edge of the base; and

two or more fingers extending perpendicular from the top surface of the base.

15. The load-bearing platform according to claim **14**, wherein a gripping means is included at a terminal end of the fingers.

16. The load-bearing platform according to claim **14**, wherein the gripping means is selected from the group consisting of a shoulder, knobs, buttons, ribs, teeth, and a collar.

17. The load-bearing platform according to claim **14**, wherein the ratio of widest diameter of terminal ends of the fingers and the diameter of the insert opening is at least 1.001.

18. The load-bearing platform according to claim **1**, wherein the leg inserts are made of a material selected from the group consisting of hard plastics, metals, ceramics, composite materials, and combinations of such materials.

19. The load-bearing platform according to claim **1**, wherein the skin comprises one or more materials selected from the group consisting of homopolymers and copolymers of styrene, homopolymers and copolymers of C_2 to C_{20} olefins, homopolymers and copolymers of C_4 to C_{20} dienes, polyesters, polyamides, homopolymers and copolymers of C_2 to C_{20} (meth)acrylate esters, polyetherimides, polycarbonates, polyphenylethers, polyvinylchlorides, copolymers of styrene, C_4 to C_{20} dienes and (meth)acrylonitrile polyurethanes, and combinations thereof.

20. The load-bearing platform according to claim **18**, wherein one or more materials selected from the group consisting of carbon fibers, aramid fibers, glass fibers, metal fibers, woven fabric or structures of the mentioned fibers, fiberglass, carbon black, graphite, clays, calcium carbonate, titanium dioxide, woven fabric or structures of the above-referenced fibers, and combinations thereof are incorporated into the thermoplastic materials.

21. The load-bearing platform according to claim **1**, wherein the skin has a thickness of from 0.1 mm to 1.5 mm.

22. The load-bearing platform according to claim **1**, wherein a device that provides a rolling mechanism is attached to the leg inserts.

23. A method of shipping articles comprising loading articles onto a top surface of the load bearing platform according to claim **1**.

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