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(54) **METHOD AND APPARATUS FOR CREATING AN IMAGE ON AN ARTICLE, AND ARTICLE RESULTING THEREFROM**

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(57) **ABSTRACT**

The present invention is directed to a method of printing an image on an object, such as a door facing or a door. An object having an exterior surface is provided. A first image component is printed on the exterior surface. A first transparent coat is applied on the exterior surface so as to cover the first image component. A second image component is printed on the first transparent coat. Optionally, a second transparent coat is applied to the first transparent coat and second image component so as to cover the first and second image components. The resulting object, such as a door, having the printed image thereon is also disclosed.

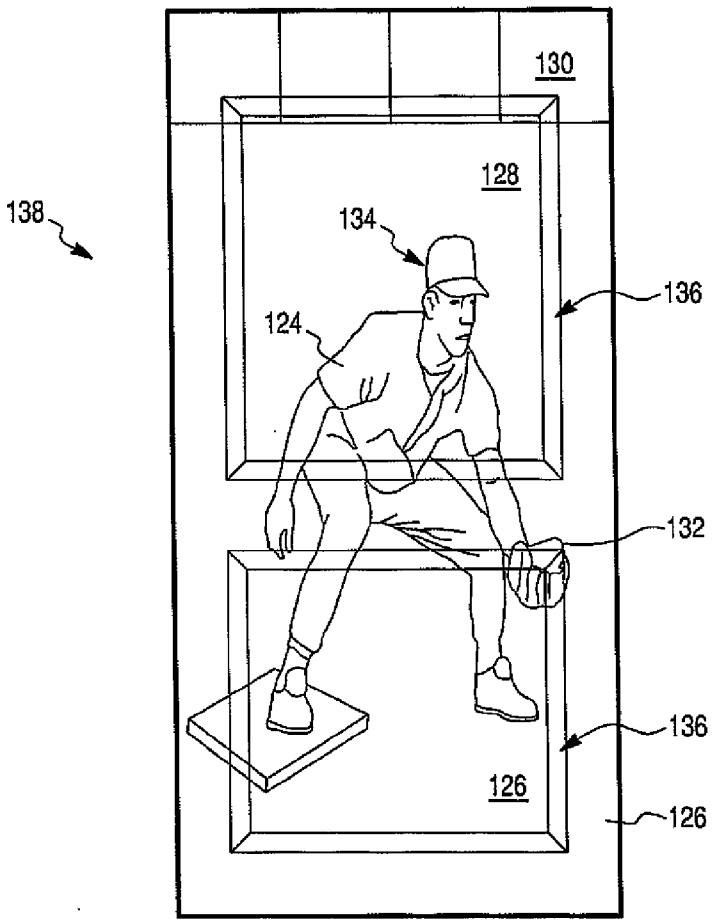


Fig. 1

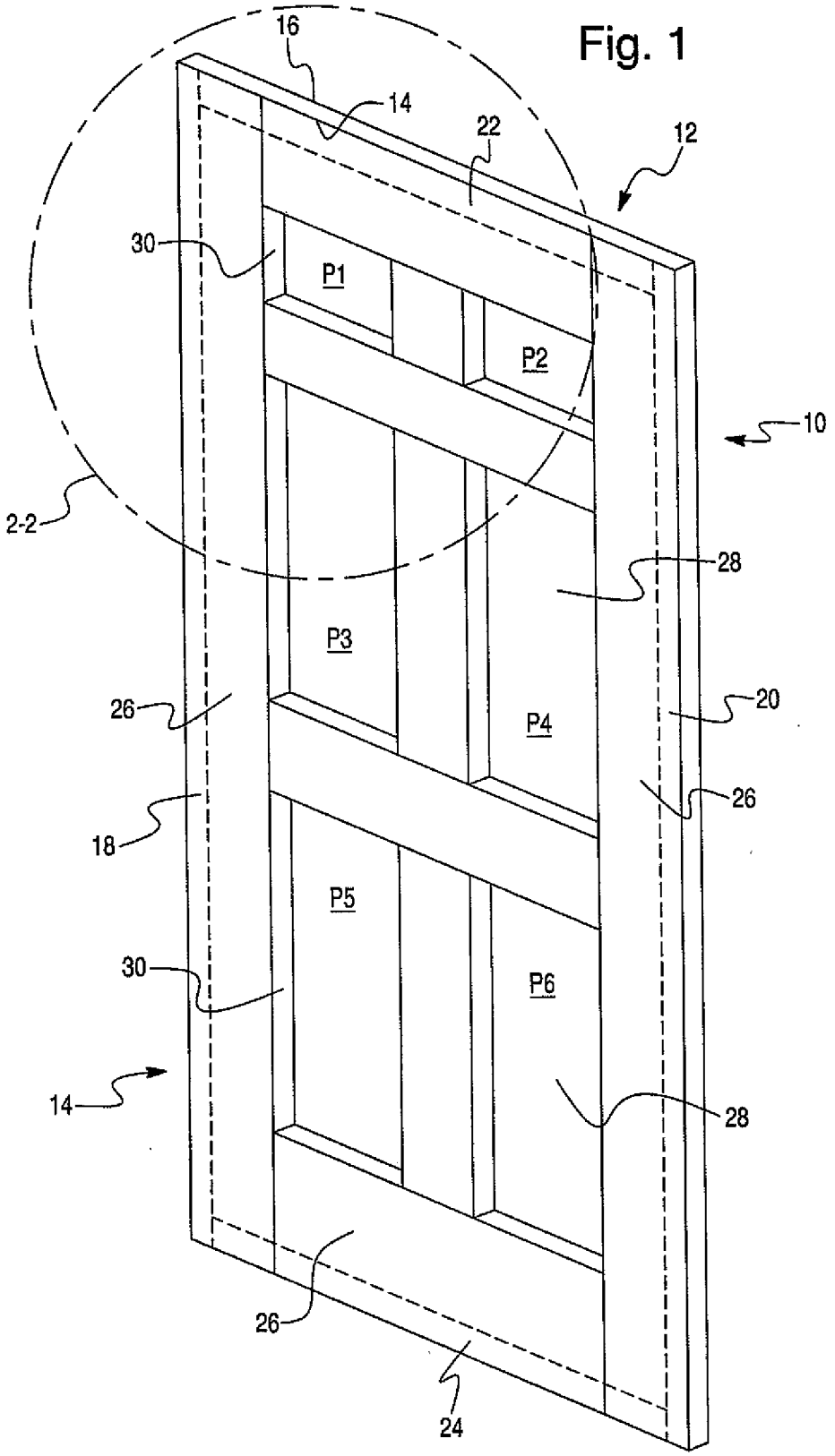


Fig. 2

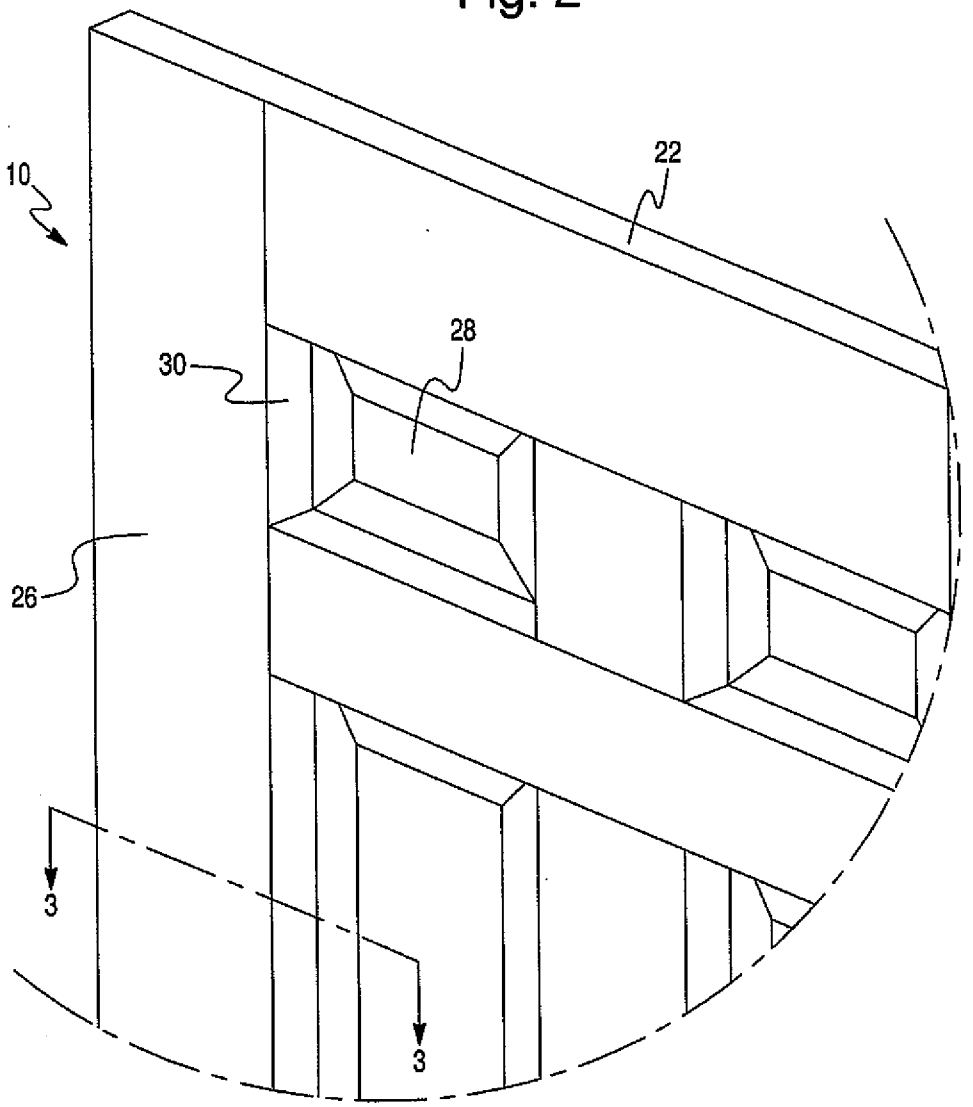


Fig. 3

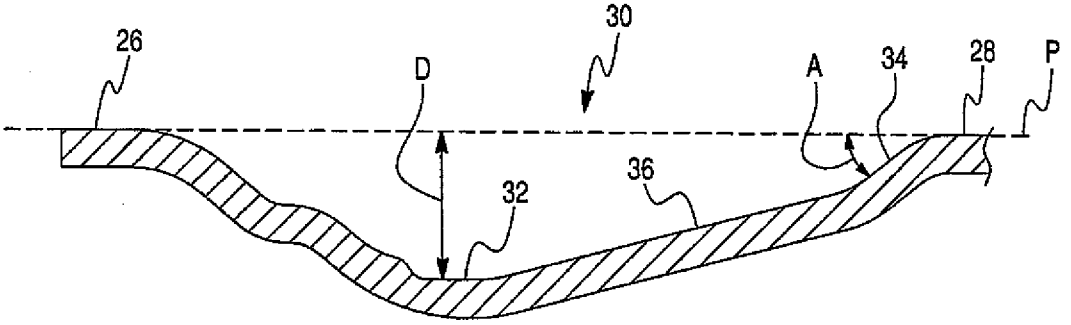
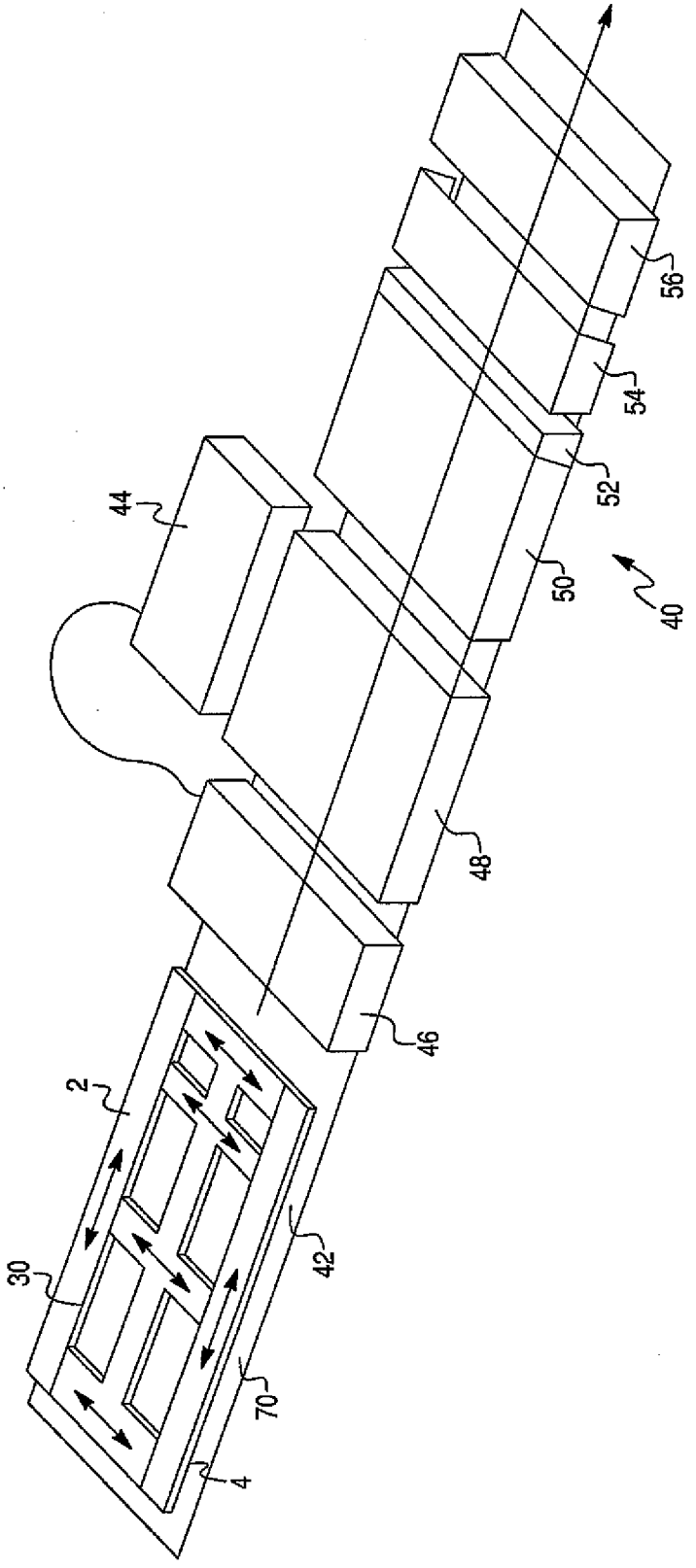


Fig. 4



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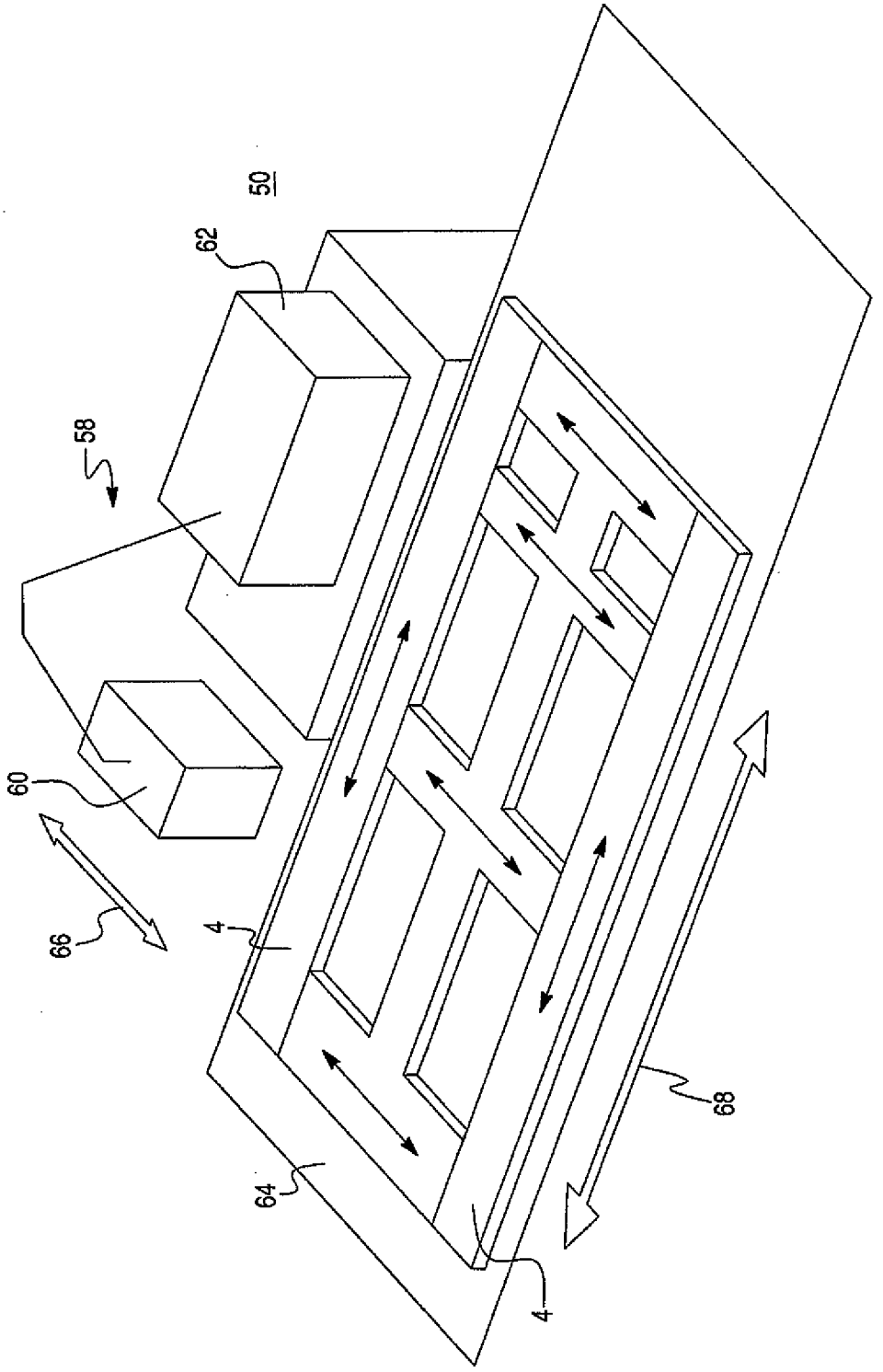

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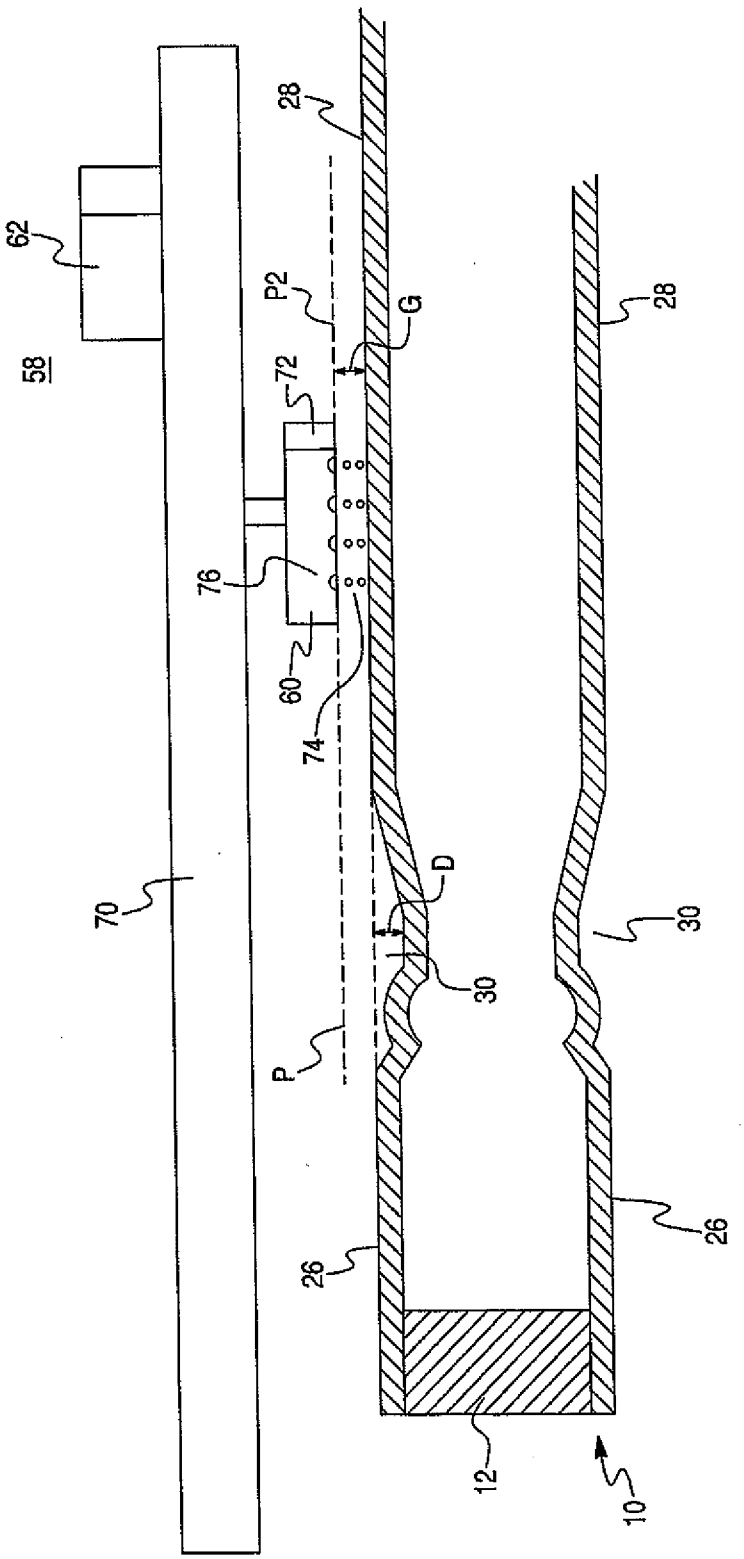


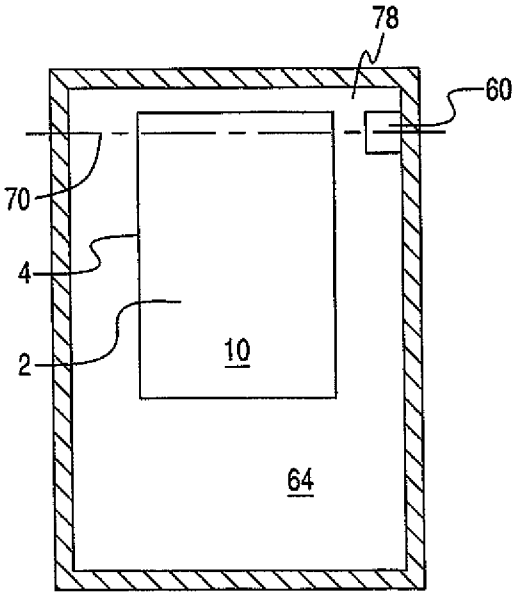


Fig. 7

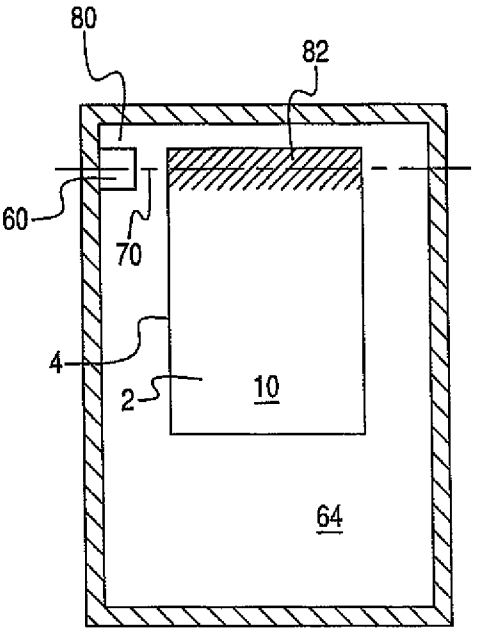


Fig. 8

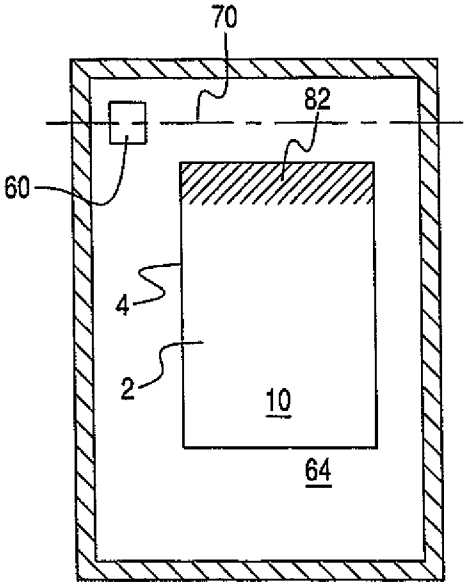
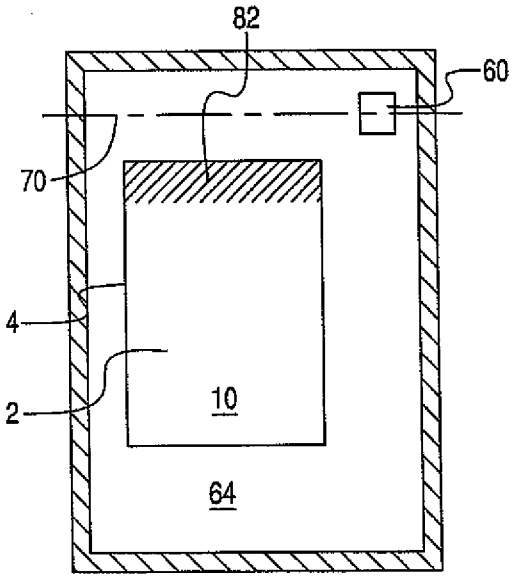


Fig. 9



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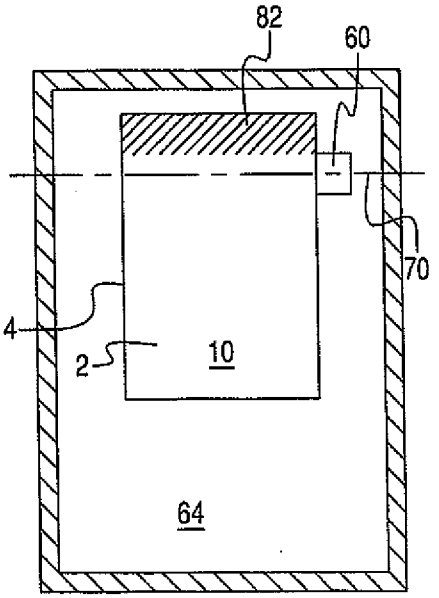

Fig. 11

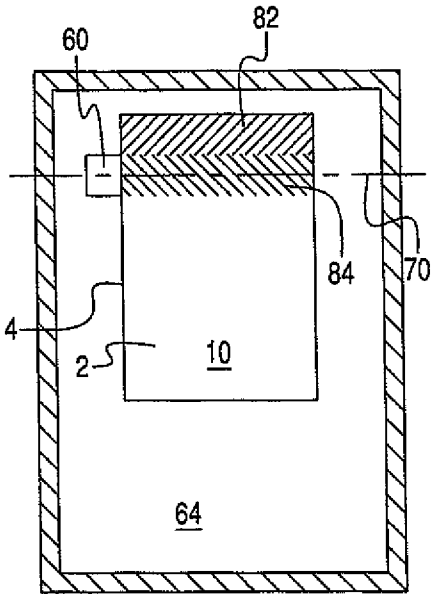

Fig. 12

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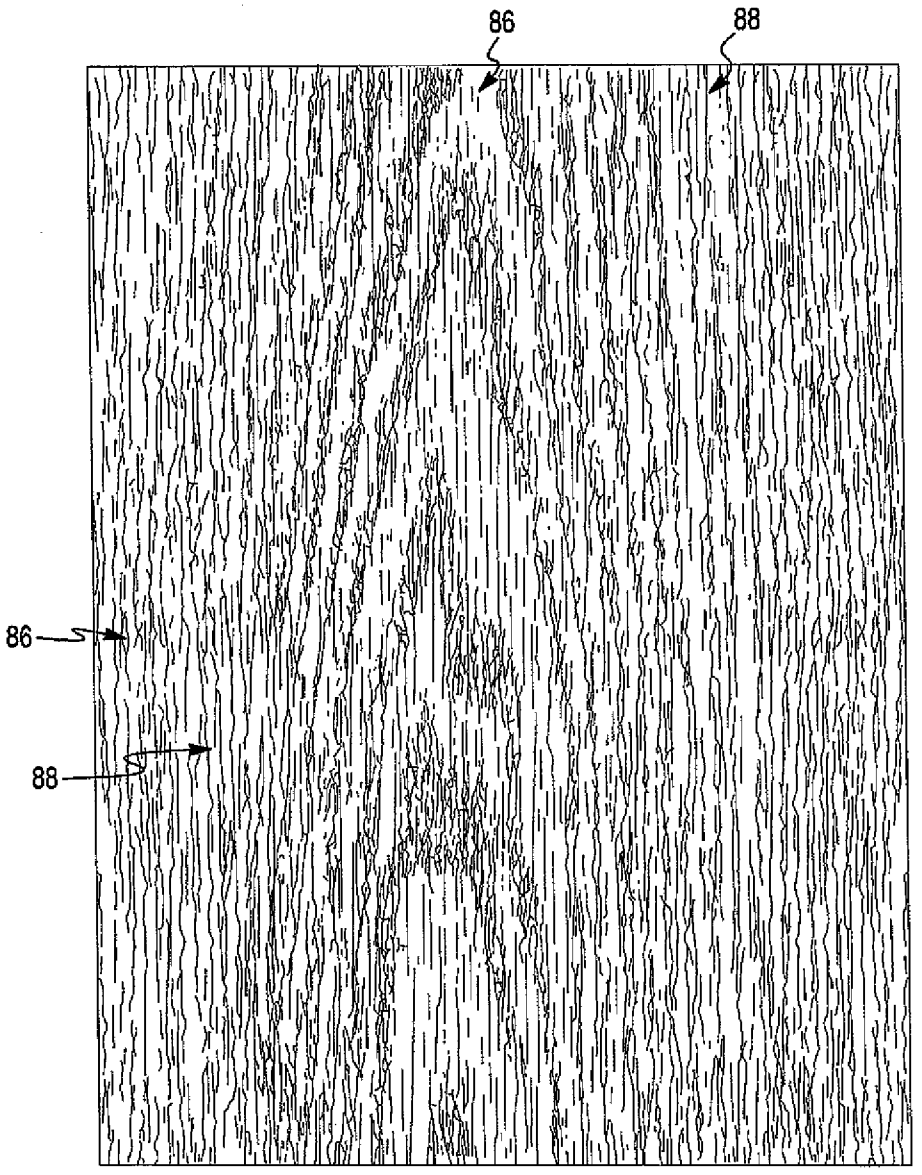

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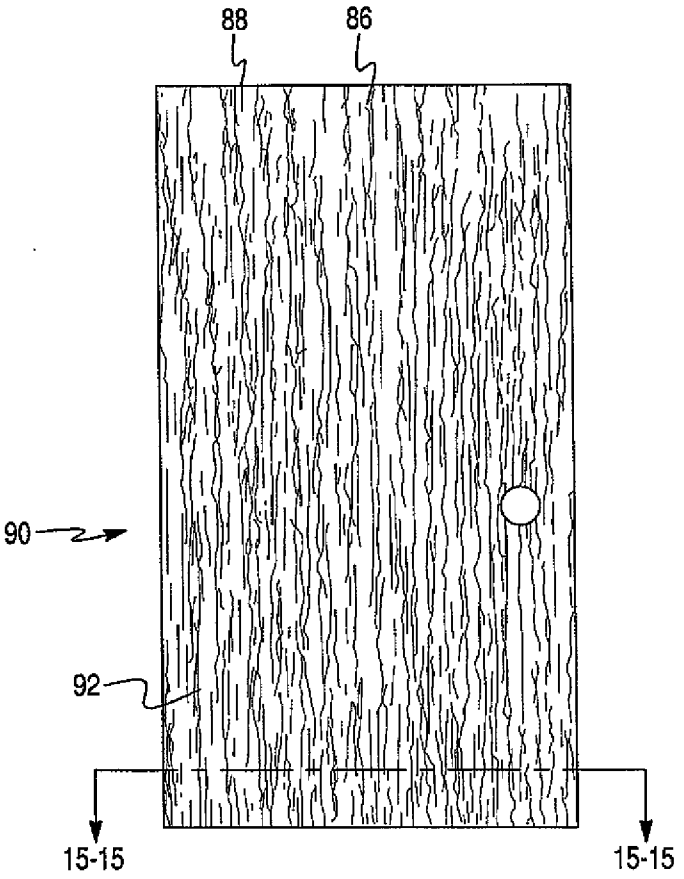

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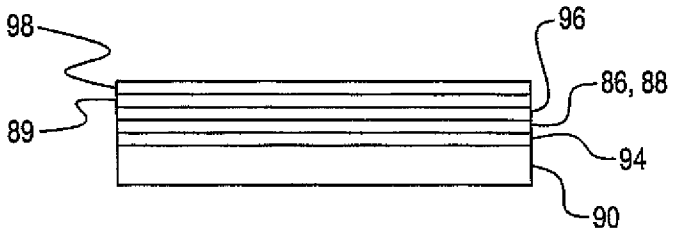

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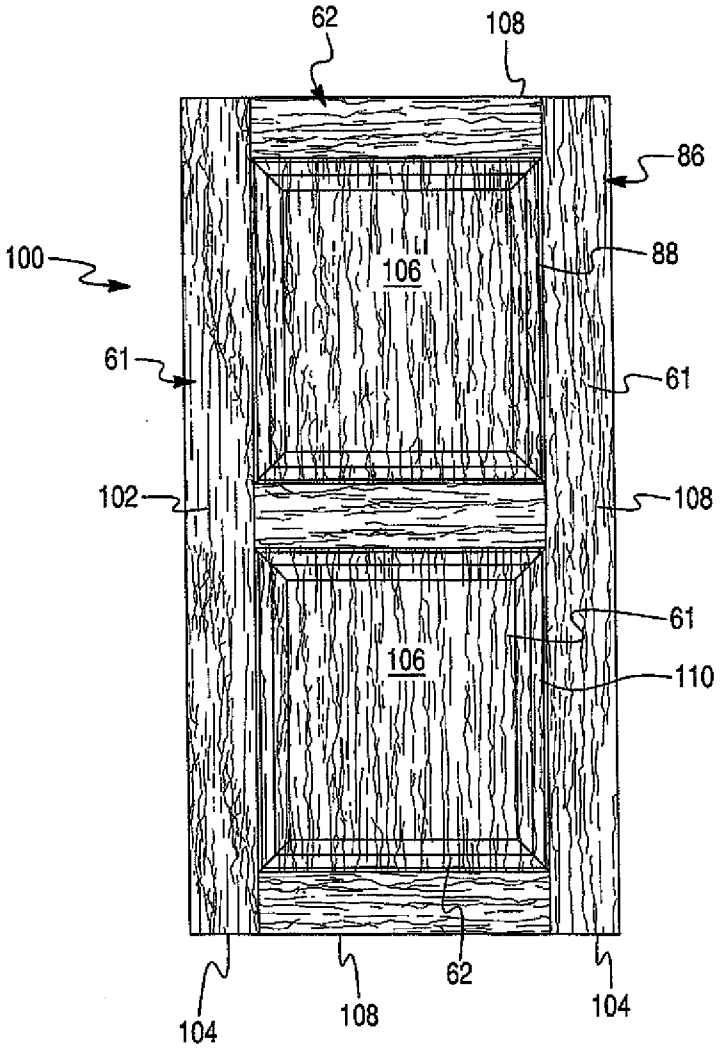
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Fig. 17

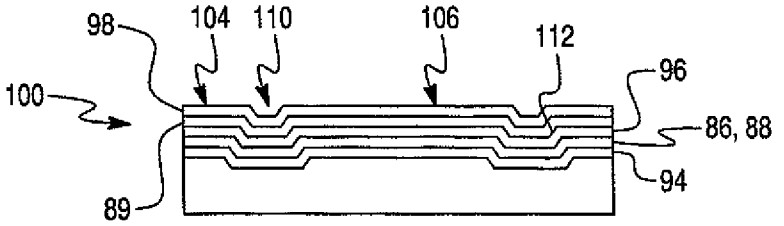
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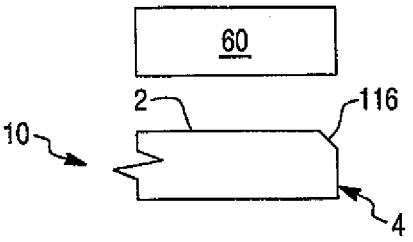
Fig. 18



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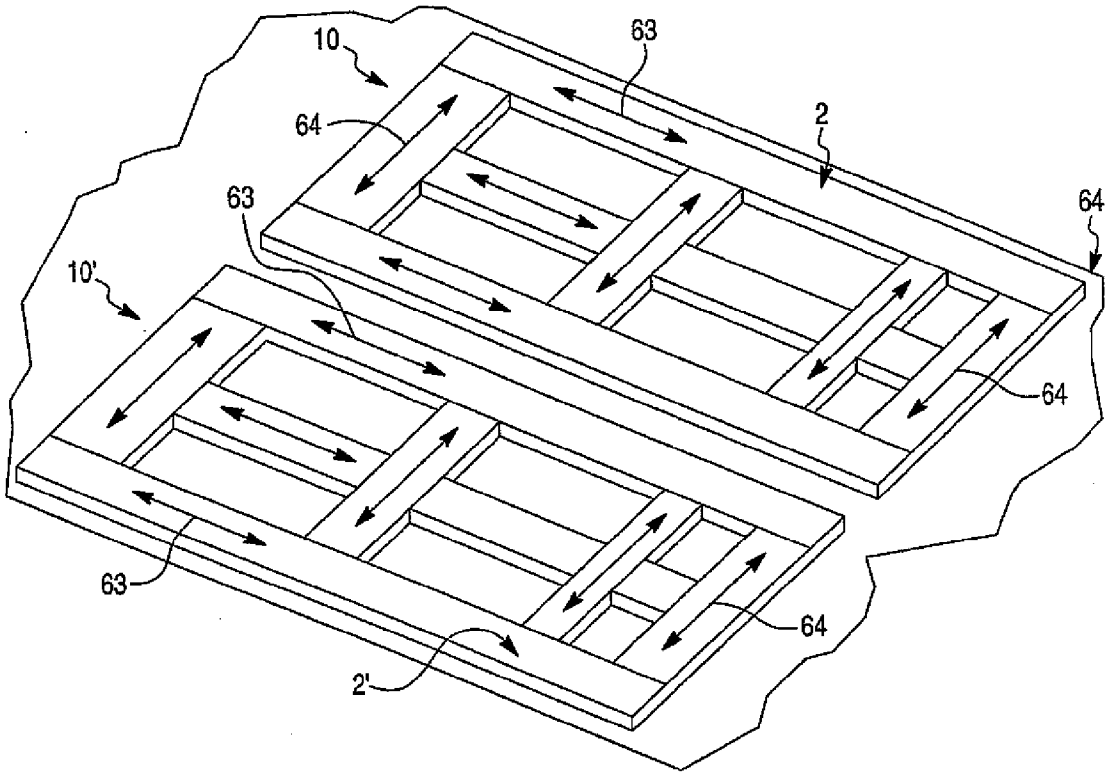


Fig. 20

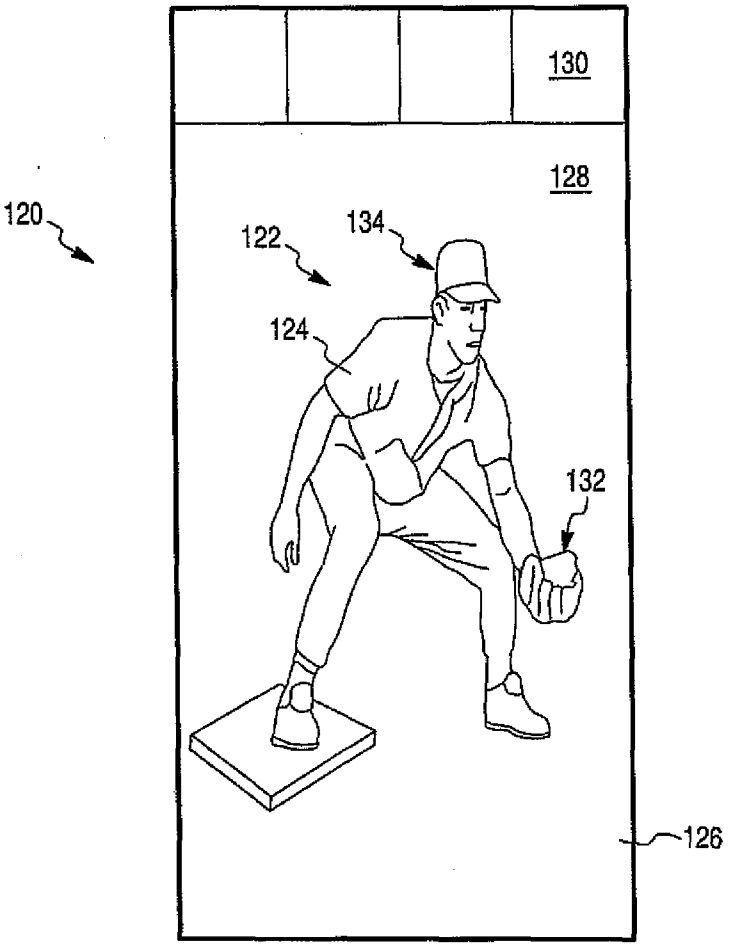
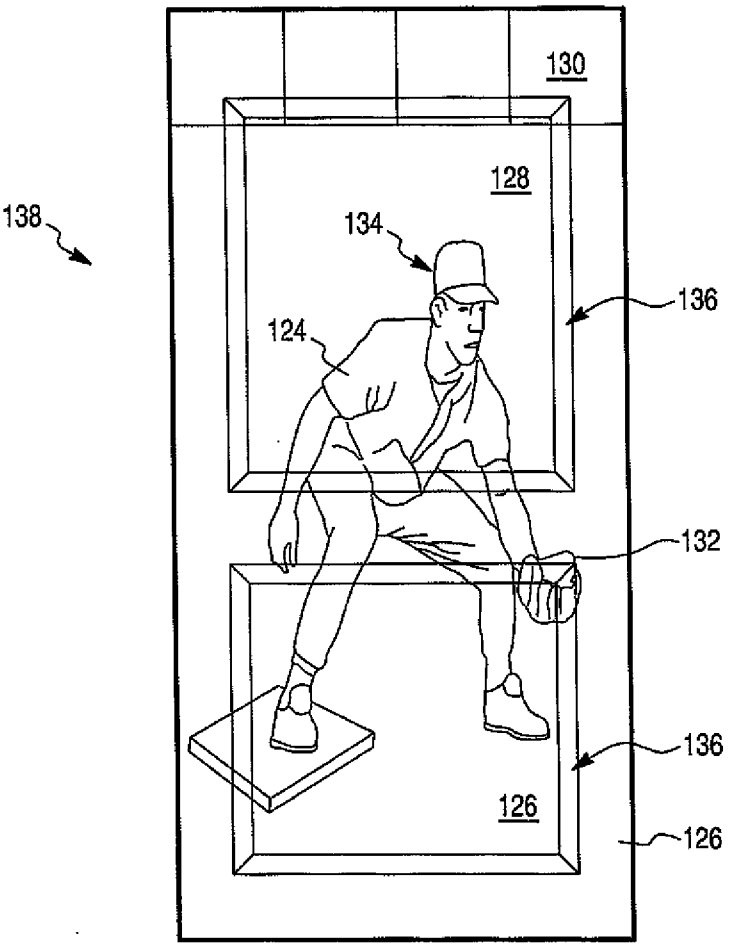


Fig. 21



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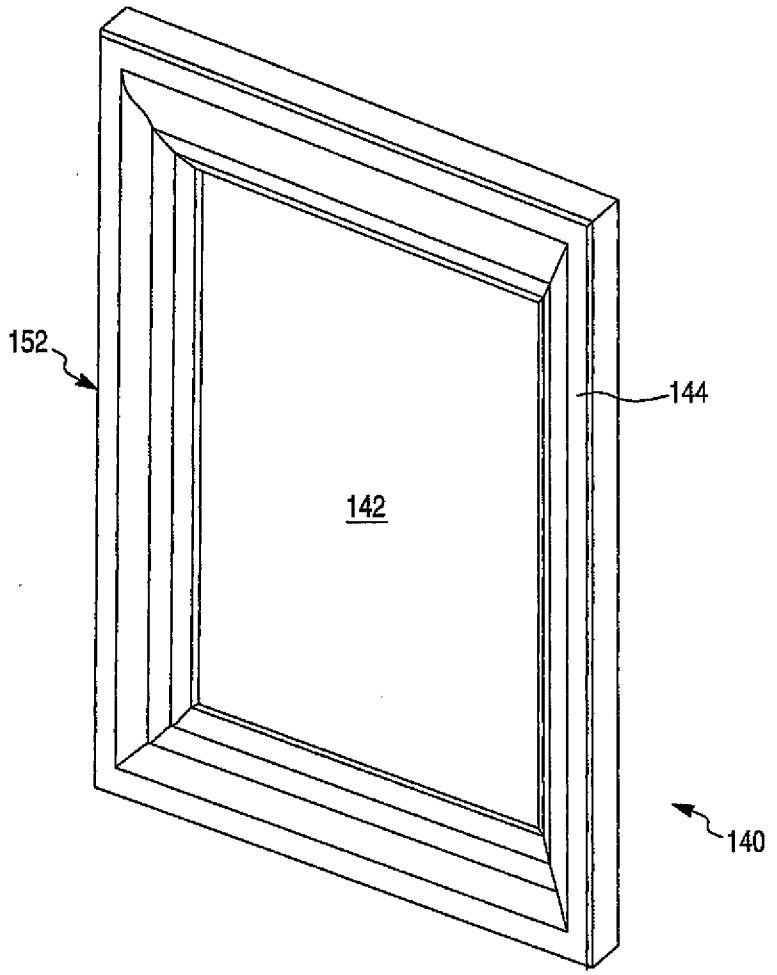
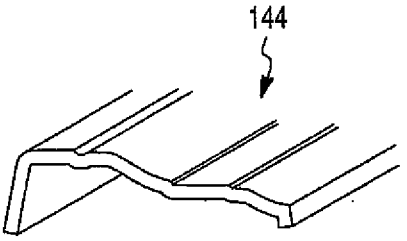


Fig. 23



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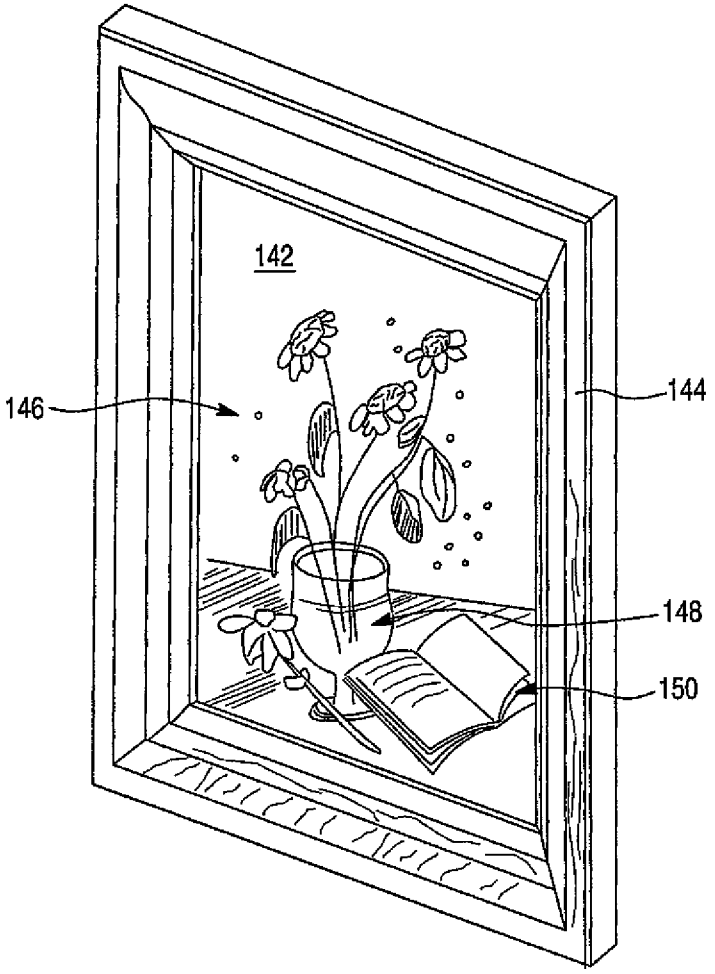

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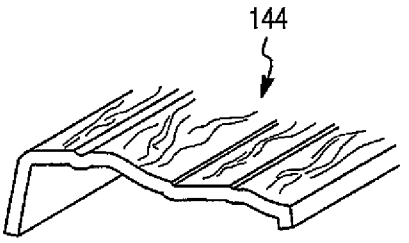

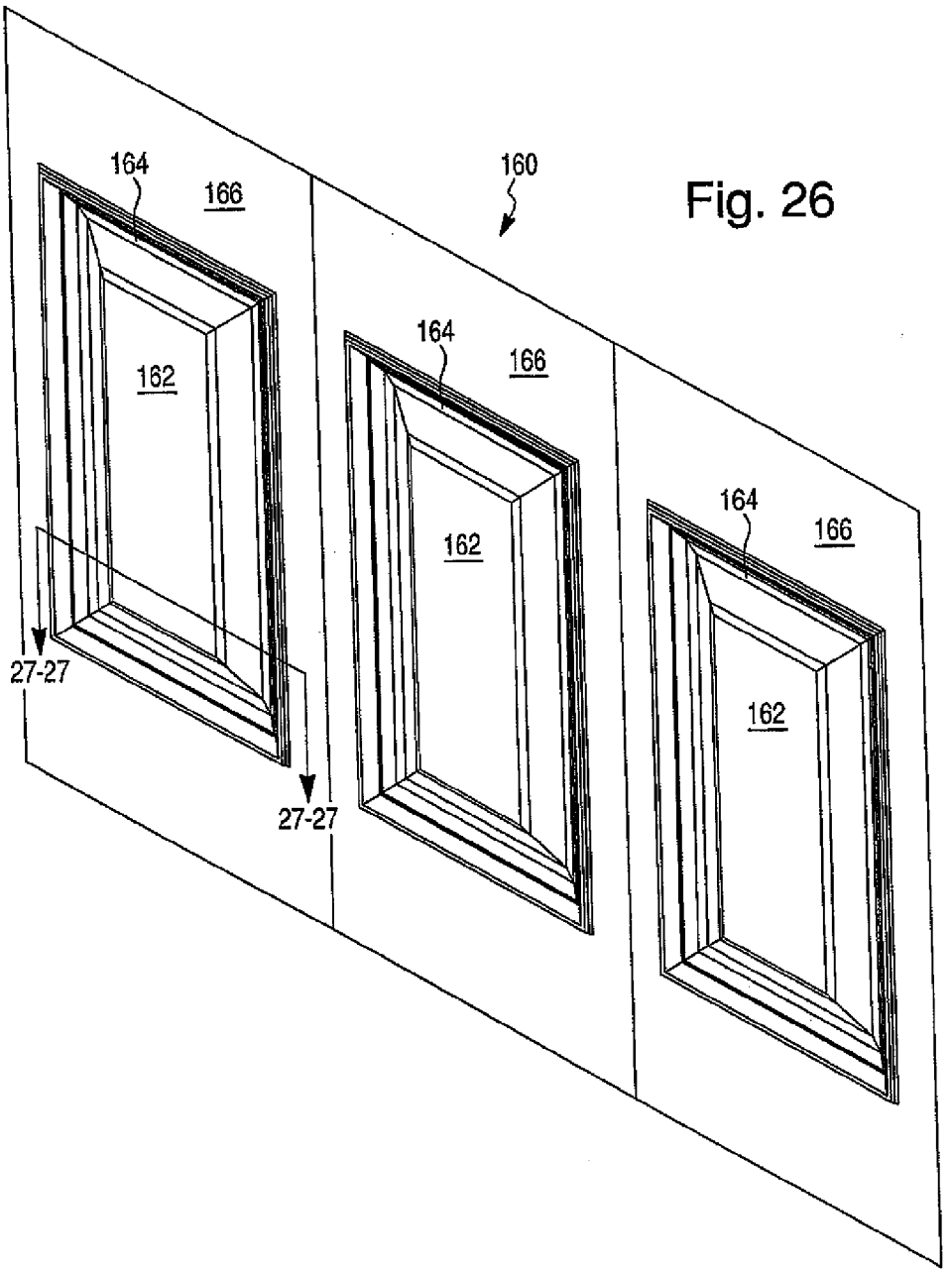
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Fig. 26

Fig. 27

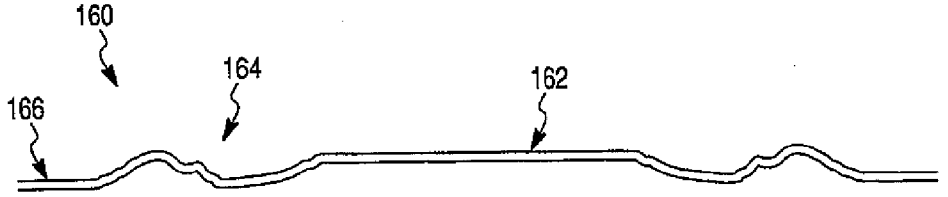
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Fig. 28

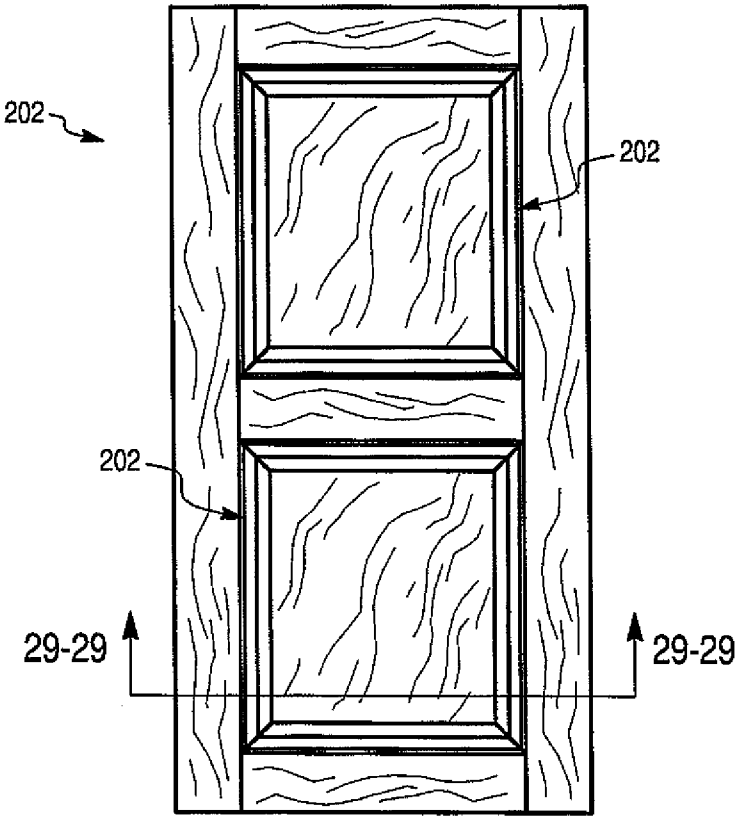
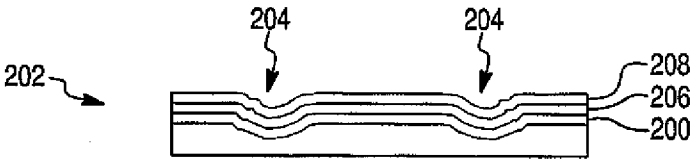


Fig. 29



METHOD AND APPARATUS FOR CREATING AN IMAGE ON AN ARTICLE, AND ARTICLE RESULTING THEREFROM

CROSS-REFERENCE TO RELATED APPLICATION AND CLAIM TO PRIORITY

[0001] This application is based on provisional application Ser. No. 60/609,868, filed Sep. 15, 2004, for Henry M. Coghlan et al, the disclosure of which is incorporated herein by reference and to which priority is claimed under 35 U.S.C. §120.

FIELD OF THE INVENTION

[0002] The present invention is directed to a method of printing an image on an object, especially a door component object, such as a door skin. The invention also relates to the object and an assembly comprising the object with the printed image, and a printing apparatus for carrying out the method and creating the printed object and assembly.

BACKGROUND OF THE INVENTION

[0003] Solid wood provides aesthetic qualities that are desirable to many consumers and therefore preferred for various products. However, solid, natural wood is a relatively expensive material, and thus items made from natural wood are generally more expensive than items made from alternative materials such as plastic or wood composite. As the price of natural wood has increased, the market for manufactured products that simulate natural wood has grown.

[0004] The door market is a good example of a market in which natural wood has been replaced with simulated wood materials. The natural wood facade of doors has been largely replaced by steel, which currently dominates the exterior entry door market. Generally, a steel door comprises a rectangular peripheral frame, and door skins (also referred to as door facings) respectively attached to the opposite sides of the peripheral frame. The interior of the door, i.e., between the skins, may remain hollow, or may be filled with, for example, corrugated pads, a contoured wood fiber core, insulation or other material if desired. The exterior surfaces of the steel door skins may possess a smooth, planar surface, known as a flush door skin, or a contoured surface simulating, for example, stiles, rails, panels, and other features found in traditional wooden rail and stile doors. Steel facings typically provide excellent corrosion resistance and heavy-duty protection, and are available with design options that complement a variety of architectural styles. Steel doors are often specified for the passage door between the home and the attached garage for fire protection.

[0005] One of the drawbacks to steel doors is the difficulty in forming a crisp, realistic multi-directional wood grain appearance and texture on the exterior surface of the door facings. Generally, wood grain patterns embossed on steel doors appear flat and lack three-dimensionality. Also, the surfaces are smooth and devoid of delicate texture that is expected of wood. These drawbacks have contributed to a recent decline in the market share held by steel doors.

[0006] Wood composite and fiberglass door skins hold a significant and expanding share of the exterior door market. However, wood composite and fiberglass doors also lack the appearance of natural wood, especially the color, grain and/or inlay patterns that are considered desirable by many consumers.

[0007] It is therefore desirable to provide a method of printing either wood grain images or other graphic images on the surface of a flush, textured, or contoured article, such as a door skin or door, in a manner that produces high quality images, an impression of depth, and optionally texture over the exterior surface being printed.

SUMMARY OF THE INVENTION

[0008] The present invention is related to a method of printing an image on an object, such as a wood grain pattern on a door skin, the resulting printed object, methods of making articles and assemblies comprising the object, and the resulting articles and assemblies. The invention is also related to an image processing apparatus for creating an image to be printed. The method and apparatus may be utilized to create various decorative products, such as passageway door systems, including exterior door sidelights and doors for residential and commercial use, millwork, molding, plant-on panels, closet or wardrobe doors, molded wainscot, decorative cabinet doors, and exterior polymeric doors. The method may also be used to enhance natural wood and veneer faced surfaces.

[0009] The images preferably are printed on the article using an ink jet printer, which provides great flexibility in what can be printed. Aspects of the present invention allow a wide variety of products to be printed easily using the disclosed printing technique. Customized objects, such as simulated wood species and decorative graphic images, can be produced quickly and cheaply. Printing a wood grain pattern onto an article using a printer according to embodiments of the invention has been found to give a good result easily and relatively cheaply compared with the use of a wood or wood veneer faced doors. As used herein, the term "wood grain" includes any pattern resembling a feature of wood grain or stained wood, preferably of any type of wood.

[0010] The disclosed method may be used to print on a part or all of a surface of an object. For example, a simulated wood region may form only a part of an object, for example a frame of a framed picture. Ink jet printing provides the flexibility to print in register on small areas of an object.

[0011] According to a first aspect of the invention, a method of printing on an object is provided. The method comprises providing an object having an exterior surface, printing a first image component on the exterior surface, applying a first transparent coat on the exterior surface so as to cover the first image component, printing a second image component on first transparent coat, and optionally yet preferably applying a second transparent coat over the first transparent coat so as to cover the first and second image components.

[0012] A second aspect of the invention provides an object having an exterior surface, a first printed image component on the exterior surface, a first transparent coat on the exterior surface and covering the first image component, a second image component printed on the first transparent coat, and optionally yet preferably a second transparent coat on the first transparent coat and covering the first and second image components.

[0013] In accordance with a third aspect of the invention, a method is provided for making a door having a printed image on an exterior surface thereof. The method comprises providing a rectangular frame and a door skin, printing a first image component on the exterior surface of the door skin, applying a first transparent coat on the exterior surface so as to cover the first image component, printing a second image compo-

nent on first transparent coat, optionally yet preferably applying a second transparent coat over the first transparent coat so as to cover the first and second image components, and attaching the first door skin to the rectangular frame.

[0014] A fourth aspect of the invention provides a door having a printed image. The door comprises a door skin attached to a rectangular frame. The door skin has an exterior surface comprising a first printed image component, a first transparent coat on the exterior surface and covering the first printed image component, a second image component printed on the first transparent coat, and optionally yet preferably a second transparent coat over the first transparent coat and covering the first and second image components.

[0015] It is preferred yet optional in the above-described aspects for the first image component and the second image component to be substantially registered with one another to provide the overall appearance of an overall image (comprising the first and second image components) with an impression of depth and optionally texture.

[0016] In another preferred yet optional embodiment of the above-described aspects of the invention, the article may comprise a printing sheet applied to the object in such a manner that the printing sheet constitutes the exterior surface on which the first image component is printed.

[0017] It is also preferred yet optional for the first and second image components to comprise a vessel wood grain image and a tick wood grain image, respectively, to collectively form an overall wood grain pattern image.

BRIEF DESCRIPTION OF THE FIGURES

[0018] The accompanying drawings are incorporated in and constitute a part of the specification. The drawings, together with the general description given above and the detailed description of the preferred embodiments and methods given below, serve to explain the principles of the invention. In such drawings:

[0019] FIG. **1** is a perspective view of a door to be printed according to an embodiment of the present invention;

[0020] FIG. **2** is a fragmentary enlarged view of circled area **2-2** of FIG. **1**;

[0021] FIG. **3** is a cross-sectional fragmentary view of the door of FIG. **2** viewed at line **3-3** in the direction of the arrows;

[0022] FIG. **4** is a schematic view of a printing apparatus according to an embodiment of the present invention;

[0023] FIG. **5** is a schematic view of a printing station according to an embodiment of the present invention;

[0024] FIG. **6** is a schematic, partially sectioned view of a printer applying ink to a door having a channel;

[0025] FIGS. **7-12** show schematically a method of ink jet printing a door according to an embodiment of the present invention;

[0026] FIG. **13** shows a wood grain pattern printed using embodied methods of the present invention;

[0027] FIG. **14** is a front elevational view of a flush door skin having a wood grain pattern ink jet printed thereon by an embodied method of the present invention;

[0028] FIG. **15** is a sectional view taken through line **15-15** of FIG. **14** and viewed in the direction of the arrows;

[0029] FIG. **16** is a front elevational view of a molded door skin having a wood grain pattern ink jet printed thereon with grain runs in two directions;

[0030] FIG. **17** is a sectional view taken through line **17-17** of FIG. **16** and viewed in the direction of the arrows;

[0031] FIG. **18** is a schematic view of a printing arrangement with a door having a chamfer;

[0032] FIG. **19** is a schematic view of another printing arrangement for printing two doors simultaneously;

[0033] FIG. **20** is a front elevational view of a door having a graphic image printed thereon using an embodiment of the method of the present invention; and

[0034] FIG. **21** is a front elevational view of a molded door having the graphic image of FIG. **20** printed thereon;

[0035] FIG. **22** is a perspective view of a molded casing to be printed according to an embodiment of the present invention;

[0036] FIG. **23** is a fragmentary perspective view of an outer frame of the molded casing of FIG. **22**;

[0037] FIG. **24** is a perspective view of the molded casing of FIG. **22** after having been printed according to an embodiment the present invention;

[0038] FIG. **25** is a fragmentary perspective view of the outer frame of FIG. **24** after having been printed according to an embodiment the present invention;

[0039] FIG. **26** is a perspective view of wainscot suitable for being printed according to an embodied printing method;

[0040] FIG. **27** is a fragmentary cross-sectional view taken along line **27-27** of FIG. **26** and viewed in the direction of the arrows;

[0041] FIG. **28** is a front elevational view of a door facing having an ink jet printed sheet laminated thereon; and

[0042] FIG. **29** is a sectional view taken along line **29-29** in FIG. **28** and viewed in the direction of the arrows.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS AND METHODS OF THE INVENTION

[0043] Reference will now be made in detail to the presently preferred embodiments and methods of the invention as illustrated in the accompanying drawings, in which like reference characters designate like or corresponding parts throughout the drawings. It should be noted, however, that the invention in its broader aspects is not limited to the specific details, representative devices and methods, and illustrative examples shown and described in this section in connection with the preferred embodiments and methods. The invention according to its various aspects is particularly pointed out and distinctly claimed in the attached claims read in view of this specification, and appropriate equivalents.

[0044] It is to be noted that, as used in the specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise.

[0045] The present invention is directed to a method and apparatus for creating an image on an article, such as a simulated wood grain pattern on a door skin, preferably using an ink jet printer. Any object (or article) that can be printed on using ink jet printing is suitable for the disclosed invention. Preferably, the printed object includes hard rigid surfaces, although other surfaces, such as wood veneer or paper overlaid wood composites, are also suitable.

[0046] The printed object preferably comprises a three-dimensional object. Examples of suitable objects to be printed upon include exterior passage and interior passage doors and door systems, furniture and cabinet doors, closet and bifold doors, door frames and moldings, window frames,

furniture components, tables, picture frames, molded wall paneling, fixtures, fittings, constructions, wainscot and other such objects.

[0047] A door and/or a door skin are particularly preferred for application of the disclosed printing method. The door skins or other objects may be made of any material suitable for their intended use, including steel, wood composites, fiberglass composites, etc. For purposes of explanation, the present invention will be explained with referenced to a door **10** that is to be printed, as best shown in FIG. **1**. However, it should be understood that other objects are suitable for printing, as noted above.

[0048] Door **10** comprises a peripheral frame **12**, and first and second door skins **14**, **16** secured to opposing sides of frame **12**. (Note that only an edge of skin **16** is shown in FIG. **1**). Frame **12** includes opposing stiles **18**, **20** and rails **22**, **24**. Door **10** is preferably a solid core door, as known in the art. Skins **14**, **16** are preferably made of or comprise a metal or metal alloy, more preferably steel. Alternatively, skins **14**, **16** may be molded from a composite wood material, such as medium density fiberboard (MDF) or high density hardboard, but other substrates such as fiberglass door faces, polymeric door faces, natural wood or plywood, post-molded wood composites, and doors with special film or paper overlay surfaces may be used. Furthermore, skins **14**, **16** may be formed using any known method, such as molding, embossing, wet-dry press molding, dry press molding, or post-forming. Each of skins **14**, **16** includes an exterior surface and an interior surface for securing to frame **12** using adhesive or other means (e.g., fasteners) to form door **10**. As known in the art, door **10** may also include additional support members and/or door core materials disposed between skins **14**, **16**. The door skins **14**, **16** may possess respective designs that are the same or different from one another.

[0049] Door skins **14**, **16** of FIGS. **1** through **5** include major planar portions **26** and simulated panels **28** surrounded by channels **30**. Channels **30** are recessed from the plane P of planar portions **26**, as best shown in FIGS. **2** and **3**. As best shown in FIG. **3**, each channel **30** has a depth D, defined as the separation between the plane P of planar portion **26** and a bottom **32** of channel **30**. Depth D is preferably between about 1 mm and about 11 mm. Channels in steel door skins usually have a depth D at the lower end or below this range. Each channel **30** may also include sloped sidewalls **34** extending downwardly at an angle A towards bottom **32** relative to the plane of panel portions **28** (which is preferably coplanar with plane P, as shown in FIG. **3**). Preferably, sloped sidewalls **34** extend downwardly at an angle A of 80 degrees or less relative to plane P of planar portion **28**. Sloped sidewalls **34** preferably include a flat portion **36**; however, portions of sloped sidewalls **34** may also be contoured. Channels **30** define simulated panels **28**, as in a natural, solid wood door. For example, door **10** includes channels **30** simulating panels P**1**, P**2**, P**3**, P**4**, P**5** and P**6**. It is to be understood, however, that the illustrated channels **30** are optional, and one or both of door skins **14**, **16** may comprise a flat, planar sheet without channels or panels.

[0050] Prior to subjecting the object to printing, the object may be prepared for printing or pre-treated. For example, the object may be cleaned, for example with a cloth or wipe, with water, acetone and/or ethanol in order to remove oil, grease, and like surface contaminants. Additionally, after being cleaned, the door skin exterior surface generally will be coated with a base or ground coat, such as by spray application, in order to provide a uniform color on which the additional image components are printed.

[0051] As best shown in FIG. **4**, a printing apparatus **40** is provided for printing an image on an object, such as door **10**. Apparatus **40** preferably includes a bed **42** for supporting door **10**. Preferably, bed **42** can support a plurality of objects to be printed. Optionally, the bed **42** may support a pre-assembled door skin **14**, **16**, i.e., before attachment of door skins **14**, **16** to peripheral frame. Bed **42** may also include means for arranging objects on bed **42**, such as a loading tray. However, the arrangement and positioning of the objects to be printed may also be carried out manually.

[0052] Preferably, door **10** includes door skins **14**, **16**. Although not shown, the door **10** may alternatively comprise a solid unitary member. After providing door **10**, an image to be printed on an upper face **2** of door **10** is selected. A plurality of images and constituent elements or components of the image (or "image components") may be stored in a memory of a controller **44**, such as a personal computer (PC). Controller **44** may include a library of images or prints, which are applied as image components as described herein to obtain a more realistic effect. Next, the dominant color of the selected image is selected, either by controller **44** or manually by a user. The dominant color is the color or tone in the selected image that is most prevalent in the image when viewing the image in its totality. A color related to the determined dominant color is determined. The color related to the dominant color is generally a shade of the dominant color. (For example, tan is a color related to a dominant color of a darker brown). The color related to the dominant color will enhance the appearance of the selected image when the selected image is printed over a groundcoat of the related color.

[0053] Preferably, the positioning of upper face **2** to be printed is registered with controller **44** by identifying the location and positioning of door **10** on bed **42**. In this way, controller **44** advantageously knows where the object to be printed (e.g., door **10**) is and can then adjust the position of the image components to be printed accordingly. Registering of the upper face **2** may comprise, for example, locating a feature on door **10**, such as the location of a channel **30**, or some other descriptive or distinct feature on the object as a registration point. An object may include more than one registration point, such as several channels **30**. It will be appreciated that registration is of particular importance where the image components have been manipulated so that the printed image components correspond to particular features of the object. For example, the image components may be manipulated so that a greater density or darker color is printed in channels **30**. Features of the object, such as an embossed grain pattern on the surface of the object, or stiles or rails of a door, may act as registration points affecting the print image.

[0054] Apparatus **40** also preferably comprises means for applying a ground coat to upper face **2** of door **10**, such as a spray coating device **46**, prior to ink jet printing door **10**. A ground coat of paint of the related color is applied to upper surface **2** and lower surface (not shown) of door **10** by spray coating device **46**. This provides a uniformly colored surface. For example, this coating may comprise a mahogany colored paint that is applied to upper face **2**, which is positioned uppermost and faces spray coating device **46**. Various methods of applying the related color to upper face **2** may be employed by spray coating device **46**, such as by manual spray gun or by robotic sprays. Preferably, the coating of the related color is applied to upper face **2**, as well as the opposing

face on door **10** (i.e. the exteriorly disposed faces of skins **14** and **16**). In addition, side edges **4** of door **10** may also be coated with the related color.

[0055] The ground coat is preferably applied to door **10** by a method other than ink jet printing, since ink jet ink is relatively expensive. In addition, this primary ground coat may be the background color and/or tone for a particular image to be printed. For example, if a wood grain pattern is being printed, the ground coat may be the background tone of the woodgrain pattern. The use of paint or other non-ink jet ink for the background tone may be appropriate if a "dark wood" is to be printed onto a light colored surface. Otherwise, a relatively large amount of ink jet ink is used for the entire image, thereby increasing manufacturing costs. It is therefore preferred that the ink-jet ink be used for printing only the wood grain or stain glazed patterns and optionally background tone of the grain for minimizing manufacturing costs. As used herein, wood grain patterns and images are a series of corresponding lines simulating wood vessels and ticks as found in natural wood, and may include width, coloration and density variations.

[0056] The ground coat will have a high surface tension, preferably in the range of 38-50 surface dynes and may be applied in a smooth coat without dry spray to maximize ink droplet formation. If the ground coat is not formulated for a smooth application, micro-cracks may form on surface of the skin, resulting in a foggy or non-continuous final print. Spread of the ink droplets on the surface of the ground coat is also important. Good absorption of the ink results in a more continuous print with more brilliant color definition.

[0057] Alternatively, ink jet ink may be used to enhance or modify the color of the ground coat applied by coating device **46**. However, a ground coat preferably is selected having a color that is similar to that of the desired background tone, so that the amount of ink jet ink used is again minimized. Using differing ground coat colors, it is possible to simulate different types of wood using the same wood grain image. It should be noted that if desired, the entire image to be printed may be done using ink jet printing technique, thereby eliminating the necessity for coating device **46**.

[0058] A second ground coat optionally may also be applied, particularly when the object to be printed includes one or more channels **30**, such as with door **10**. In the illustrated embodiment, the secondary ground coat is applied into channels **30**. Preferably, this secondary ground coat is also a color related to the dominant color of the selected image, but is generally a darker shade compared to the primary ground coat. In this way, the secondary ground coat provides a suggestion of shadowing in channels **30** of upper face **2** and masks any slight decrease in print quality that may occur on the irregular surfaces of channels **30**. The darker ground coat tone provides a richer and greater depth appearance compared to printing on a lighter toned ground coat, and reduces the amount of ink jet ink needed.

[0059] In addition, there is a tendency for the print density to decrease in optional contoured portions, such as channels **30**. Controller **44** aligns the object to be printed by registering particular features of the object, and then applies a print grid to the object, which determines the placement of the ground coat pigments and ink jet ink. The print grid is a two dimensional construct used by controller **44**. However, the object to be printed is three-dimensional. As such, when the print grid overlays the object, contoured portions may not be adequately accounted for with respect to print density of ink and/or pigment needed. Specifically, the surface area of contoured portions of the object may not be accurately accounted for, causing "stretching" of the print grid which gives an apparent lower density of ink required for printing the image. However, a substantially constant density of the printed image is preferred in order to achieve a high image quality. If a regular printing frequency were used for recessed portions, the print density in such recesses might be less than elsewhere on the surface. The density can be made constant by, for example, increasing the density of ink to be printed in channels **30** (or on a projection), by changing the color of the ink printed in channels **30** and/or adjusting the image to be printed, for example by adjusting the print grid. The density of the ink to be printed may also be adjusted by adjusting the speed of print bed **42**. For example, density of the ink may be increased by decreasing the speed of print bed **42**, or density of the ink may be decreased by increasing the speed of print bed **42**.

[0060] The secondary ground coat compensates for such reduced print density and/or lessens the visual impact of any imperfections in the image by darkening channels **30**. Therefore, the secondary ground coat preferably has a color that is darker than the primary ground coat color. The secondary ground coat may be non-ink jet ink, such as paint or stain, which is cheaper than ink jet ink, and may be applied by spraying or a robotic device as long as surface tension of the ground coat is maintained, preferably in the range of 38-50 surface dynes.

[0061] The first and second ground coats are then cured or dried at a drying station **48**. Drying station **48** may comprise an induction radiation heater for drying the ground coat, or some other pigment-drying device known in the art. Door **10** (or another door skin **14**, **16**) is then forwarded to a printing station **50** (described in detail below) and the selected image components are ink jet printed on upper face **2** as described below. Although not shown, it should be understood that the ground coat(s) may be pre-applied in a separate process, i.e., the coating device, drying station **48**, and printing station **50** need not be arranged for continuous processing with one another.

[0062] Printing of a first component of the image (or first image component) at printing station **50** is preferably conducted with an ink jet printer using a UV-curable ink, for example Sericol UviJet curing ink. The UV-curable ink is then cured using a UV curing lamp **52**, which is preferably incorporated into printing station **50**.

[0063] A first UV curable, transparent coat or protective layer may then be applied to upper face **2** of door **10** at a topcoat station **54**. Topcoat station **54** includes a device for applying the first protective coat onto door **10**, such as by spraying, thereby covering the printed first image component on upper face **2**. The first coat may comprise, for example, PPG Flexicron UV solvent-based exterior topcoat consisting essentially of 85 percent 20 degree sheen and 15 percent flat gloss sprayed at a fluid pressure of 8 psi. The thickness of the first coat is not particularly limited, although an exemplary range is 0.3 (7.6 microns) to 0.4 mils (10.2 microns). The first protective coat is then dried at a UV topcoat curing station **56** using conventional curing techniques, dependent on the first coat formulation. We have found that the gloss of the first and second protective coats should be less than typically utilized in order to provide a more realistic appearance. If the gloss is too high, the resulting finished door will have an artificial glossy appearance.

[0064] The protective layers are preferably transparent. As referred to herein, the term transparent means optically transmissive so as to allow the natural eye viewing of the image components printed under the coating. Although transparent preferably means clear and without color, within the scope of this disclosure the term transparent may encompass coatings having a tint of any color that is not dense and opaque enough to significantly impede the transmission of light for viewing of the image.

[0065] A second component of the image (or second image component) is then printed on the first protective coat and dried, after which a second protective coat is applied over the second image component. Application of the second image component and the second protective layer may be comprise returning the door **10** to a position upstream of printing station **50** (and optionally but not necessarily upstream of the spray coating device **46** and drying station **48**), then passing door **10** with upper face **2** facing upward through the printing station **50** for printing the second image component, the drying station **52** for drying the second image component, the topcoat station **54** for applying the second protective coating over the second image component, and the curing station **56**. Alternatively, separate downstream printing, drying, and topcoat stations (not shown) may be provided for applying the second image component and the second protective coat.

[0066] It is preferred that the first image component and the second image component be substantially registered with one another to provide a visually acceptable complete image that does not appear to comprise separate and distinct components. For example, the image registration may be offset by, for example, not more than 0.5 inch (1.27 cm), preferably not more than 0.125 inch (0.3175 cm). Still more preferably, the first and second image components are placed in exact registry. The first and second image components may comprise exact copies of one another, or may differ from one another in part or in whole. The first and second image components may, for example, complement one another, as in the case in which the first image component comprises a wood grain vessel or stain glazed pattern and the second image component comprises wood grain tick and/or knot images. One or both of the image components may take the form of, for example, a pattern, random design, a tangible object or objects, or combinations thereof. The printing ink for printing the second image component may be the same as or different from the printing ink of the first image component.

[0067] The first and second coats may be made of a material or materials that are the same as or different from one another. The first and second coats may be, for example, a clear varnish. The respective thicknesses of the coats may be the same or different from one another. Although the thickness of the second coat is not particularly limited, a representative thickness is approximately 0.5 mils (12.7 microns).

[0068] The low sheen protective topcoat provides a realistic finish. Because the first and second image components have a depth due to the thickness or depth of the ink forming them, the resulting product has a rubbed natural, textured wood-like feel and is not smooth to the touch. The positioning of a clear coat between the print image components adds translucence, reflectance, and a depth of print. The second coat protects the printed images from, for example, mechanical damage, and may also improve color fastness of the printed product. In addition, it has been found that, although substantially clear, the UV protective topcoats unify the various elements of the printed image and masks any graininess produced by the individual droplets of ink jet ink.

[0069] Door **10** may then be turned over to expose the face opposite upper face **2** (the exteriorly disposed face of skin **16**) or alternatively another door skin may be prepared for printing. The coating and printing steps may then be repeated by passing door **10** through the same apparatus **40**, or by using a different apparatus. It will be appreciated that the opposing sides of door **10** may be coating and printed to have identical or different images (e.g., figures and/or patterns). It will also be appreciated that different methods could be used to provide the initial and/or final coating steps described herein. For example, the coating or uniform color for printing could be provided using a toned groundcoat or overlay, in which case the preferred coating is a water-based paint.

[0070] Printing station **50** will now be described in detail. As best shown in FIG. **5**, printing station **50** includes a printer **58**. Printer **58** has at least one ink jet printhead **60**, which is connected to a print control device **62**, and a printer bed **64**. Printer bed **64** may be operably associated with bed **42** of printing apparatus **40**, or bed **42** may be integrated with printer **58**. Print control device **62** includes an image processor for creating the image. For example, the image processor may create an image based on a photo of a wood grain pattern input into print control device **62**. Each image might be created from scratch for each type and size of object. Typically for a door, the individual rails, stiles and panels will be made using different photo images and assembled on graphics software by print control device **62**. Then, color density manipulations and adjustments may be made if needed, so that the image accurately simulates wood grain and compensates for any shallow angles of printing.

[0071] The imaging separates the initial photographed image into multiple components based upon the end product desired. For example, we have found that a realistic image is created if the ticks of the wood grain are removed, so that the resulting first image component comprises the relatively large "vessels" of the wood grain. The ticks are then applied over the vessels and their protective coat. The ticks are relatively small and delicate and typically are colored somewhat differently than the vessels. In this way the vessels and ticks more accurately represent a wood grain, such as mahogany, oak, etc.

[0072] Where a particular image is to be printed in a channel or projection of an object, the object should be in the correct position before printing. In some cases, it may be possible to position the object in exactly the same position every time in printer **58**. However, apparatus **40** preferably includes a means for registering the position of the surface to be printed, such as with a laser optical device operably associated with printer control device **62**. In this way, the image to be printed may be accurately aligned with a print grid used by printer control device **62**. For example, the optical device may identify corners of door **10** or channels **30**, and use the position information to align the image to be printed with the object within 1/64 inch (0.4 mm). In this way, artwork may be tailored for each given object size, such as a particular door design or shape, by registering to the molded features of the object, or even the embossed grain texture on a molded or a flush object.

[0073] Printhead **60** is mounted for movement in a direction perpendicular to the direction of movement of door **10**. Arrow **66** shows direction of movement of printhead **60**, and in this way, printer bed **64** is moveable relative to printhead **60**.

Relative movement encompasses moving the printhead while maintaining the print bed stationary, moving the print bed while maintaining the printhead stationary, or moving both the print bed and the printhead.

[0074] Preferably, printer **58** is a flat bed printer, such as the Eagle **44** scanning moving bed ink jet printer of Inca Digital Printers Limited of Cambridge, United Kingdom. Door **10** may be arranged on printer bed **64**, and printer bed **64** is able to move longitudinally backwards and forwards relative to printhead **60**, which moves transversely (i.e. perpendicular to the direction of movement of printer bed **64**). In this way, the whole width and length of door **10** may be effectively printed.

[0075] As best shown in FIG. **6**, printer **58** may include a gantry **70** for supporting printhead **60**. Gantry **70** provides for lateral movement of printhead **60** under the control of print control device **62**, as described above. The gantry **70** is also preferably slidable longitudinally along the length of the print bed. Controller **44** of apparatus **40** preferably controls print control device **62**. In this way, data stored in the memory of controller **44**, including positioning information and image data, may be communicated to print control device **62**. In addition, printhead **60** preferably includes a UV curing lamp **72** for drying and curing the ink jet ink. Alternatively, a separate curing station **52** may be provided, if included in the printer unit. Ink jet ink droplets **74** are emitted from nozzles **76** on printhead **60**.

[0076] The nozzle outlets of printhead **60** travel in a plane P**2** that is separated from plane P of door **10** by a space G. Therefore, in the event the entire surface of the object is not planar, the distance traveled by ink droplets **74** emitted from nozzles **76** varies depending on whether printhead **60** is over a planar portion **26** (or panel portion **28**) or over a channel **30**. The maximum printing distance between nozzles **76** and upper surface **2** of door **10** is therefore equal to the depth D of a channel **30** plus space G (D+G=maximum printing distance). For example, if depth D is 12 mm, and gap G is 3 mm, the maximum printing distance will be about 15 mm. The maximum printing distance is preferably less than about 25 mm, more preferably less than about 15 mm. Commercially acceptable images are obtained when the maximum printing distance is about 12 mm or less. It is envisioned that greater depths could be printed successfully by droplet size, space distance and depth manipulations, and therefore it should be understood that the present invention is not restricted with regard to the depth of the recess being printed. However, if the distance (D+G) is too great, the placement control of droplets **74** may become unacceptable in some cases, causing blurred images in channels **30**.

[0077] Preferably yet optionally, the object to be printed primarily includes planar portions and/or recesses, but few, and more preferably no, projections. The presence of projections can lead to large recessed areas which may result in poor ink coverage. Thus, it is preferred that nozzles **76** print a majority of upper face **2** at a closer distance (i.e., G as opposed to D+G). To compensate for any potential visual imperfections, the density of droplets **74** that are printed in channels **30** is preferably greater than elsewhere on face **2**. In addition, increased printing density in recessed areas compensates for any "stretching" of the print grid, as explained above.

[0078] To darken the channels **30**, the printing density may be increased either before or after printing an initial image. A different density or color of droplets **74** may be applied to channels **30**, such as by a spray application of a groundcoat or paint, optionally followed by a wiped or sprayed stain. Alternatively, the ovalo or recessed area may be rendered by building a darker tone into the registered ink jet artwork.

[0079] Nozzles **76** preferably have a diameter of about 20 μm or more, preferably about 30 μm or more, more preferably about 40 μm or more. As such, droplets **74** will have a diameter approximately the same as the diameter of nozzles **76**. For example, a Spectra NovaJet 256 printhead may be used, which creates droplets having a diameter of about 40 μm. By providing that droplets **74** are relatively large, for example having a diameter greater than 20 μm, preferably not less than 25 μm, preferably greater than 30 μm, more preferably greater than 40 μm, it has been found that the effects of the relatively long distance of travel of droplets **74** (i.e. space G as well G+D), are reduced and, surprisingly, accurate placement of droplets **74** is achieved, resulting in a high quality image. Preferably, the ink that forms droplets **74** is a pigment-based ink that is UV curable, and therefore is cured almost immediately after its application by UV source **72**. Several inks suitable for this use are produced by Sericol, Inc. of Kansas City, Kansas, under the brand name UviJet.

[0080] The movement of printhead **60** relative to upper face **2**, and the shape of channels **30** are such that droplets **74** can be printed onto substantially the whole surface of channels **30**, even if channels **30** are relatively deep (for example, 10 mm) and sloped sidewalls **34** and **36** are relatively steep (such as 75 degrees relative to plane P). This is achieved by adjusting the relative speed of print bed **64**, and/or by adjusting the pitch of nozzles **76** relative to plane P**2** (for example the nozzles could be tilted), and/or the angle of upper face **2** of channels **30**. This defines the incident angle at which droplet **74** is emitted from nozzle **76** relative to upper face **2**. Preferably, a droplet **74** is emitted from nozzle **76** at an angle less than 20 degrees from perpendicular relative to printer bed **64**.

[0081] The selected first image component is printed onto upper face **2** of door **10** and the first protective coat in several lateral passes across the width of door **10** by printhead **60**. In addition, each pass may include the use of more than one printhead **60** and/or more than one row of nozzles **76**, so that each pass may effectively print in more than one set of print grid positions. Those skilled in the art recognize that nozzles **76** emit droplets of various desired colors in order to create the correct printed color.

[0082] The relative movement and printing paths of printhead **60** relative to the surface being printed, e.g., door **10**, is further explained with reference to FIGS. **6-12**. Door **10** having upper face **2** and side edges **4** is supported on bed **64** of printer **58**. Bed **64** is movable relative to printhead **60**. For the purposes of this example, it will be assumed that the bed is movable longitudinally, although it is within the scope of the invention to maintain bed **64** stationary and move the printhead **60** longitudinally. Bed **64** moves under the control of print control device **62** with respect to gantry **70** and printhead **60**. Ink jet droplets **74** are applied to door **10** in vertical strips running perpendicular to gantry **70**. Thus, to print an image component that covers upper face **2**, printhead **60** passes multiple times across the width of door **10**. FIG. **7** shows printhead **60** in a first position **78** adjacent door **10** and movable bed **64** holding an edge of door **10** beneath printhead **60**, so that a first strip of an image component can be applied to door **10** next to one edge thereof. FIG. **8** shows printhead **60** moved to a second position **80** and a first strip **82** of ink that has been applied to door **10**. Printhead **60** includes a UV

source **72** that illuminates ink applied to door **10**. Thus, the ink of first strip **82** is cured almost immediately after it is applied to door **10**.

[0083] FIG. **9** shows door **10** moved away from printhead **60** and gantry **70** so that printhead **60** can be rapidly moved from second position **80** to first position **78** as shown in FIG. **10**; without danger of accidentally coming into contact with door **10**. Because the door **10** or the door skin **14** remains fixed, then accurate registration of print head **60** relative to the door can be achieved. Printing in one direction also allows for curing of UV curable ink using a single UV source **72**. FIG. **11** shows door **10** moved so that an unprinted portion thereof adjacent to first strip **82** underlines gantry **70**, and, as shown in FIG. **12**, a second strip **84** of an image is ink-jet printed on door **10** adjacent first strip **82**. These steps are repeated until the selected image component has been completely formed on door **10**. During all of the passes, printhead **60** is maintained at a constant distance from the plane P of planar portions **26** of door **10**, even when printhead **60** is passing over channels **30**.

[0084] A preferred drop velocity of droplets **74** is about 8 m/s and a typical velocity of bed **64** is 1.5 m/sec. As such, the perpendicular of a printed surface should preferably be no less than, for example, 20 degrees from the path of the incident droplet **74** relative to the surface being printed. This is sometimes particularly relevant for the small areas, for example, little chamfers and ledges at the edge of moldings. In some cases, it is possible to compensate for angle by increasing the density of droplets **74** printed in a given area according to the relative angle (typically density of print should be multiplied by a factor of 1/cos of the angle between the perpendicular to the surface and the path of the incident droplet relative to the surface). This can be done by standard color management techniques, but accurate registration may be needed. Preferably the surface is such that the angle between adjacent regions of the surfaces to be printed is less than 90 degrees, preferably less than 85 degrees, preferably less than 80 degrees. For example, sloped sidewalls **34** preferably extend downwardly at an angle A of 80 degrees or less relative to plane P, as shown in FIG. **3**. This ensures adequate ink coverage of all contoured portions, achieving a high quality image.

[0085] It is generally believed that smaller droplet sizes produce higher quality images. However, when printing on a substrate having depressions, molded channels, or protrusions, it has been found that the opposite is true. As noted above, the placement of smaller droplets is often difficult due to air currents, slipstream effects, and air viscosity. However, relatively large droplets **74** have sufficient mass and momentum to remain relatively unaffected by such turbulence or other adverse effects. As such, the use of relatively large droplets **74** creates a high quality image, even on contoured surfaces such as upper face **2** of door **10**.

[0086] It is possible to obtain high quality print images, even photographic quality print images, by following the method of the present invention. (Note that "photographic quality" refers to very high quality images that closely resemble a photograph in image quality and color accuracy. Posters or reproductions of artwork, for example, are generally of photographic quality as this term is used herein. Prints that are blotchy or that include color inaccuracies or uneven edges are not included within this definition.)

[0087] In a preferred embodiment of the invention, the disclosed method can be used to create a simulated wood grain pattern, even if the surface to be printed already comprises real wood. For example, the surface to be printed may comprise low quality plywood. By use of methods described herein, the plywood may be made to resemble a more expensive wood, such as cherry wood. This may be achieved, for example, by staining or painting the plywood with a "cherry" color ground coat. Then, a wood grain pattern (e.g., cherry wood) is applied to the painted plywood in multiple printing steps, e.g., a step of printing wood grain vessels as a first image component and a subsequent step of printing wood grain ticks as a second image component, preferably substantially registered with the first image. Interposed between the printing steps is a coating step. The use of real wood such as plywood in the printed area has the added advantage that the plywood already has a wood texture that gives further perceived quality to the simulated "cherry wood".

[0088] When printing a wood grain pattern, preferably ink having color tones found in natural wood is used. This helps to reduce the amount of ink jet ink needed, and possibly the number of ink colors required, and therefore the number of printheads **60** required. Preferably a standard CMYK ink set is used in the disclosed method.

[0089] A representation of an example of a wood grain pattern is best shown in FIG. **13**. The pattern includes detail of the heartwood and sapwood of a particular grain pattern. This image can be precisely duplicated based upon photographic images. Although the application of a ground coat prior to printing the wood grain pattern is sometimes preferred, it is not necessary. The background tones **86** of the wood grain image with the initially prepared ground coat. The darker lines such as vessels **88** are then ink jet printed as the first image component and markings such as ticks **89** are subsequently printed as the second image component. The application of protective topcoat between ink jet printing steps and following the final ink jet-printing step controls gloss, provides long term performance, provides depth impression, and provides the textured feel of real wood.

[0090] A flush door **90** having a wood grain pattern printed on at least one face **92** of door **90** is best shown in FIGS. **14** and **15**. The wood grain pattern includes background tone **86**, a first image component of vessels **88**, and a second image component of wood ticks **89**. Using the method described above, a primary groundcoat **94** of paint, stain, or other pigment, having a color similar to background tone **86** is applied to face **92**. Background tone **86** may then be further enhanced and colored by ink jet printing. In addition, the first image **88** is ink jet printed. A first protective coat **96** may then be applied to door **10** following ink jet printing of background tone **86** and the first image **88**. Next, the second image **89** of wood ticks is printed on the first protective coat **96**. A second protective coat **98** may then be applied to door **10** following ink jet printing of the second image **89** so as to cover the second image **89** and the first protective coat **96**. The resulting printed door **90** has a high quality, photographic image of a natural wood surface. Further, the spacing of first and second print image components at different protective layers contributes to the formation of an overall image having depth.

[0091] Alternately, to reduce the amount of expensive ink jet ink used in the printing process, a primary groundcoat **94** having a color corresponding to the color of background tone **86** may be used, thereby eliminating the necessity of additional coloration with ink jet printing for background tone **86**. Only the first image **88** is thus printed in the first ink-jet printing step. Beneficially, this method reduces the amount of

expensive ink jet ink needed, since less than half of face **92** needs to be coated with the ink jet ink. However, some of the fullness of the image obtained by inkjet printing both the background tone **86** and the first and second images **88** and **89** may be reduced.

[0092] Traditional rail and stile doors are formed with wooden elements each having wood grain running in the longitudinal direction of the element. Some of these elements are positioned at right angles to one another when a door is assembled, and, therefore, traditional doors may have wood grain running in two mutually orthogonal directions. As best shown in FIGS. **16** and **17**, door **100** includes a wood grain pattern printed on at least one contoured face **102**, and has the appearance of wood grain running in two directions to simulate the appearance of such traditional doors. As with door **90**, door **100** includes background tone **86**, vessel pattern **88**, and wood ticks **89**. However, background tone **86**, vessel pattern **88**, and wood ticks **89** are printed so that a first wood grain pattern G**1** runs in a first direction on vertical stile portions **104** and panel portions **106**, and a second wood grain pattern G**2** runs in a second direction on horizontal rail portions **108**. Because the stored image of wood grain pattern has wood grain running in two directions, this pattern can be printed in register to the design features of the molded door design or embossed textured pattern. The wood grain pattern may also be printed in channels **110** surrounding panel portions **106** in a direction corresponding to adjacent stile and rail portions **104**, **108**. Similar to door **90**, face **102** of door **100** includes primary ground coat **94**. Preferably, a darker secondary ground coat **112** is applied to channels **110** covering primary ground coat **94**. Background tones **86** and vessel patterns **88** are then printed using ink jet printing techniques, followed by an application of a first topcoat **96**, printing of the wood ticks **89**, and application of a second topcoat **98**. The result is a high quality image over the entire surface of contoured face **102** of door **100**.

[0093] In some cases it will be sufficient for just the front and back faces of a door, such as exteriorly disposed surfaces of skins **14**, **16**, to be printed with a wood grain pattern. In other cases, it will be sufficient for just one face of a door to be printed with a wood grain pattern, for example, for a door leading from a house to an attached garage. However, side edges **4** of door **10** may also be provided with the wood grain pattern. Alternatively, a veneer could be applied to side edges **4**.

[0094] In a preferred embodiment, the corner of door **10**, where upper face **2** meets side edge **4**, includes a chamfer **116**, as best shown in FIG. **18**. The presence of chamfer **116** gives a better finish to door **10**. A printhead **60**, when located adjacent side edge **4**, may extend slightly beyond upper face **2** and therefore print onto at least a part of the chamfer **116**. This achieves high image and print quality of portions of upper face **2** adjacent edges **4**.

[0095] FIG. **19** illustrates a printing system for printing two doors **10** and **10'** at the same time. The doors are placed side by side on bed **64**. One or more printheads **60** may be provided to print the upper faces **2** and **2'** of doors **10** and **10'**, respectively. In addition, a printhead may be provided for printing side edges of each door, as described above. As shown by arrows G**3** and G**4**, image components of a wood grain pattern may be printed sequentially in a first and second direction. Ink jet printing permits precise placement of ink droplets **74**, and therefore the printing of wood grain in directions G**3** and G**4** may be accomplished as the printheads pass over the combined width of both doors **10**, **10'** (just as described for door **10** in FIGS. **7-12**). As described above, a protective coating is applied between the image component printing steps, wherein the doors may be removed from the print bed. Once the printing operation for upper faces **2**, **2'** is complete, doors **10** and **10'** may be flipped to expose the unprinted faces, which may then be printed in a similar manner. A preferred ink jet ink used for this printing arrangement is Sericol UviJet UV curing ink.

[0096] As best shown in FIG. **20**, any image may be printed on an object, including a multi-color photographic quality image. For example, a door **120** may be printed to include a graphic image. The image comprises a baseball player **122** wearing an off-white uniform **124** standing on a light brown dirt infield **126** adjacent a green outfield **128** bounded by a dark green wall **130**. Player **122** has a brown glove **132** and a red cap **134**. In this example, the dominant color of the graphic image is light brown. This color covers approximately half of the door **120**, and is compatible with the greens of the outfield **128** and wall **130**. Therefore, a white primary ground coat is preferably applied to door **120** before the image is printed thereon to bring out the colors of the image. The image is broken down or otherwise organized into two separate components, a first image component to be applied on the exterior surface of the door in a first print step, and a second image component to be applied to a first topcoat so as to provide a three, dimensional sensation. For example, portions of the player **122** in the foreground, e.g., the glove **132**, red cap **134** and base, may be printed in the second printing step as part of the second image component. The features of the first image component are thereby provided with an exaggerated depth appearance. The image may overlap molded recessed areas **136** of a door **138** without reducing image quality, as best shown in FIG. **21**.

[0097] For some applications, it may be desirable to print onto contoured portions (such as channels **30**) of a molded object in a manner that suggests a frame surrounding an image, as best shown in FIGS. **22-25**. It should be understood that the object may be formed from various substrates, including steel, wood composite, post-formed MDF, molded fiberglass polymeric material, or pressed steel, or any combination thereof. As shown in FIGS. **22** and **23**, a molded casing **140** includes a central planar portion **142** and a contoured outer frame **144**. As shown in FIGS. **24** and **25**, a wood grain pattern has been printed onto contoured outer frame **144** by ink jet printing. In addition, an image **146** of a flowerpot **148**, flowers **149** and book **150** has been printed onto planar portion **142**. The image **146** may be printed using ink jet printing techniques disclosed herein. Image **146** may include various colors, just as with the image of baseball player **122** in FIG. **21**. Image **146** does not extend onto outer frame **144**. Thus, a fully "framed" picture is simulated after one printing operation onto molded casing **140**.

[0098] According to another embodiment, either one of the image **146** or the wood grain pattern of the frame **144** may be printed using an embodied method of the invention, whereas the other is printed without being separated into distinct image components and interposed by a first coating layer. For example, contoured outer frame **144** may also be printed to have a plain border, such as black or brown.

[0099] The appearance of ornate, carved wood frames or wood inlays may also be simulated. It will be appreciated that an acceptable effect might still be achieved even if outer frame **144** is not contoured but rather planar with planar

portion **142**. For example, a similar image may be obtained on a flush door or planar tabletop. However, the contour of outer frame **144** often advantageously allows for the production of a more realistic looking frame. The same or a different image can be printed on the opposite surface.

[0100] As best shown in FIGS. **26** and **27**, wainscot **160** may also be printed with a wood grain pattern and/or image in a similar manner, wherein central planar portions **162** may be printed with an image, and outer molded portions **164** may be printed with a wood grain pattern. The printing procedure embodied herein may be applied to the central planar portions **162** alone, the outer molded portions **164** alone, or a combination of the central planar portions **162** and the outer molded portions **164**. Wainscot **160** may also include an outer portion **166**. Of course, the entire surface (**162**; **164** and **166**) may also be printed with the wood grain pattern, if desired by the consumer.

[0101] In another aspect of the present invention, a synthetic printing sheet **200**, such as made of Teslin™, is first molded onto a surface to be printed, such as door facing **202** as best shown in FIGS. **28** and **29**. Preferably, printing sheet **200** has a color that is related to the dominant color (as explained above), or has a color that is the dominant color. In this way, application of ground coats may be obviated. Printing sheet **200** is laminated onto facing **202** using conventional techniques, such as with a membrane press or post molding press, either in-press or out of press.

[0102] Preferably, printing sheet **200** is comprised of a moldable, polyolefin material that stretches as it is formed onto facing **202**. As such, sheet **200** does not wrinkle as it is being formed onto facing **202**, even in contoured portions and molded corners, such as contoured portions **204** of facing **202**. A suitable printing sheet is a Teslin™ sheet manufactured by PPG Architectural Finishes, Inc. of Pittsburgh, Pa. The Teslin™ sheet preferably has a thickness of about 7 millimeters.

[0103] Then, facing **202** is forwarded to a printing station (such as printing station **50**) for ink jet printing the first desired pattern or image component **206** thereon. The surface of facing **202**, covered by printing sheet **200**, is particularly well suited for ink jet printing because printing sheet **200** has a uniform surface. Teslin™ material is designed as a printing surface. Facing **202** is ink jet printed as described above. Alternatively, printing sheet **200** may first be ink jet printed with the desired pattern or image component **206** (and optional component **210**) prior to laminating sheet **200** onto facing **202**.

[0104] Printing sheet **200** is ink jet printed as disclosed above, i.e., is subjected to a first printing step for forming a first desired pattern or image component **206**, a first protective coating application step for forming a first topcoat **208**, and a second printing step for forming a second desired pattern or image component **210**. Then, sheet **200** is laminated onto facing **202** during an in-press lamination process. The printed pattern stretches onto any molded or contoured portions **204** of facing **202** as sheet **200** stretches onto facing **202**. In this way, the image quality is maintained, achieving a high quality print. Pre-printing of sheet **200**, prior to lamination onto facing **202**, is suitable for non-directional images and patterns. However, ink jet printing sheet **200** after it has been laminated onto facing **202** is preferred for more detailed images and multi-directional patterns. Further, sheet **200** is formed onto facing **202** and facing **202** is molded into its final contoured configuration in one molding step. Thus, printing and forming are accomplished in a cost efficient manner.

[0105] After printing sheet **200** is printed and formed onto facing **202** (either before or after ink jet printing sheet **200**), a second topcoat **212** may be applied to facing **202** as described above. Alternatively, the second topcoat **212** may be applied prior to joining the printing sheet **200** to the facing **202**.

[0106] It is to be understood that the image may be separated into two constituent elements or components, with two topcoats applied to the object. For example, a process may comprise printing first and second image components of an overall image. In this example, the process may comprise the steps of applying a first top coat between the first and second image components, and a top second coat after the second image component. Thus, the process may comprise printing the first image component on the object exterior surface, applying a first coat to the exterior surface to cover the first image component, printing the second image component on the first coat, then applying a second coat over the second image components. It thus becomes apparent that many combinations and variations may be practiced and produced under aspects of the invention.

[0107] The present invention has been described herein in terms of several preferred embodiments. However, it should be understood that numerous modifications and variations to these embodiments would be apparent to those skilled in the art upon a reading of the foregoing description. For example, nearly any image that can be captured or stored digitally, or generated on a digital image generating system, can be applied to an object to be printed, such as a door skin or similar wood composite substrate. In addition, the disclosed invention may be applied to various objects, such as moldings, cabinet doors, wainscot panels, and the like. Therefore, it is intended that any such modifications and variations comprise a part of this invention, provided they come within the scope of the following claims and their equivalents.

1. A method of printing an image on an object, comprising the steps of:

providing an object having an exterior surface;

printing a first image component on the exterior surface;

applying a first transparent coat on the exterior surface so as to cover the first image component;

printing a second image component on the first transparent coat; and

optionally applying a second transparent coat over the first transparent coat and second image component so as to cover the first and second image components.

2-20. (canceled)

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