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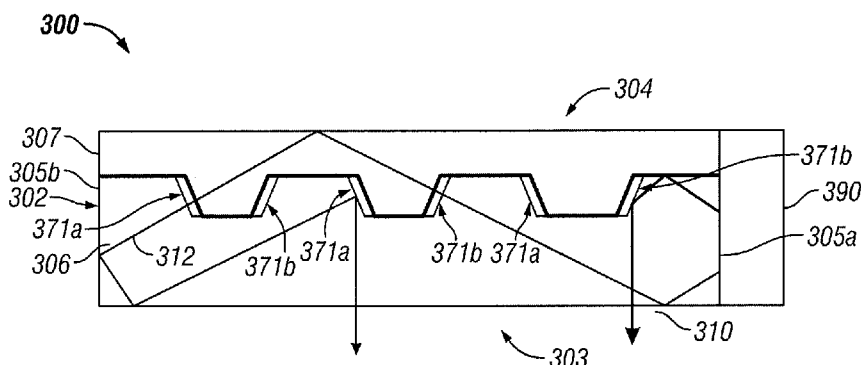


FIG. 3D

(57) **Abstract:** Methods of manufacturing light panels having at least one re-entrant turning feature. In one implementation, a method of manufacturing a light panel includes providing a base layer, providing a cover layer, and coupling the cover layer to the base layer to form at least one re-entrant turning feature between the base layer and the cover layer. In another implementation, a method of manufacturing a light panel includes providing a base layer, forming at least one receiving space in the base layer, providing at least one prismatic block, and coupling at least a portion of the prismatic block into the receiving space such that re-entrant turning features are formed between the prismatic block and the base layer.

METHODS OF MANUFACTURING ILLUMINATION SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This disclosure claims priority to U.S. Patent Application No. 12/868,656, filed August 25, 2010, entitled "METHODS OF MANUFACTURING ILLUMINATION SYSTEMS," and assigned to the assignee hereof. The disclosure of the prior applications is considered part of, and is incorporated by reference in, this disclosure.

BACKGROUND

Technical Field

[0002] This disclosure relates to the field of lighting, and in particular, light extraction in illumination systems.

Description of the Related Art

[0003] A variety of architectural lighting configurations are utilized to provide artificial illumination in a wide variety of indoor and/or outdoor locations. Such illumination systems can include fixed and portable architectural lighting. Various configurations can employ technologies such as incandescent, fluorescent, and/or light emitting diode based light sources.

[0004] One type of architectural lighting configuration can be referred to generally as panel lighting. Panel lights may include, for example, fluorescent lighting in a light box behind a plastic lenticular panel. Panel lighting is often configured as planar and square or rectangular and having width and length dimensions significantly greater than a thickness dimension. While the thickness of panel lighting is generally significantly less than corresponding width and length dimensions, it is frequently the case that the thickness of existing panel lighting forces limitations in installation and use. Display front and backlight techniques can be applied to large area (such as 4' x 8') flat panel lighting.

[0005] One specific type of panel lighting is flat panel lighting. Flat panel lights are commonly found in flat panel display applications, which include a transparent panel designed to provide illumination from its planar surface. Light is provided into the panel from a light source (e.g., LEDs or a CCFL lamp), which may be positioned along one or more

edges of the panel. Light travels throughout the panel, staying within the panel due to total internal reflection at its front planar surface and back planar surface. At some places on the panel, light may be directed out of the panel by a light extraction or turning feature.

[0006] Flat light panels can be sized for luminaire or architectural applications. For architectural applications a panel may be about 4' x 8', or made of tiles of smaller dimensions. Some implementations include two or more flat light panels adjacently disposed. Thus, flat panel lights can be applied to large areas. Flat panel lights can be used as a luminaire or as a partially transparent light panel and screen. For example, a flat panel light may be used as a privacy screen. The panel can be glass, polymer such as acrylic, polyethylene terephthalate, polycarbonate etc. A 4' x 8' panel may have a thickness of about 0.25" or greater to allow adequate transmission of light along its width, when illuminated from two edges.

[0007] In existing panel designs, light extraction features are often grooves or other features cut into the surface of the panel. However, these machined or embossed features are can be inefficient.

SUMMARY

[0008] The system, method, and devices of the present disclosure each have several aspects, no single one of which is solely responsible for its desirable attributes. Without limiting the scope of this disclosure, its more prominent features will now be discussed briefly. After considering this discussion, and particularly after reading the section entitled "Detailed Description," one will understand how the features of this disclosure provide advantages over other lighting devices.

[0009] Certain implementations of the subject matter described herein include methods of manufacturing a light panel having re-entrant turning features formed therein. According to one implementation a method of manufacturing a light panel includes providing a base layer having an upper surface, a lower surface opposite the upper surface, a first end configured to receive light from a light source, and a second end opposite the first end, the upper surface including a first plurality of planar portions and a plurality of receiving spaces disposed between the first plurality of planar portions, wherein the plurality of receiving

spaces are disposed at least partially between the first plurality of planar portions and the lower surface. The method further includes providing a cover layer having a first surface and a second surface opposite the first surface, the second surface including a second plurality of planar portions and a plurality of protrusions extending from the cover layer away from the first surface, wherein the second plurality of planar portions are disposed at least partially between the plurality of protrusions and the first surface, and coupling the cover layer to the base layer such that at least one of the first plurality of planar portions is positioned over at least one of the second plurality of planar portions and such that at least one of the plurality of receiving spaces receives at least one of the plurality of protrusions to form at least one re-entrant turning feature between the base layer and the cover layer.

[0010] In another aspect, each of the first plurality of planar portions share a common plane and/or each of the second plurality of planar portions share a common plane. In another aspect, the base layer has an index of refraction characteristic, the cover layer has an index of refraction characteristic, and the index of refraction characteristic of the base layer is greater than the index of refraction characteristic of the cover layer. In one aspect, an adhesive is used to couple the base layer to the cover layer and the adhesive layer has an index of refraction characteristic that is closer to the index of refraction characteristic of the cover layer than the index of refraction characteristic of the base layer. In another aspect, the upper surface of the base layer is bonded to the second surface of the cover layer. In one aspect, the index of refraction characteristic of the adhesive is about the same as the index of refraction characteristic of the cover layer.

[0011] In yet another aspect, the at least one re-entrant turning feature extends between the lower surface of the base layer and the first surface of the cover layer at an angle relative to the plane shared by the plurality of first planar portions. In one aspect, coupling the cover layer to the base layer forms a first re-entrant turning feature and a second re-entrant turning feature between the base layer and the cover layer, the first re-entrant turning feature extends between the lower surface of the base layer and the first surface of the cover layer at a first angle relative to the plane shared by the first plurality of planar portions, the second re-entrant turning feature extends between the lower surface of the base layer and the first surface of the cover layer at a second angle relative to the plane shared by the first

plurality of planar portions, and the first angle is different from the second angle. In another aspect, the at least one of the plurality protrusions includes a trapezoidal prism having first and second sidewalls, the first sidewall is disposed between the second sidewall and the first end at a first angle relative to the lower surface, and the second sidewall is disposed at a second angle relative to the lower surface. In one aspect, at least one of the receiving spaces includes a trapezoidal trough having third and fourth sidewalls, the third sidewall is disposed at a third angle relative to the lower surface, and the fourth sidewall is disposed at a fourth angle relative to the lower surface. In another aspect, the third sidewall is disposed adjacent to at least a portion of the first sidewall, and the fourth sidewall is disposed adjacent to at least a portion of the second sidewall. In one aspect, the first angle is different from the third angle and the second angle is different from the fourth angle. In another aspect, the first sidewall and the third sidewall define a re-entrant turning feature therebetween and the second sidewall and the fourth sidewall define a re-entrant turning feature therebetween.

[0012] According to another implementation, a method of manufacturing a light panel includes providing a base layer having an upper surface, a lower surface opposite the upper surface, forming at least one receiving space in the upper surface, the at least one receiving space extending from the upper surface toward the lower surface, wherein the at least one receiving space has a first sidewall and a second sidewall, wherein the first sidewall forms a first angle with the lower surface, and wherein the second sidewall forms a second angle with the lower surface, providing at least one prismatic block, wherein the at least one prismatic block has a third sidewall, a fourth sidewall, and a first planar surface disposed therebetween, wherein the third sidewall forms a third angle with the first planar surface, and wherein the fourth sidewall forms a fourth angle with the first planar surface, and coupling at least a portion of the at least one prismatic block into the at least one receiving space such that at least a portion of the third sidewall is disposed adjacent to at least a portion of the first sidewall and such that at least a portion of the second sidewall is disposed adjacent to at least a portion of the fourth sidewall such that the first and third sidewalls form a first re-entrant turning feature therebetween, and the second and fourth sidewalls form a second re-entrant turning feature therebetween.

[0013] In one aspect, the base layer includes a first end for receiving light from a light source and a second end opposite the first end, and the first and second re-entrant turning features are configured to turn at least a portion of light received through the first end toward the lower surface of the base layer. In another aspect, the at least one prismatic block includes a trapezoidal prism and the at least one receiving space includes a trapezoidal trough. In another aspect, the first angle is different than the second angle and the first angle is different than the fourth angle. In another aspect, the second angle is different than the fourth angle. In yet another aspect, the base layer has an index of refraction characteristic, the at least one prismatic block has an index of refraction characteristic, and the index of refraction characteristic of the at least one prismatic block is about the same as the index of refraction characteristic of the base layer. In one aspect, the method further includes coupling the at least one prismatic block to the base layer. In another aspect, an adhesive is used to couple the at least one prismatic block to the base layer, wherein the adhesive has an index of refraction characteristic that is about the same as the index of refraction characteristic of the base layer.

[0014] According to another implementation, a method of manufacturing a light panel includes providing a layer having an upper surface, a lower surface opposite the upper surface, a first end configured to receive light from a light source, and a second end opposite the first end, providing a first prismatic block, the first prismatic block having a first sidewall, a second sidewall, and a first planar surface disposed therebetween, wherein the first sidewall forms a first angle with the first planar surface, and wherein the second sidewall forms a second angle with the first planar surface, disposing the first prismatic block on the base layer, providing a second prismatic block, the second prismatic block having a third sidewall, a fourth sidewall, and a second planar surface disposed therebetween, wherein the third sidewall forms a third angle with the second planar surface, and wherein the fourth sidewall forms a fourth angle with the second planar surface, disposing the second prismatic block on the base layer such that the first prismatic block and the second prismatic block form a receiving space therebetween, wherein the receiving space is disposed between the second sidewall and the third sidewall, providing a third prismatic block, the third prismatic block having a fifth sidewall, a sixth sidewall, and a third planar surface disposed therebetween,

wherein the fifth sidewall forms a fifth angle with the third planar surface, and wherein the sixth sidewall forms a sixth angle with the third planar surface, and disposing at least a portion of the third prismatic block in the receiving space such that at least a portion of the fifth sidewall is disposed adjacent to at least a portion of the second sidewall and such that at least a portion of the sixth sidewall is disposed adjacent to at least a portion of the third sidewall, wherein the second and fifth sidewalls form a first re-entrant turning feature therebetween, wherein the third and sixth sidewalls form a second re-entrant turning feature therebetween.

[0015] In one aspect, the first re-entrant turning feature extends along a first longitudinal axis that forms a first angle with the upper surface and the second re-entrant turning feature extends along a second longitudinal axis that forms a second angle with the upper surface. In another aspect, the first angle is different from the second angle. In one aspect, the method further includes coupling the first prismatic block to the base layer, coupling the second prismatic block to the base layer, and coupling the third prismatic block to the base layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 is a cross-section of an illumination system schematically illustrating one implementation of a light turning feature.

[0017] Figure 2 is a cross-section of an illumination system schematically illustrating an implementation of a re-entrant turning feature.

[0018] Figure 3A is a cross-section of a base layer used to manufacture a first implementation of an illumination system having a plurality of re-entrant turning features.

[0019] Figure 3B is a cross-section of a cover layer used to manufacture the first implementation of an illumination system.

[0020] Figure 3C is a cross-section of the base layer of Figure 3A shown with the cover layer of Figure 3B with a coupling layer applied to the cover layer.

[0021] Figure 3D is a cross-section of the first implementation of an illumination system having a plurality of re-entrant turning features formed between the cover layer of Figure 3B and the base layer of Figure 3A.

[0022] Figure 3E is a process flow diagram illustrating an implementation of a method of manufacturing the light panel schematically illustrated in Figure 3D.

[0023] Figure 4A is a cross-section of a base layer used to manufacture a second implementation of an illumination system having a plurality of re-entrant turning features.

[0024] Figure 4B is a cross-section of a prismatic block used to manufacture the second implementation of an illumination system.

[0025] Figure 4C is a cross-section of a set of prismatic blocks from Figure 4B shown with the base layer of Figure 4A and a coupling layer applied to each of the plurality of prismatic blocks.

[0026] Figure 4D is a cross-section of the second implementation of an illumination system having a plurality of re-entrant turning features formed between the prismatic blocks of Figure 4B and the base layer of Figure 4A.

[0027] Figure 4E is a process flow diagram illustrating an implementation of a method of manufacturing the light panel schematically illustrated in Figure 4D.

[0028] Figure 5A is a cross-section of a base layer used to manufacture a third implementation of an illumination system having a plurality of re-entrant turning features.

[0029] Figure 5B is a cross-section of a first prismatic block used to manufacture the third implementation of an illumination system.

[0030] Figure 5C is a cross-section of a second prismatic block used to manufacture the third implementation of an illumination system.

[0031] Figure 5D is a cross-section of a set of the first prismatic blocks from Figure 5B and the second prismatic blocks from Figure 5C shown with the base layer of Figure 5A and a coupling layer applied to each of the prismatic blocks.

[0032] Figure 5E is a cross-section of the third implementation of an illumination system having a plurality of re-entrant turning features formed between the prismatic blocks of Figures 5B and 5C and the base layer of Figure 5A.

[0033] Figure 5F is process flow diagram schematically illustrating an implementation of a method of manufacturing the light panel schematically illustrated in Figure 5E.

DETAILED DESCRIPTION

[0034] The following detailed description is directed to certain specific implementations of the present disclosure. However, the implementations described herein can be implemented in a multitude of different ways. For example, methods of manufacturing turning features can be used in manufacturing architectural light panels and also in manufacturing front light systems for display devices. It will be appreciated that the illustrated systems are not necessarily drawn to scale and their relative sizes can differ. Moreover, the relative angles of the edges of the turning features can differ from those illustrated. Furthermore, the cross-sectional areas of the turning features can vary and the relative orientations and angles defined by the edges of the turning features can vary from turning feature to turning feature. In this description, reference is made to the drawings wherein like parts are designated with like numerals throughout.

[0035] Illumination systems may include numerous light turning or extraction features that are cut or embossed into at least one planar surface of the system (e.g., a planar surface of a light panel). The light turning features may include, for example, grooves, pits, dots, or prismatic features, which are formed as part of the system. In some implementations, illumination systems include v-shaped grooves that are configured to turn (for example, reflect) light propagating within a light panel, that is incident on an edge of the groove, toward a particular direction (e.g., toward a surface of the light panel so that the light exits the surface). However, light that is propagating within a light panel and incident on an edge of the v-shaped groove at an angle above the critical angle can propagate through the groove and can be considered “lost” light as it is not turned toward the desired particular direction (e.g., and therefore does not exit a surface of the light panel).

[0036] The loss of light through turning features in an illumination system can be reduced or mitigated by incorporating re-entrant turning features into the illumination system. As used herein, a “re-entrant turning feature” refers to a turning feature in an illumination system configured to re-inject light that propagates through the turning feature back into a light panel. In some implementations, re-entrant turning features comprise “slit-shaped” turning features. Slit-shaped turning features may comprise gaps, slits, volumes, or spaces within at least a portion of a light panel that extend at an angle relative to the top and/or

bottom surfaces of the panel. Such turning features can reduce light loss by recycling light that propagates through a turning feature and redirecting or re-injecting this light back into the light guide. Re-entrant turning features can be formed monolithically using traditional molding processes (e.g., injection molding) or by computer controlled machining. However, these processes can limit flexibility in design. For example, these methods limit how close the leading and trailing edges of a turning feature can be fabricated relative to each other. Methods disclosed herein incorporate composition approaches to re-entrant turning feature fabrication that allow for increased efficiency (e.g., reduction of light loss) and flexibility in illumination system design.

[0037] Figure 1 is a cross-section of an illumination system **100** including a light panel **101** having a v-shaped turning feature **120**. A light source **190** is positioned adjacent to a first edge **105a** of the light panel **101** and a second edge **105b** is disposed opposite to the first edge **105a**. The light panel **101** also includes a generally planar upper surface **104** and a generally planar lower surface **103** disposed opposite to the upper surface. For clarity of description, the implementations disclosed herein will generally be described in relation to an upper surface and a lower surface (e.g., as referenced by the relative positions of the illustrated surfaces with respect to page orientation). However, one having ordinary skill in the art will appreciate that the systems can be oriented in any direction during use, including flipped from top-to-bottom and/or side-to-side; accordingly, every implementation and example described herein with reference to the upper surface can also be implemented on the back surface and vice-versa.

[0038] In some implementations, the upper surface **104** and the lower surface **103** of the light panel **101** may have approximately the same surface area. However, it is possible they could be different in size and/or shape, for example, in implementations where the first edge **105a** and/or the second edge **105b** are slanted (e.g., not perpendicular to the upper and lower surfaces **104**, **103**). In some implementations, the upper surface **104** and the lower surface **103** can each be about 4' x 8' and they can be generally vertically aligned with one another. The light panel **101** can comprise various optically transmissive materials, for example, glass, polymer, polycarbonate, polyethylene terephthalate, glycol-modified polyethylene terephthalate, amorphous thermoplastic, and/or other substrates.

[0039] The light source **190** can be configured to inject light into the light panel **101** at least through the first edge **105a**. The light source **190** may comprise one or more light emitting diodes, fluorescent lights, light bars, or any other suitable light source(s). In some implementations, the system **100** can include more than one light source **190**, for example, a second light source **190** can be disposed adjacent to the second edge **105b**. Injected rays of light **110**, **112** may propagate from the light source **190** into the panel **101**. Light propagating through the panel **101** can be trapped within the panel **101** by total internal reflection (“TIR”) until it encounters a light turning feature **120** that is configured to turn light so that the light propagates toward the lower surface **103** of the light panel **101**. Light turning feature **120** includes a first edge **121** and a second edge **123** that define a v-shaped groove or trough in the upper surface **104** of the light panel **101** that extends toward the lower surface **103**. The upper surface **104** includes a first planar portion **102a** and a second planar portion **102b** disposed on opposite sides of the light turning feature **120**. When light propagating within the light panel **101** encounters the first edge **121** and/or second edge **123** of the light turning feature **120**, some of the light may be extracted from the panel and turned toward the lower side **103** making the panel **101** appear bright to a viewer from that side. For example, ray of light **110** can be injected into the light panel **101** by the light source **190** and turned toward the lower surface **103** by the second edge **123** of the light turning feature **120**.

[0040] V-shaped turning features similar to turning feature **120** schematically illustrated in Figure 1 are susceptible to light loss, which can reduce the overall proportion of light that is ultimately turned out of the light panel **101** to light that is injected into the light panel **101** by the light source **190**. In one implementation, light incident on turning feature **120** at an angle close to the critical angle (e.g., the angle of incidence above which total reflection occurs for a given medium boundary) is not reflected by the turning feature **120** and can propagate through the turning feature and out of the panel **101**. Light that passes through the turning feature and out of the panel **101** can be considered lost because it is not reflected toward one or more desired directions. In illumination systems, lost light can reduce the brightness and/or uniformity of a display. For example, ray of light **112** in Figure 1 encounters the turning feature **120** at an angle of incident that is close to 90° and propagates

through the turning feature **120** instead of being redirected or turned. Thus, ray of light **112** can be considered lost because it is not extracted through the lower surface **103**.

[0041] Turning now to Figure 2, an implementation of an illumination system **200** is schematically illustrated including a light panel **201** and a light source **290** disposed near the light panel **101**. The light panel **201** includes a re-entrant turning feature **220** that comprises a slit formed in the upper surface **204** of the light panel **201**. The turning feature **220** extends along a longitudinal axis **229** from the upper surface toward the lower surface at an angle relative to the upper surface. The turning feature **220** includes a first edge **221**, a second edge **225** opposite to the first edge, and a base edge **223** disposed between the first edge and the second edge. In some implementations, the first edge **221** and the second edge **225** can extend generally parallel to one another and in other implementations, the first edge **221** can extend at an angle relative to the second edge **225** and vice-versa. The turning feature **220** can thus define a volume having the shape of a parallelogram. To allow for the re-injection (or recycling) of light that passes through the turning feature **220**, the second edge **225** is positioned such that it is disposed between a portion of the light panel **201** and the first edge **221**. Additionally, the first edge **221** is positioned such that it is disposed between at least a portion of the light panel **201** and at least a portion of the second edge **225**. Thus, the light turning feature **220** is oriented within the light panel **201** such that at least a portion of the light panel **201** is disposed on opposite sides of the longitudinal axis **229** of the turning feature.

[0042] The slit-shaped re-entrant turning feature **220** can reduce lost light and improve the efficiency of the system **200** by recycling light that propagates through the turning feature **220**. For example, ray of light **210** injected into the panel **201** through the first edge **205a** by the light source **290** generally propagates toward the second edge **205b**. The ray **210** encounters the second edge **225** of the turning feature **220** at an angle above the critical angle and is turned by TIR toward the lower surface **203** of the panel **201**. In some implementations, light turned by the turning feature **220** can encounter the lower surface **203** at an angle below the critical angle and propagate out of the light panel. In other implementations, light turned by the turning feature **220** can encounter the lower surface **203** at an angle above the critical angle and continue to be bound within the light panel by TIR.

In another example, ray of light **212** is injected into the panel **201** by the light source **290** and encounters the second edge **225** of turning feature **220** at an angle of incidence that is below the critical angle. Because ray of light **212** encounters the turning feature **220** at an angle below the critical angle, the ray **212** is not bound by TIR and propagates through the turning feature **220**. However, because of the shape and orientation of the turning feature **220**, after propagating through the turning feature, ray **212** is re-injected into the panel **201** and the ray can be considered to be recycled. The re-injection or recycling of ray **212** can increase the brightness and efficiency of the illumination system **200** as ray of light **212** can continue to propagate within the panel **201** until it is turned toward the lower surface by turning feature **220** instead of being lost.

[0043] As discussed above, re-entrant turning features, for example, turning feature **220** in Figure 2, can be formed monolithically using various methods. Implementations disclosed herein below disclose methods of manufacturing re-entrant turning features using composite methods. Composite methods of manufacturing utilize two or more discrete pieces of material to form re-entrant turning features therebetween. These methods can allow for increased efficiency and flexibility in illumination system design. The turning features disclosed herein can be utilized in various devices and systems in which light turning, extraction, or redirection, is desired. In some implementations, the turning features are utilized as light turning features in illumination devices. Such illumination devices can include wide area lights for indoor or outdoor use or different architectural lighting systems. For example, illumination devices can provide overhead lighting for rooms and other indoor spaces. In other implementations, the turning features are utilized as light turning features in light guides configured to provide light in a display device, for example, a reflective display device.

[0044] Figure 3A schematically illustrates an implementation of a base layer **306** that can be used in a composite method of manufacturing an illumination system having re-entrant turning features. The base layer **306** includes a plurality of receiving spaces **340a-c** disposed in an upper surface **220** and extending toward a lower surface **303**. The receiving spaces **340a-c** can be sized and shaped to receive at least a portion of a cover lay to form re-entrant turning features therebetween. The receiving spaces **340a-c** can comprise various

shapes and sizes. In some implementations, the receiving spaces **340a-c** can be similarly sized and shaped. In other implementations, at least one receiving space **340** can be differently sized and/or shaped than at least one other receiving space **340**. For example, a first receiving space **340** can comprise a trapezoidal shaped groove and a second receiving space **340** can comprise a triangular shaped groove.

[0045] In the implementation illustrated in Figure 3A, receiving spaces **340a-c** each define similarly sized trapezoidal shaped grooves having first sidewalls **341a-c**, second sidewalls **345a-c**, and base walls **343a-c** extending therebetween. The first sidewalls **341a-c** can form an angle θ_1 with the base walls **345a-c** and the second sidewalls can form an angle θ_2 with the base walls to define a trapezoidal shaped depression in the base layer **306**. In some implementations, angle θ_1 can be the same as angle θ_2 . In other implementations, angles θ_1 and θ_2 can be different. In some implementations, angles θ_1 and θ_2 can both be greater than about 75° , for example, greater than or equal to about 90° . The receiving spaces **340a-c** can be disposed adjacent to one another with generally planar portions **347a-d** separating the receiving spaces. The generally planar portions **347a-d** can be disposed on a common plane that extends generally parallel to the lower surface **303** and/or the upper surface **330** of the base layer **306**. The base walls **343a-c** can be disposed generally parallel to one another and/or to one or more of the generally planar portions **347a-d**. In some implementations, the receiving spaces **340a-c** can be similarly sized and shaped such that each base wall **343a-c** is separated from the base surface **303** by substantially the same distance.

[0046] Figure 3B schematically illustrates an implementation of a cover layer **307** that is configured to be coupled to (or mated with) the base layer **306** of Figure 3A to form a light panel having re-entrant turning features. The cover layer **307** includes an upper surface **304**, a lower surface **331**, and a plurality of protrusions **350a-c** that extend from lower surface **331** away from the upper surface **304**. The protrusions **350a-c** are sized and shaped such that at least a portion of the protrusions can be received within the receiving spaces **340a-c** of Figure 3A to form re-entrant turning features therebetween.

[0047] The protrusions **350a-c** can comprise various shapes that are complimentary to the receiving spaces **340a-c** of Figure 3A, for example, such that the

protrusions **350a-c** fit into the receiving spaces **340a-c** to form the re-entrant turning features therebetween. In one implementation, the protrusions **350a-c** comprise trapezoidal extensions, prism, or shapes having first sidewalls **351a-c**, second sidewalls **355a-c**, and base walls **353a-c** extending therebetween. The protrusions **350a-c** can be separated from one another by generally planar portions **357a-d** of the lower surface **331**. The generally planar portions **357a-d** can be co-planar with one another or disposed on different planes. In some implementations, the protrusions **350a-c** extend from the lower surface **331** such that the base walls **353a-c** are generally parallel to the generally planar portions **357a-d**. The protrusions can be similarly or differently shaped. For example, the first sidewalls **351a-c** can form an angle θ_3 with the base walls **355a-c** and the second sidewalls **353a-c** can form an angle θ_4 with the base walls with the base walls. In some implementations, angle θ_3 can be the same as angle θ_3 . In other implementations, angles θ_3 and θ_4 can be different. Additionally, angles θ_1 and θ_2 can be the same or different as angles θ_3 and θ_4 .

[0048] As shown in Figure 3C, a coupling layer **360** can be disposed on at least a portion of the cover layer **307** to couple the lower surface **331** of the cover layer **307** to the upper surface **330** of the base layer **306**. In some implementations, the coupling layer **360** can be disposed on one or more portions of the generally planar portions **357a-d** of the cover layer **307** to couple the cover layer **307** to the generally planar portions **347a-d** of the base layer **306**. In other implementations, the coupling layer **360** can be disposed on at least a portion of the upper surface **330** of the base layer **306** to couple the base layer to the cover layer **307**. The coupling layer **360** can comprise various materials, for example, adhesives and/or bonding agents.

[0049] The base layer **306** of Figure 3A and the cover layer **307** of Figure 3B can comprise various optically transmissive materials, for example, glass, polymer, polycarbonate, polyethylene terephthalate, glycol-modified polyethylene terephthalate, amorphous thermoplastic, and/or other substrates. In some implementations, the base layer **306** comprises a material with a higher refractive index than the cover layer **307** to promote TIR within the base layer **306**. In such implementations, the coupling layer **360** can comprise a material with an index of refraction that is substantially matched with the index of

refraction of the cover layer **307** to promote TIR within the base layer **306** and to allow for re-entry of light from the cover layer into the base layer through the coupling layer **360**.

[0050] Turning now to Figure 3D, an implementation of an illumination system **300** is schematically illustrated. The illumination system **300** includes a light source **390** disposed adjacent to a light panel **301**. The light panel **301** comprises base layer **306** and cover layer **307** that have been coupled or mated together. Re-entrant turning features **371a**, **371b** are disposed between the receiving spaces **340a-c** of the base layer **306** and the protrusions **350a-c** of the cover layer **306**. A first set **371a** of the turning features is formed between the first sidewalls **351a-c** of the protrusions **350a-c** and the first sidewalls **341a-c** of the receiving spaces **340a-c**. The first set **371a** comprises slits, gaps, spaces, or volumes that extend within the light panel **301** at an angle relative to the upper surface **304** and lower surface **303**. A second set **371b** of the turning features is formed between the second sidewalls **355a-c** of the protrusions **350a-c** and the second sidewalls **345a-c** of the receiving spaces **340a-c**. The second set **371b** also comprises slits, spaces, or volumes that extend within the light panel **301** at an angle relative to the upper surface **304**.

[0051] The second set **371b** of turning features can be configured to turn light propagating within the light panel **301** from the first edge **305a** toward the second edge **305b** and the first set **371a** can be configured to turn light propagating within the light panel from the second edge **305b** toward the first edge **305a**. For example, a first ray of light **310** can be injected into the light panel **301** through the first edge **305a** by the light source **390**. The first ray of light **310** can propagate within the light panel **301** toward the second edge **305b** and encounter a turning feature **371b** at an angle of incidence greater than the critical angle such that the ray is turned toward the lower surface **303** of the panel **301** by TIR. A second ray of light **312** can be injected into the light panel **301** through the first edge **305a** and propagate generally toward the second edge **305b**. Ray **312** can encounter turning feature **371b** at an angle of incidence that is less than the critical angle for the boundary between the turning feature **371b** and the base layer **306** such that the ray breaks TIR and propagates through the turning feature **371b**. After propagating through turning feature **371b**, ray **312** can be re-injected into the cover layer **307** portion of the light panel **301** and continue to propagate within the panel **301** by TIR. When propagating from the second edge **305b** toward the first

edge **305a**, ray **312** can encounter a turning feature **371a** at an angle of incidence that is greater than the critical angle such that the ray **312** is turned toward the lower surface **303**. Thus, after propagating through the turning feature **371b**, ray of light **312** can be recycled and extracted or turned toward a desired direction to increase the overall brightness and efficiency of the system **300**.

[0052] Figure 3E is a process flow diagram illustrating an implementation of a method **380** of manufacturing the illumination system of Figure 3D. As illustrated in block **381**, method **380** includes providing a base layer, the base layer having an upper surface and a lower surface opposite the upper surface, the upper surface including a first plurality of planar portions and a plurality of receiving spaces disposed between the first plurality of planar portions, wherein the plurality of receiving spaces are disposed at least partially between the first plurality of planar portions and the lower surface. The base layer can have a first end configured to receive light from a light source, and a second end opposite the first end. In one implementation, the base layer provided can be similar to base layer **306** schematically illustrated in Figure 3A. Method **380** further includes providing a cover layer as illustrated in block **383**. The cover layer can have a first surface and a second surface opposite the first surface. In some implementations, the second surface includes a second plurality of planar portions and a plurality of protrusions extending from the cover layer away from the first surface, wherein the second plurality of planar portions are disposed at least partially between the plurality of protrusions and the first surface. In one implementation, the cover layer provided is similar to cover layer **307** schematically illustrated in Figure 3B.

[0053] As illustrated in block **385**, method **380** also includes disposed the cover layer over the base layer such that at least one of the first plurality of planar portions is positioned over at least one of the second plurality of planar portions and such that at least one of the plurality of receiving spaces receives at least one of the plurality of protrusions to form at least one re-entrant turning feature between the base layer and the cover layer. In this, way method **380** can be used to manufacture an illumination system with re-entrant turning features similar to illumination **300** schematically illustrated in Figure 3D.

[0054] Turning now to Figure 4A an implementation of a base layer **406** that can be used in a composite method of manufacturing an illumination system having re-entrant

turning features is schematically illustrated. The base layer **406** can be similar to or different than the base layer **306** illustrated in Figure 3A. In one implementation, base layer **406** comprises receiving spaces **440a-c** disposed in an upper surface **404** of the base layer **406** and extending toward a lower surface **403**. The receiving spaces **440a-c** can be sized and shaped to receive at least a portion of a prismatic block to form re-entrant turning features therebetween.

[0055] Receiving spaces **440a-c** can comprise various shapes. In one implementation, receiving spaces **440a-c** each define similarly sized trapezoidal shaped grooves or troughs having first sidewalls **441a**, second sidewalls **445a-c**, and base walls **443a-c** extending therebetween. The first sidewalls **441a-c** can form an angle θ_5 with the base walls **445a-c** and the second sidewalls can form an angle θ_6 with the base walls to define a trapezoidal shaped depression in the base layer **406**. In some implementations, angle θ_5 can be the same as angle θ_6 . In other implementations, angles θ_5 and θ_6 can be different. In some implementations, angles θ_5 and θ_6 can both be greater than about 75° , for example, greater than or equal to about 90° . The receiving spaces **440a-c** can be disposed adjacent to one another with generally planar portions **447a-d** separating the receiving spaces. The generally planar portions **447a-d** can be disposed on a common plane that extends generally parallel to the lower surface **403** and/or the upper surface **404** of the base layer **406**. The base walls **443a-c** can be disposed generally parallel to one another and/or to one or more of the generally planar portions **447a-d**. In some implementations, the receiving spaces **440a-c** can be similarly sized and shaped such that each base wall **443a-c** is separated from the base surface **403** by substantially the same distance.

[0056] Figure 4B schematically illustrates an implementation of a prismatic block **450** that can be coupled to or mated with the base layer **406** of Figure 4A to form a light panel having re-entrant turning features. The prismatic block **450** can be sized and shaped to compliment one or more of the receiving spaces **440a-c** of the base layer **406** to form re-entrant features therebetween. In one implementation, prismatic block **450** comprises a trapezoidal prism having a top surface **457**, a bottom surface **453** that extends parallel to the top surface, a first sidewall **451** extending between the top surface and the bottom surface, and a second sidewall **455** disposed opposite to the first sidewall and extending between the

top surface and the bottom surface. The first sidewall **451** can form an angle θ_7 with the plane of the bottom surface **453** and the second sidewall **455** can form an angle θ_8 with the plane of the bottom surface. In some implementations, angle θ_7 can be the same as angle θ_8 . In other implementations, angles θ_7 and θ_8 can be different. Additionally, angles θ_5 and θ_6 in Figure 4A can be the same or different as angles θ_7 and θ_8 .

[0057] As shown in Figure 4C, a set of prismatic blocks **450a-c** can be provided as part of a method of manufacturing an illumination system that includes the prismatic blocks **450a-c** and base layer **406**. Coupling layers **460a-c** can be disposed over at least a portion of the prismatic blocks **450a-c** to couple the prismatic blocks to the receiving spaces **440a-b** of the base layer **406**. In one implementation, coupling layers **460a-c** are disposed over portions of the bottom surfaces **453a-c** to couple the bottom surfaces to the base layer **406**. In other implementations, the coupling layers **460a-c** can be disposed over portions of the base layer **406** to couple the base layer to the prismatic blocks **450a-c**. The coupling layers **460a-c** can comprise various materials, for example, adhesives and/or bonding agents. In some implementations, the coupling layers **460a-c** comprise materials with an index of refraction characteristic that substantially matches an index of refraction characteristic of the base layer **406** such that a ray of light propagating from base layer **406** through a coupling layer **460** into a prismatic block **450** is not reflected or refracted by the medium boundaries of the path.

[0058] Turning now to Figure 4D, an implementation of an illumination system **400** is schematically illustrated. The illumination system **400** includes a light source **490** disposed adjacent to a light panel **401**. The light panel **401** includes base layer **406** with prismatic blocks **450a-c** received within the receiving spaces **440a-c**. This configuration results in turning features **471a**, **471b** disposed between the receiving spaces of the base layer **406** and the prismatic blocks **450a-c**. A first set **471a** of the turning features is formed between the first sidewalls **441a-c** of the receiving spaces **440a-c** and the first sidewalls **451a-c** of the prismatic blocks **450a-c**. The first set **471a** comprises slits, gaps, spaces, or volumes that extend within the light panel **401** at an angle relative to the upper surface **404** and lower surface **403**. A second set **471b** of the turning features is formed between the second sidewalls **455a-c** of the prismatic blocks **450a-c** and the second sidewalls **445a-c** of

the receiving spaces **440a-c**. The second set **471b** also comprises slits, spaces, or volumes that extend within the light panel **401** at an angle relative to the upper surface **404**.

[0059] The second set **471b** of turning features can be configured to turn light propagating within the light panel **401** from the first edge **405a** toward the second edge **405b** and the first set **471a** can be configured to turn light propagating within the light panel from the second edge **405b** toward the first edge **405a**. In one implementation, a first ray of light **410** can be injected into the light panel **401** through the first edge **405a** by the light source **490**. The first ray of light **410** can propagate within the light panel **401** toward the second edge **405b** and encounter a turning feature **471b** at an angle of incidence greater than the critical angle such that the ray is turned toward the lower surface **403** of the panel **401** by TIR. A second ray of light **412** can be injected into the light panel **401** through the first edge **405a** and propagate generally toward the second edge **405b**. Ray **412** can encounter turning feature **471b** at an angle of incidence that is less than the critical angle for the boundary between the turning feature **471b** and the base layer **406** such that the ray breaks TIR and propagates through the turning feature **471b**. Because of the orientation and configuration of the re-entrant turning feature **471b**, ray **412** can pass through the turning feature and be re-injected into the prismatic block **450b** portion of the panel **401** such that ray **412** continues to propagate within the panel **401** until being turned by a turning feature **471a**, **471b**. Thus, after propagating through the turning feature **471b**, ray of light **412** can be recycled and extracted or turned toward a desired direction to increase the overall brightness and efficiency of the system **400**.

[0060] Figure 4E is a process flow diagram illustrating an implementation of a method **480** of manufacturing the illumination system of Figure 4D. As illustrated in block **481**, method **480** includes providing a base layer having an upper surface, a lower surface opposite the upper surface, a first end configured to receive light from a light source, and a second end opposite the first end. Method **480** further includes forming at least one receiving space in the upper surface as illustrated in block **483**. The receiving space can extend from the upper surface toward the lower surface and the receiving space can have a first sidewall and a second sidewall. In some implementations, the first sidewall forms a first angle with

the lower surface and the second sidewall forms a second angle with the lower surface resulting in a base layer similar to base layer **406** in Figure 4A.

[0061] As illustrated in block **485**, method **480** can include providing at least one prismatic block, wherein the at least one prismatic block has a third sidewall, a fourth sidewall, and a first planar surface disposed therebetween. Similar to prismatic block **450** of Figure 4B, the third sidewall can form a third angle with the first planar surface and the fourth sidewall can form a fourth angle with the first planar surface. Method **480** also includes disposing at least a portion of the at least one prismatic block in the at least one receiving space such that at least a portion of the third sidewall is disposed adjacent to at least a portion of the first sidewall and such that at least a portion of the second sidewall is disposed adjacent to at least a portion of the fourth sidewall as illustrated in block **487**. The first and third sidewalls can form a first re-entrant turning feature therebetween and the second and fourth sidewalls can form a second re-entrant turning feature therebetween resulting in a light panel similar to panel **401** schematically illustrated in Figure 4D.

[0062] Figure 5A schematically illustrates an implementation of a base layer **506** that can be used in a composite method of manufacturing an illumination system having re-entrant turning features. Base layer **506** can comprise various shapes, for example, a rectangular prism. In one implementation, base layer **506** includes a generally planar receiving surface **537** and a generally planar lower surface **503** disposed opposite to the receiving surface. The base layer **506** can comprise various optically transmissive materials, for example, glass, polymer, polycarbonate, polyethylene terephthalate, glycol-modified polyethylene terephthalate, amorphous thermoplastic, and/or other substrates.

[0063] Figure 5B schematically illustrates an implementation of a first prismatic block **540** that can be coupled to or mated with the base layer **506** to form a light panel having re-entrant turning features. The prismatic block **540** can comprise various shapes having various sizes, for example, trapezoidal prisms, triangular prisms, and other polygonal prisms. In one implementation, prismatic block **540** comprises a trapezoidal prism having a top surface **547**, a bottom surface **543** that extends parallel to the top surface, a first sidewall **541** extending between the top surface and the bottom surface, and a second sidewall **545** disposed opposite to the first sidewall and extending between the top surface and the bottom

surface. The first sidewall **541** can form an angle θ_9 with the plane of the bottom surface **543** and the second sidewall **545** can form an angle θ_{10} with the plane of the bottom surface. In some implementations, angle θ_9 can be the same as angle θ_{10} . In other implementations, angles θ_9 and θ_{10} can be different. In some implementations, angles θ_9 and θ_{10} can both be greater than about 75° , for example, greater than or equal to about 90° .

[0064] Figure 5C schematically illustrates an implementation of a second prismatic block **550** that can be coupled to or mated with the base layer **506** to form a light panel having re-entrant turning features. The prismatic block **550** can comprise various shapes having various sizes, for example, trapezoidal prisms, triangular prisms, and other polygonal prisms. In some implementations, the prismatic block **550** comprises a shape having a size that is complimentary to the first prismatic block **540** of Figure 5B to form at least one re-entrant turning feature therebetween. In one implementation, prismatic block **550** comprises a trapezoidal prism having a top surface **557**, a bottom surface **553** that extends parallel to the top surface, a first sidewall **551** extending between the top surface and the bottom surface, and a second sidewall **555** disposed opposite to the first sidewall and extending between the top surface and the bottom surface. The first sidewall **551** can form an angle θ_{11} with the plane of the bottom surface **553** and the second sidewall **555** can form an angle θ_{12} with the plane of the bottom surface. In some implementations, angle θ_{11} can be the same as angle θ_{12} . In other implementations, angles θ_{11} and θ_{12} can be different. Additionally, angles θ_9 and θ_{10} in Figure 5B can be the same or different as angles θ_{11} and θ_{12} .

[0065] As shown in Figure 5D, a set of first prismatic blocks **540a-d** and a set of second prismatic blocks **550a-c** can be provided as part of a method of manufacturing an illumination system that includes the first prismatic blocks **540a-d**, second prismatic blocks **550a-c**, and base layer **506**. Coupling layers **560a-d** can be disposed over at least a portion of first prismatic blocks **540a-d** to couple the first prismatic blocks to the base layer **506**. When coupled to the base layer **506**, the set of first prismatic blocks **540a-d** can form receiving spaces therebetween for receiving the second prismatic blocks **550a-c**. Coupling layers **561a-c** can be disposed over at least a portion of second prismatic blocks **550a-d** to couple the second prismatic blocks to the base layer **506** in the receiving spaces formed by the first prismatic blocks **540a-d**. One or more coupling layers (not shown) can also be disposed over

the base layer **506** to couple the base layer to the first prismatic blocks **540a-d** and the second prismatic blocks **550a-c**. The coupling layers **560a-d**, **561a-c** can comprise various materials, for example, adhesives and/or bonding agents. In some implementations, the coupling layers **560a-d**, **561a-c** comprise materials with an index of refraction characteristic that substantially matches the index of refraction characteristics of the base layer **506**, first prismatic blocks **540a-d**, and second prismatic blocks **550a-c** such that a ray of light propagating from base layer **506** through a coupling layers **560a-d**, **561a-c** into a prismatic block **540**, **550** is not reflected or refracted by the medium boundaries of the path.

[0066] Turning now to Figure 5E, an implementation of an illumination system **500** is schematically illustrated. The illumination system **500** includes a light source **590** disposed adjacent to a light panel **501**. The light panel **501** includes base layer **506** and the set of first prismatic blocks **540a-d** and the set of second prismatic blocks **550a-c**. This configuration results in turning features **571a**, **571b** disposed between the set of first prismatic blocks **540a-d** and the set of second prismatic blocks **550a-c**. A first set **571a** of the turning features is formed between the second sidewalls **545a-d** of the first prismatic blocks **540a-d** and the first sidewalls **551a-c** of the second prismatic blocks **550a-c**. The first set **571a** comprises slits, gaps, spaces, or volumes that extend within the light panel **501** at an angle relative to the upper surface **504** and lower surface **503**. A second set **571b** of the turning features is formed between the first sidewalls **541a-d** of the first prismatic blocks **540a-d** and the second sidewalls **555a-c** of the second prismatic blocks **550a-c**. The second set **571b** of re-entrant turning features also comprises slits, spaces, or volumes that extend within the light panel **501** at an angle relative to the upper surface **504**.

[0067] The second set **571b** of turning features can be configured to turn light propagating within the light panel **501** from the first edge **505a** toward the second edge **505b** and the first set **571a** can be configured to turn light propagating within the light panel from the second edge **505b** toward the first edge **505a**. In one implementation, a first ray of light **510** can be injected into the light panel **501** through the first edge **505a** by the light source **590**. The first ray of light **510** can propagate within the light panel **501** toward the second edge **505b** and encounter a turning feature **571b** at an angle of incidence greater than the critical angle such that the ray is turned toward the lower surface **503** of the panel **501** by

TIR. A second ray of light **512** can be injected into the light panel **501** through the first edge **505a** and propagate generally toward the second edge **505b**. Ray **512** can encounter turning feature **571b** at an angle of incidence that is less than the critical angle for the boundary between the turning feature **571b** and the base layer **506** such that the ray breaks TIR and propagates through the turning feature **571b**. Because of the orientation and configuration of the re-entrant turning feature **571b**, ray **512** can pass through the turning feature and be re-injected into the prismatic block **540a-d**, **550a-c** portion of the panel **501** such that ray **512** continues to propagate within the panel **501** until being turned by a re-entrant turning feature **571a**, **571b**. Thus, after propagating through the turning feature **571b**, ray of light **512** can be recycled and extracted or turned toward a desired direction to increase the overall brightness and efficiency of the system **500**.

[0068] Figure 5F is a process flow diagram illustrating an implementation of a method **580** for manufacturing the illumination system of Figure 5E. As illustrated in block **581**, method **580** includes providing a base layer. In some implementations, the base layer can be similar to base layer **506** of Figure 5A and have an upper surface, a lower surface opposite the upper surface, a first end configured to receive light from a light source, and a second end opposite the first end. Method **580** further includes providing a first prismatic block as illustrated in block **583**. The first prismatic block can have a first sidewall, a second sidewall, and a first planar surface disposed therebetween. The first sidewall can form a first angle with the first planar surface and the second sidewall can form a second angle with the first planar surface. In some implementations, the first prismatic block can be similarly sized and/or shaped to the prismatic block **540** of Figure 5B. As shown in block **585**, method **580** can include disposing the first prismatic block on the base layer. In some implementations, the first prismatic block can be disposed on a portion of the upper surface of the base layer.

[0069] Method **580** can include providing a second prismatic block as illustrated in block **587**. The second prismatic block can have a third sidewall, a fourth sidewall, and a second planar surface disposed therebetween. The third sidewall can form a third angle with the second planar surface and the fourth sidewall can form a fourth angle with the second planar surface. In some implementations, the second prismatic block can be similarly sized and/or shaped to the prismatic block **540** of Figure 5B. As shown in block **589**, method **580**

can include disposing the second prismatic block on the base layer such that the first prismatic block and the second prismatic block form a receiving space between the second sidewall and the third sidewall.

[0070] Method **580** can include providing a third prismatic block as illustrated in block **591**. The third prismatic block can have a fifth sidewall, a sixth sidewall, and a third planar surface disposed therebetween. The fifth sidewall can form a fifth angle with the third planar surface and the sixth sidewall can form a sixth angle with the second planar surface. In some implementations, the third prismatic block can be similarly sized and/or shaped to the prismatic block **550** of Figure 5C. As shown in block **593**, method **580** can include disposing at least a portion of the third prismatic block in the receiving space formed between the first prismatic block and the second prismatic block such that at least a portion of the fifth sidewall is disposed adjacent to at least a portion of the second sidewall and such that at least a portion of the sixth sidewall is disposed adjacent to at least a portion of the third sidewall. This can result in a first re-entrant turning feature formed between the second and fifth sidewalls and a second re-entrant turning feature formed between the third and sixth sidewalls.

[0071] The foregoing description details certain implementations of the disclosure. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the implementations disclosed herein can be practiced in many ways. As is also stated above, it should be noted that the use of particular terminology when describing certain features or aspects of the disclosure should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the disclosure with which that terminology is associated. The scope of the disclosure should therefore be construed in accordance with the appended claims and any equivalents thereof.

CLAIMS:

1. A method of manufacturing a light panel, the method comprising:
providing a base layer having an upper surface, a lower surface opposite the upper surface, a first end configured to receive light from a light source, and a second end opposite the first end, the upper surface including a first plurality of planar portions and a plurality of receiving spaces disposed between the first plurality of planar portions, wherein the plurality of receiving spaces are disposed at least partially between the first plurality of planar portions and the lower surface;
providing a cover layer having a first surface and a second surface opposite the first surface, the second surface including a second plurality of planar portions and a plurality of protrusions extending from the cover layer away from the first surface, wherein the second plurality of planar portions are disposed at least partially between the plurality of protrusions and the first surface; and
coupling the cover layer to the base layer such that at least one of the first plurality of planar portions is positioned over at least one of the second plurality of planar portions and such that at least one of the plurality of receiving spaces receives at least one of the plurality of protrusions to form at least one re-entrant turning feature between the base layer and the cover layer.
2. The method of Claim 1, wherein each of the first plurality of planar portions share a common plane.
3. The method of Claim 1, wherein each of the second plurality of planar portions share a common plane.
4. The method of Claim 1, wherein the base layer has an index of refraction characteristic, wherein the cover layer has an index of refraction characteristic, and wherein the index of refraction characteristic of the base layer is greater than the index of refraction characteristic of the cover layer.
5. The method of Claim 4, wherein an adhesive is used to couple the base layer to the cover layer, and wherein the adhesive has an index of refraction characteristic that is closer to the index of refraction characteristic of the cover layer than the index of refraction characteristic of the base layer.

6. The method of Claim 5, wherein the upper surface of the base layer is bonded to the second surface of the cover layer.

7. The method of Claim 5, wherein the index of refraction characteristic of the adhesive is about the same as the index of refraction characteristic of the cover layer.

8. The method of Claim 2, wherein the at least one re-entrant turning feature extends between the lower surface of the base layer and the first surface of the cover layer at an angle relative to the plane shared by the first plurality of planar portions.

9. The method of Claim 8, wherein coupling the cover layer to the base layer forms a first re-entrant turning feature and a second re-entrant turning feature between the base layer and the cover layer, wherein the first re-entrant turning feature extends between the lower surface of the base layer and the first surface of the cover layer at a first angle relative to the plane shared by the first plurality of planar portions, wherein the second re-entrant turning feature extends between the lower surface of the base layer and the first surface of the cover layer at a second angle relative to the plane shared by the first plurality of planar portions, and wherein the first angle is different from the second angle.

10. The method of Claim 1, wherein at least one of the plurality of protrusions comprises a trapezoidal prism having first and second sidewalls, wherein the first sidewall is disposed between the second sidewall and the first end at a first angle relative to the lower surface, and wherein the second sidewall is disposed at a second angle relative to the lower surface.

11. The method of Claim 1, wherein at least one of the receiving spaces comprises a trapezoidal trough having third and fourth sidewalls, wherein the third sidewall is disposed at a third angle relative to the lower surface and the fourth sidewall is disposed at a fourth angle relative to the lower surface.

12. The method of Claim 11, wherein the third sidewall is disposed adjacent to at least a portion of the first sidewall, and wherein the fourth sidewall is disposed adjacent to at least a portion of the second sidewall.

13. The method of Claim 12, wherein the first angle is different from the third angle.

14. The method of Claim 13, wherein the second angle is different from the fourth angle.

15. The method of Claim 14, wherein the first sidewall and the third sidewall define a re-entrant turning feature therebetween.

16. The method of Claim 15, wherein the second sidewall and the fourth sidewall define a re-entrant turning feature therebetween.

17. A method of manufacturing a light panel, the method comprising:

providing a base layer having an upper surface, a lower surface opposite the upper surface;

forming at least one receiving space in the upper surface, the at least one receiving space extending from the upper surface toward the lower surface, wherein the at least one receiving space has a first sidewall and a second sidewall, wherein the first sidewall forms a first angle with the lower surface, and wherein the second sidewall forms a second angle with the lower surface;

providing at least one prismatic block, wherein the at least one prismatic block has a third sidewall, a fourth sidewall, and a first planar surface disposed therebetween, wherein the third sidewall forms a third angle with the first planar surface, and wherein the fourth sidewall forms a fourth angle with the first planar surface; and

coupling at least a portion of the at least one prismatic block into the at least one receiving space such that at least a portion of the third sidewall is disposed adjacent to at least a portion of the first sidewall and such that at least a portion of the second sidewall is disposed adjacent to at least a portion of the fourth sidewall such that the first and third sidewalls form a first re-entrant turning feature therebetween, and the second and fourth sidewalls form a second re-entrant turning feature therebetween.

18. The method of Claim 17, wherein the base layer comprises a first end for receiving light from a light source and a second end opposite the first end, and wherein the first and second re-entrant turning features are configured to turn at least a portion of light received through the first end toward the lower surface of the base layer.

19. The method of Claim 17, wherein the at least one prismatic block comprises a trapezoidal prism.

20. The method of Claim 19, wherein the at least one receiving space comprises a trapezoidal trough.

21. The method of Claim 17, wherein the first angle is different than the second angle.

22. The method of Claim 21, wherein the first angle is different than the third angle.

23. The method of Claim 21, wherein the second angle is different than the fourth angle.

24. The method of Claim 17, wherein the base layer has an index of refraction characteristic, wherein the at least one prismatic block has an index of refraction characteristic, and wherein the index of refraction characteristic of the at least one prismatic block is about the same as the index of refraction characteristic of the base layer.

25. The method of Claim 24, further comprising coupling the at least one prismatic block to the base layer.

26. The method of Claim 25, wherein an adhesive is used to couple the at least one prismatic block to the base layer, wherein the adhesive has an index of refraction characteristic that is about the same as the index of refraction characteristic of the base layer.

27. A method of manufacturing a light panel, the method comprising:

providing a layer having an upper surface, a lower surface opposite the upper surface, a first end configured to receive light from a light source, and a second end opposite the first end;

providing a first prismatic block, the first prismatic block having a first sidewall, a second sidewall, and a first planar surface disposed therebetween, wherein the first sidewall forms a first angle with the first planar surface, and wherein the second sidewall forms a second angle with the first planar surface;

disposing the first prismatic block on the base layer;

providing a second prismatic block, the second prismatic block having a third sidewall, a fourth sidewall, and a second planar surface disposed therebetween,

wherein the third sidewall forms a third angle with the second planar surface, and wherein the fourth sidewall forms a fourth angle with the second planar surface;

disposing the second prismatic block on the base layer such that the first prismatic block and the second prismatic block form a receiving space therebetween, wherein the receiving space is disposed between the second sidewall and the third sidewall;

providing a third prismatic block, the third prismatic block having a fifth sidewall, a sixth sidewall, and a third planar surface disposed therebetween, wherein the fifth sidewall forms a fifth angle with the third planar surface, and wherein the sixth sidewall forms a sixth angle with the third planar surface; and

disposing at least a portion of the third prismatic block in the receiving space such that at least a portion of the fifth sidewall is disposed adjacent to at least a portion of the second sidewall and such that at least a portion of the sixth sidewall is disposed adjacent to at least a portion of the third sidewall, wherein the second and fifth sidewalls form a first re-entrant turning feature therebetween, wherein the third and sixth sidewalls form a second re-entrant turning feature therebetween.

28. The method of Claim 27, wherein the first re-entrant turning feature extends along a first longitudinal axis that forms a first angle with the upper surface.

29. The method of Claim 28, wherein the second re-entrant turning feature extends along a second longitudinal axis that forms a second angle with the upper surface.

30. The method of Claim 29, wherein the first angle is different than the second angle.

31. The method of Claim 27, further comprising coupling the first prismatic block to the base layer.

32. The method of Claim 31, further comprising coupling the second prismatic block to the base layer.

33. The method of Claim 32, further comprising coupling the third prismatic block to the base layer.

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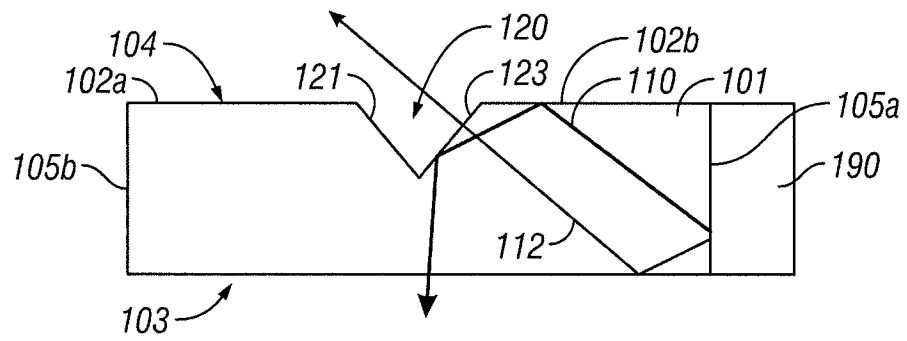


FIG. 1

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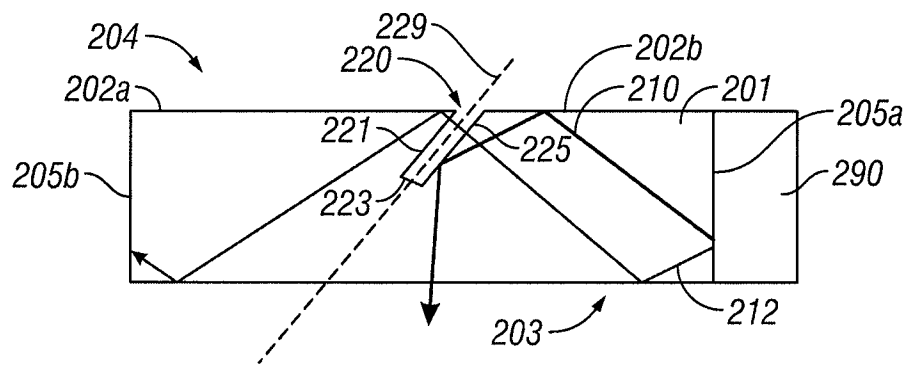
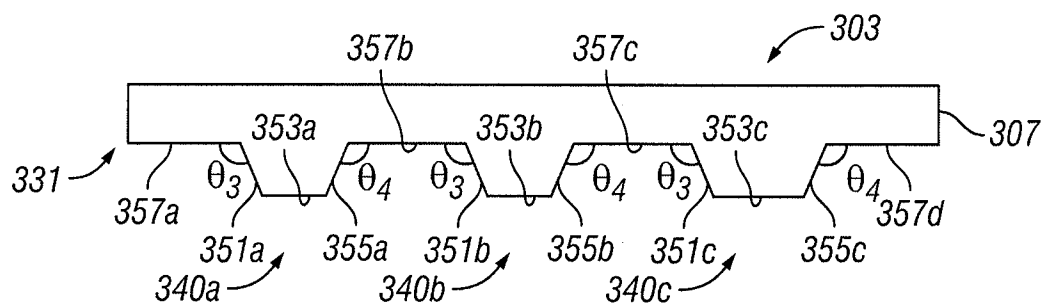
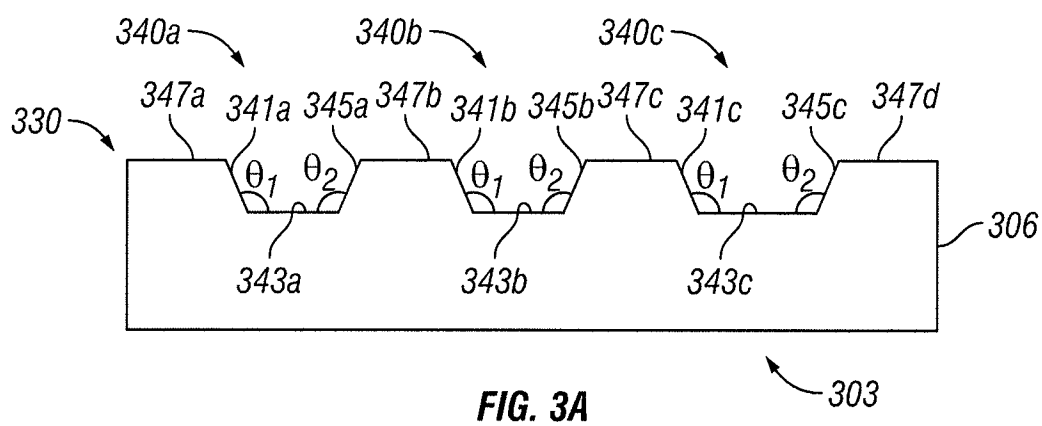
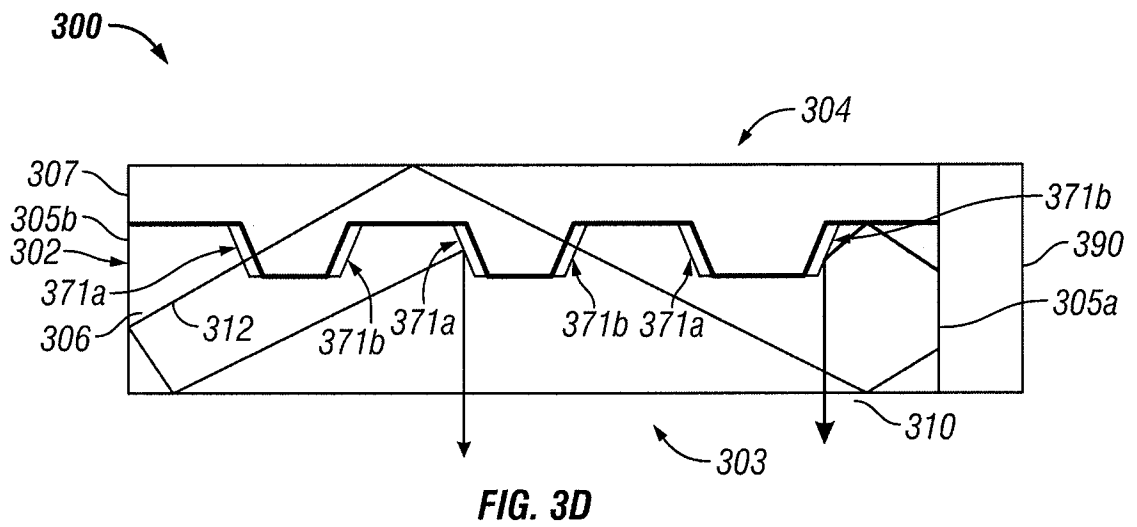
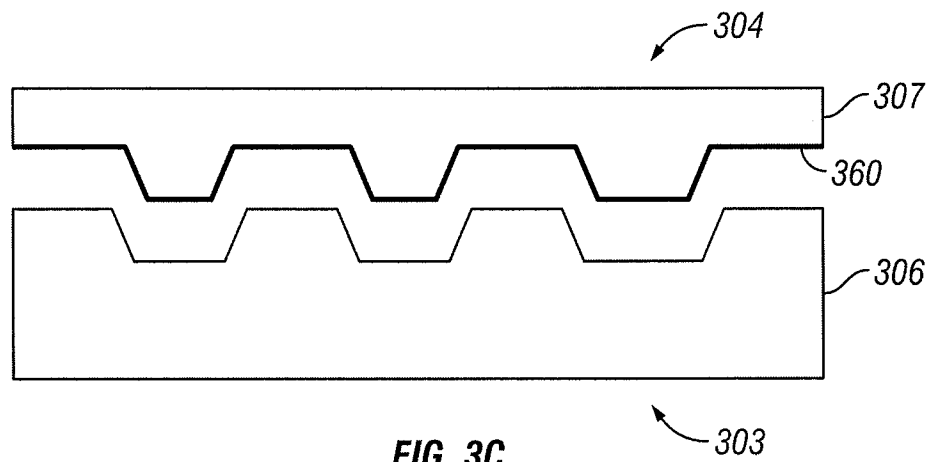


FIG. 2

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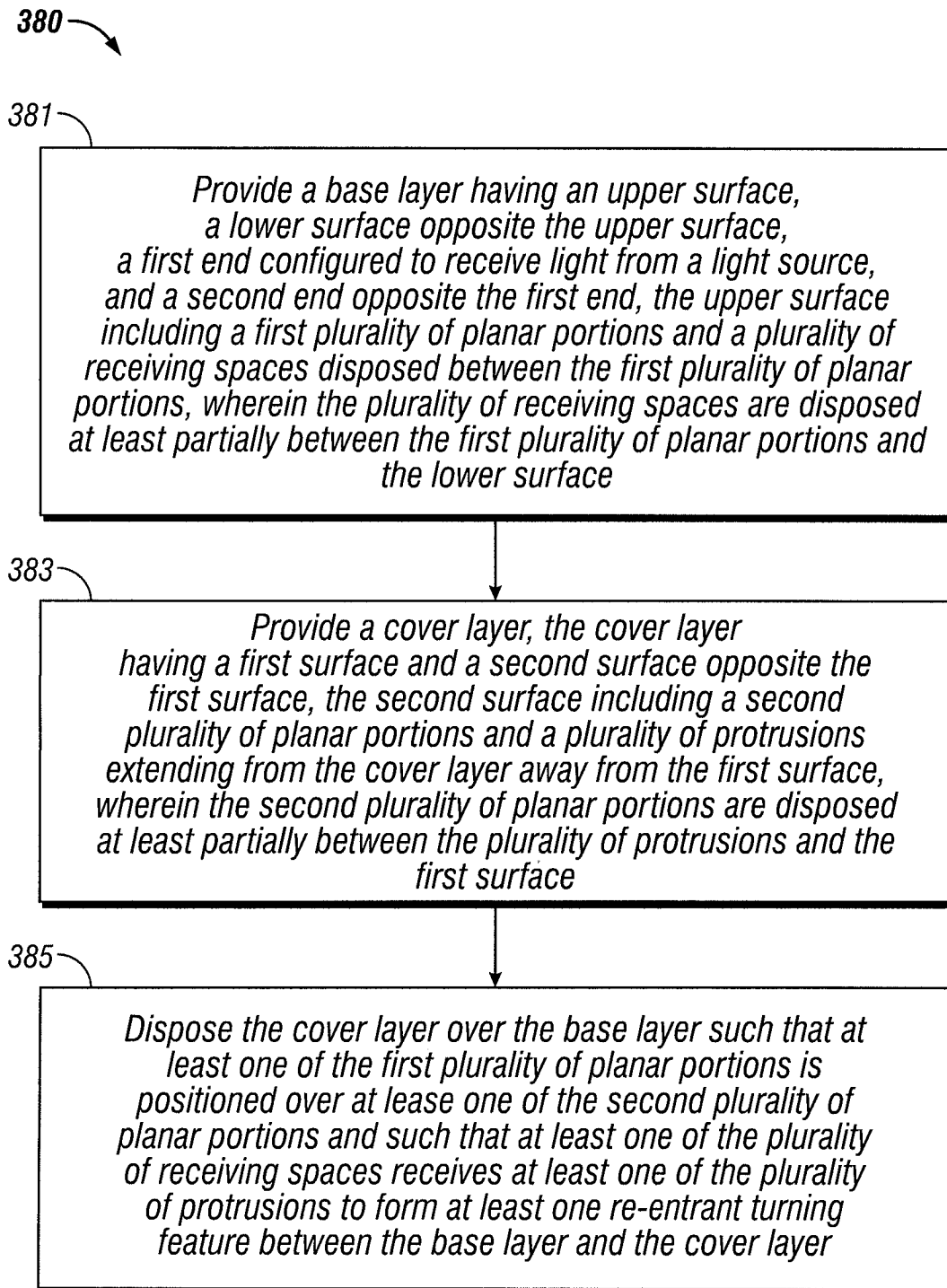
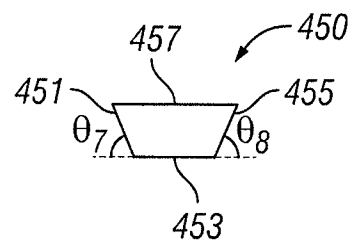
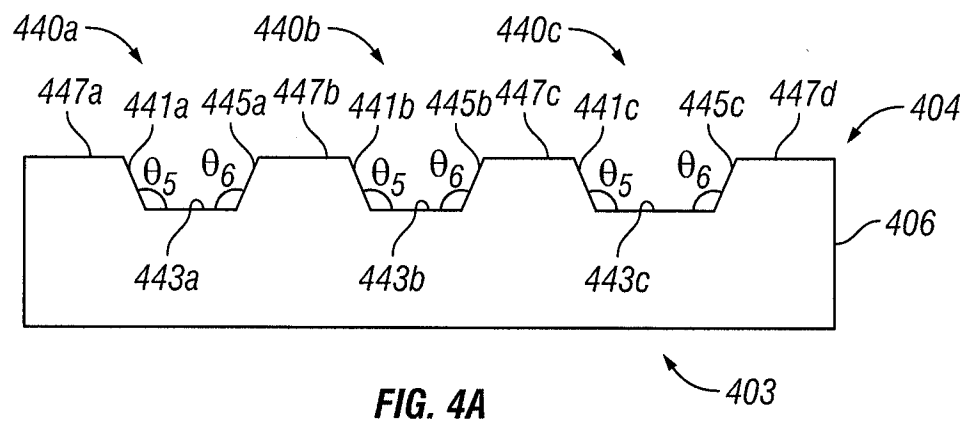


FIG. 3E

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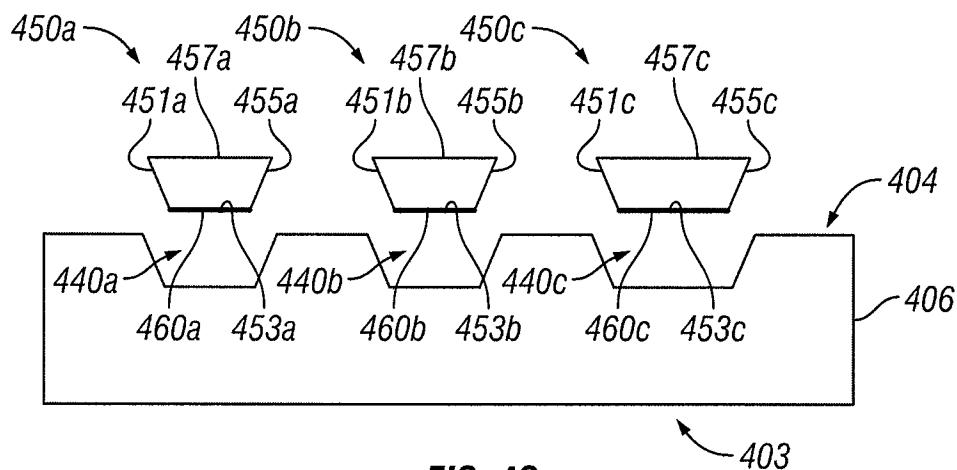


FIG. 4C

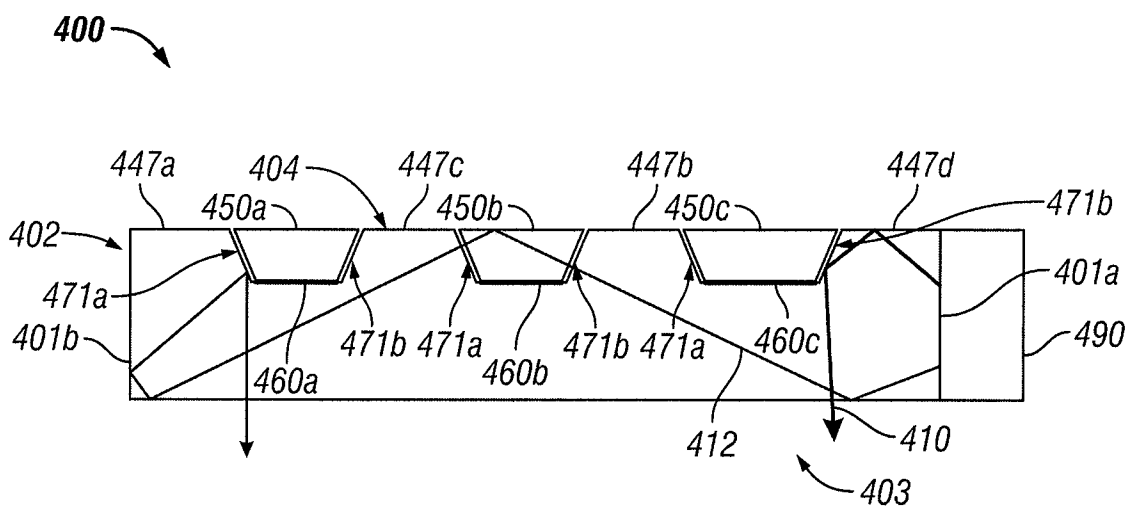


FIG. 4D

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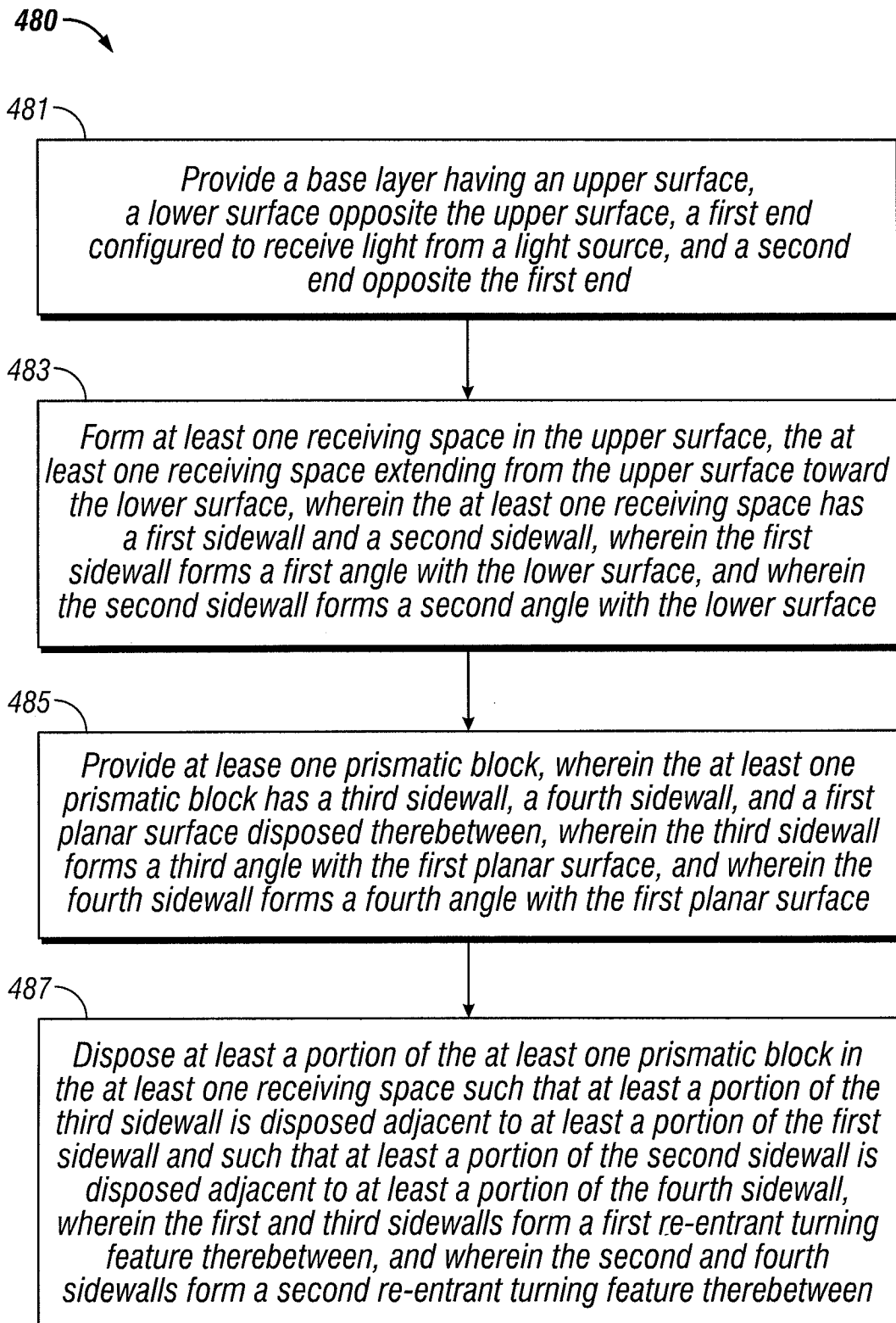


FIG. 4E

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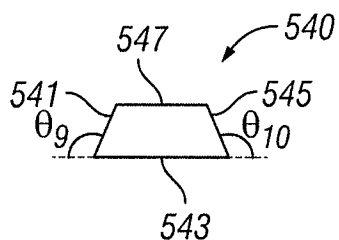
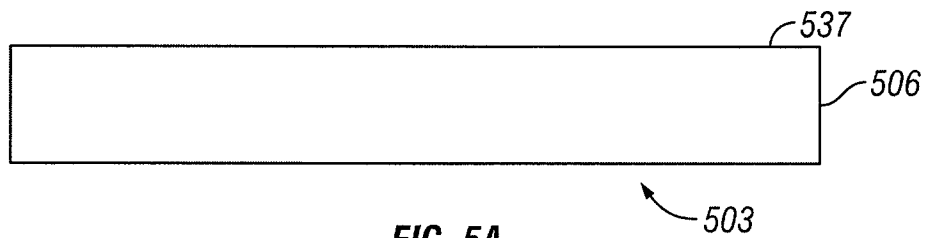


FIG. 5B

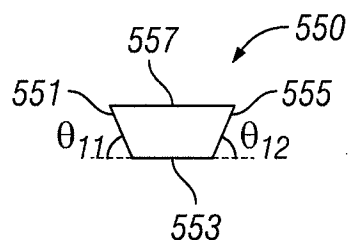


FIG. 5C

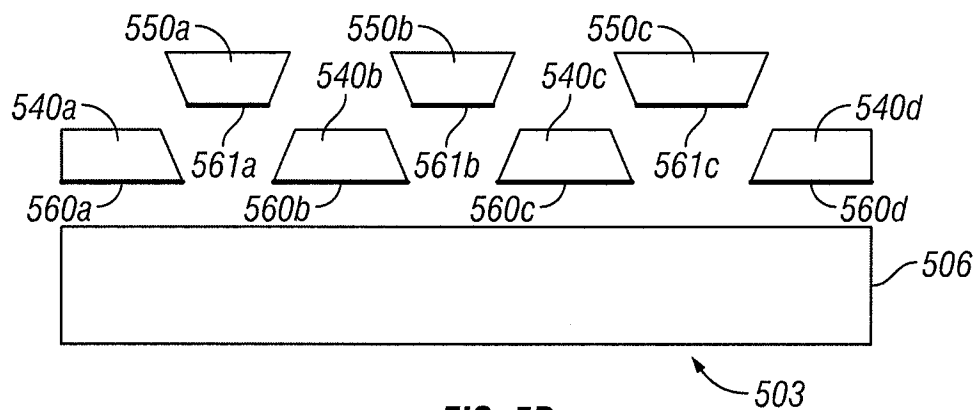


FIG. 5D

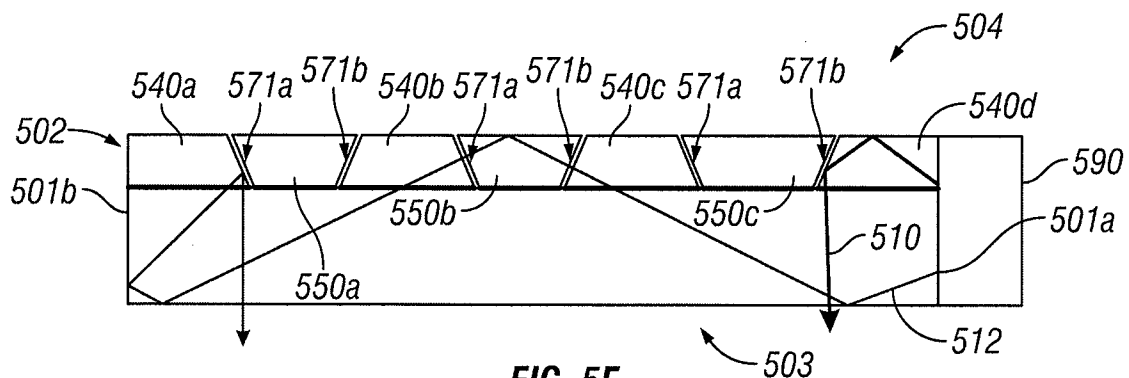


FIG. 5E

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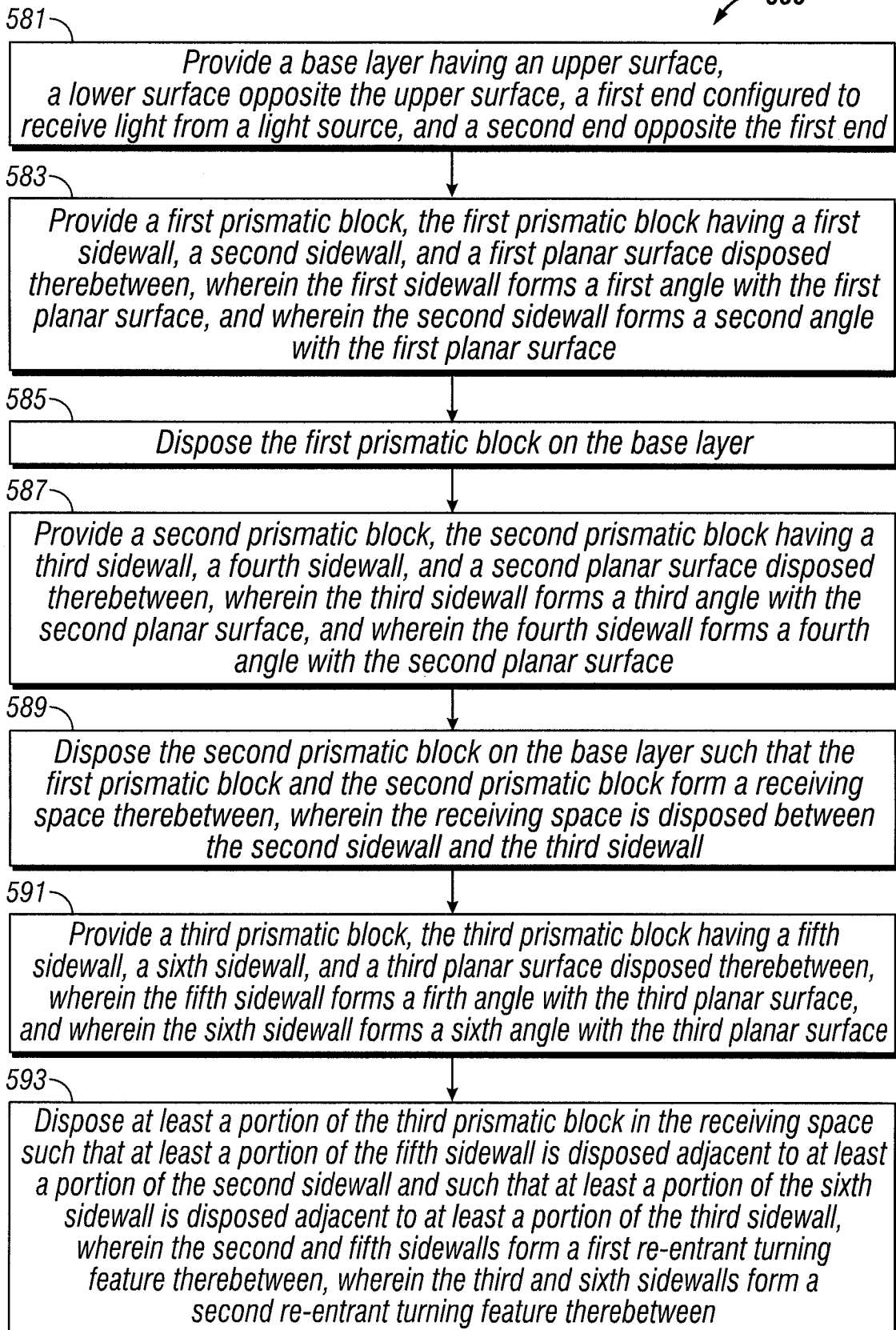


FIG. 5F

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/048689

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/00 F21V8/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2010/157624 A1 (LIAO CHUN-CHIEN [TW] ET AL) 24 June 2010 (2010-06-24) paragraphs [0027] - [0038], [0043] - [0045]; figures 2,3,7 -----	1-3, 8-12, 17-21, 24,25
X	WO 01/59362 A2 (BOSCH GMBH ROBERT [DE]) 16 August 2001 (2001-08-16)	1-3,8,9, 17,18, 24,25
Y	the whole document ----- -/--	4-7, 13-16, 22,23,26

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

27 January 2012

Date of mailing of the international search report

07/02/2012

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Authorized officer

Wolf, Steffen

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/048689

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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