



Published:

— *with international search report (Art. 21(3))*

— *with amended claims (Art. 19(1))*

ILLUMINATION ASSEMBLY FOR DISTRIBUTING LIGHT

BACKGROUND OF THE INVENTION

[0001] The present invention relates to illumination assemblies, and more particularly to illumination assemblies for distributing light along a length of the illumination assembly.

[0002] Lights are often mounted to cabinetry, shelving, counters, and desks to provide task lighting or to illuminate displayed items. In a retail setting, it is often advantageous for stores to illuminate products stored on display surfaces to improve the appearance and appeal of the products and to promote product sales. However, providing such product lighting can be expensive in terms of the initial set-up costs and electricity costs. For example, a traditional shelf lighting fixture can require 10 to 20 watts of lighting for every 4 feet of shelf length, with operating costs over a five-year period of approximately \$55 to \$110 US dollars.

[0003] Compact fluorescent lamp ("CFL") fixtures have been used to provide shelf lighting for retail products. More recently, many CFL lighting fixtures have been replaced with light emitting diode ("LED") lighting fixtures, which typically have greater efficiency and reduced harmful materials compared to CFL lighting. However, LEDs are point sources of light and thus do not generally lend themselves to producing a uniform emission of light along a length of a display surface or across an area. LED lighting can also result in hot spots and glares, which can be diminished partially using diffusing lenses. LEDs can also vary in color from one LED to the next, and can also vary in color across their emission angle. Thus, a light fixture utilizing multiple LEDs can vary in color along a length of the light fixture as well as across the emission angles of the LEDs.

SUMMARY

[0004] The aforementioned problems are overcome in the present invention in which an illumination assembly includes a light pipe configured to distribute light more uniformly across a length of the light pipe.

[0005] According to one embodiment, an illumination assembly includes a light pipe and a light engine. The light pipe includes a first end portion including a light inlet, a second end portion opposite the first end portion defining a length therebetween, and a first light outlet extending along at least a portion of the length between the first end portion and the second end portion. The light engine is adapted to direct light into the light inlet, whereby light subsequently exits the light pipe through the first light outlet. The light pipe

further includes means for distributing the light exiting the first light outlet generally uniformly along at least the portion of the length of the light pipe.

[0006] In another embodiment, an illumination assembly includes a light pipe, a first light engine, and a second light engine. The light pipe includes a first end portion including a first light inlet, a second end portion opposite the first end portion including a second light inlet, and a first light outlet extending at least partially between the first end portion and the second end portion. The first light engine is attached to the first end portion and adapted to direct light into the first light inlet, and the second light engine is attached to the second end portion and adapted to direct light into the second light inlet. The light pipe can be configured to at least partially mix light emitted by the first light engine and the second light engine prior to the mixed light exiting the first light outlet.

[0007] These and other advantages and features of the invention will be more fully understood and appreciated by reference to the description of the current embodiments and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 is a perspective view of an illumination assembly according to a first embodiment of the invention.

[0009] Figure 2 is a perspective view of the illumination assembly of Figure 1.

[0010] Figure 3 is a perspective view of a light engine according to the first embodiment of the invention.

[0011] Figure 4 is a schematic view of an illumination assembly according to the first embodiment of the invention.

[0012] Figure 5 is front view of an illumination assembly according to a second embodiment of the invention.

[0013] Figure 6 is side view of the illumination assembly of Figure 5.

[0014] Figure 7 is a schematic view of a portion of a light pipe having a cross-sectional shape that varies along a length of the light pipe according to a third embodiment of the invention.

[0015] Figure 8 is a schematic view of a portion of a light pipe having a cross-sectional shape that varies along a length of the light pipe according to a fourth embodiment of the invention.

[0016] Figure 9 is a schematic view of a portion of a light pipe having a cross-sectional shape that varies along a length of the light pipe according to a fifth embodiment of the invention.

[0017] Figure 10 is a perspective view of an illumination assembly according to a sixth embodiment of the invention.

[0018] Figure 11 is a perspective view of a light pipe having a plurality of optical aberrations according to the sixth embodiment of the invention.

[0019] Figure 12 is a side view of an illumination assembly according to a seventh embodiment of the invention.

[0020] Figure 13 is a side view of an illumination assembly according to an eighth embodiment of the invention.

[0021] Figure 14 is a side view of an illumination assembly according to a ninth embodiment of the invention.

DESCRIPTION

I. Structure

[0022] With reference to Figure 1, an illumination assembly 10 is illustrated in accordance with a first embodiment of the invention. The illumination assembly 10 can include a first light guide or pipe 12 and an optional second light pipe 12' at least partially encompassed by a frame 14. The illumination assembly 10 can be mounted to a surface 14, such as a shelf, for providing illumination to items 18 stored on the shelf. The illumination assembly 10 can also include at least one light engine 20 provide at an end of the light pipes 12, 12' for providing illumination to the light pipes 12, 12'. While the illumination assembly 10 is described in the context of being mounted to a horizontal surface 14, it will be understood that the illumination assembly 10 can similarly be mounted to a vertical surface or a surface disposed at an angle relative to the horizontal.

[0023] This specification consistently uses the term "light pipe" to refer to the portion 12. The term "light guide" could be used interchangeably with "light pipe". Light pipe in this specification is intended to include any device designed to transport light from a light source to a location at some distance from the light source with minimal, or at least modest, loss. Light is transmitted through a light pipe by means of internal reflection.

[0024] Referring now to Figure 2, the frame 14 can be used to at least partially frame the first and second light pipes 12, 12' as well as mount the light engines 20 at each end of the light pipes 12, 12'. In addition to framing the assembly 10 and optionally

holding the light engines 20 in place relative to the light pipe 32, the frame 14 can also provide additional features, such as acting as a reflector and/or a heat sink for the light engines 20. As illustrated in Figure 2, the light engines 20 can optionally include a heat sink, illustrated as a plurality of fins 22.

[0025] The frame 14 and/or the light engines 20 may be used to secure the illumination assembly 10 relative to the surface 16 using any known fastening or mounting system. In one example, a pair of mounting brackets sized to receive the light engines 20 may be secured to the surface 16 or adjacent the surface 16 using one or more screws. The light engines 20 can then be slid into or snap-fit into the mounting brackets to secure the illumination assembly 10 relative to the surface 16. In another example, the frame 14 can include one or more apertures configured to receive a screw or pin that is then used to secure the illumination assembly to the surface 16. Additional examples of mounting elements include magnets, tape, and clips.

[0026] Figure 3 illustrates the exemplary light engine 20. The light engine 20 can include a first mounting slot 26 configured to receive an end of the first light pipe 12 and an optional second mounting slot 26' configured to receive an end of the second light pipe 12'. The mounting slots 26, 26' can be configured to snap on to the light pipes 12, 12' through an interference fit. Alternatively, the light engine 20 can be held in place relative to the light pipe 12 by adhesive or mechanical fasteners, such as clamps or screws. It will be understood that the light engine 20 can be designed in a similar manner to include only a single mounting slot 26 for mounting a single light pipe 12.

[0027] The mounting slots 26, 26' each include at least one light source 30 for providing illumination to the light pipes 12, 12'. In the present embodiment, the light source 30 is in the form of a light emitting diode (LED). Optional light sources that can be used with the illumination assembly 10 include small fluorescent lamp bulbs, electroluminescent lighting (EL), organic light emitting diodes (OLEDs), and/or other non-LED light sources. The light engine 20 can include multiple LEDs provided in a row configured to align with a light inlet formed in the end of the light pipe 12, 12'. The number, spacing, voltage, current, intensity, and color of the LEDs 30 can be selected depending on the configuration of the illumination assembly 10 and the intended use. For example, the light engine 20 provided on both ends of the light pipes 12, 12' can include the light source 30 or only one light engine 20 on one end of the light pipes 12, 12' can include a light source 30.

[0028] Figure 4 is a schematic representation of a portion of the illumination assembly 10 including the light pipe 12. It will be understood that the optional light pipe 12' can be configured in a similar manner, when present. The light rays 34 are provided to illustrate some of the transmission of light through the light pipe 10. These light rays are provided for illustrative purposes only for the purposes of discussion and should not be interpreted as a representation of the actual transmission of light through the light pipe 10 or all of the emitted and extracted light.

[0029] As illustrated in Figure 4 with respect to the first light pipe 12, the light pipe 12 can include opposing first and second end portions 40 and 42, opposing first and second surface edge portions 44 and 46, and opposing first and second surface face portions 50 and 52. The light pipe 12 can be configured such that at least a portion of the first and/or second end portions 40, 42 include a light inlet for receiving light emitted from the light engine 20. The light pipe 12 can further be configured such that at least a portion of the first and/or second surface edge portions 44, 46 include a light outlet to extract light, or to permit light to exit, from the light pipe 12. The first and/or second surface face portions 50, 52 can also be configured to include a light outlet to extract light, or to permit light to exit, from the light pipe 12 in addition to, or as an alternative to permitting light to exit through the first and or second surface edge portions 44, 46.

[0030] The light pipe 12 has a longitudinal length 60 defined between the first and second end portions 40, 42. The light pipe 12 can also have a geometry that varies along at least a portion of the length 60 of the light pipe 12. In the embodiment of Figure 4, the light pipe 12 has a geometry in which the cross-sectional shape of the light pipe 12 varies along at least a portion of the length 60 of the light pipe 12. The cross-sectional shape of the light pipe 12 can vary continuously, as illustrated in Figure 4, or discontinuously along the length 60 of the light pipe 12. The light pipe 12 can also optionally include an axis of symmetry about a plane defined by a vertical axis 62 of the light pipe 12. As illustrated in Figure 4, the geometry of the light pipe 12 can be in the form of a ramp in which a first portion of the second surface edge portion 46 is angled toward the first surface edge portion 44 from the light engine toward the vertical axis 62 on both sides of the vertical axis 62. The angle of the ramp on both sides of the vertical axis 62 can be the same or different. Additional examples of light pipe geometries include steps and arcs. The surface of the light outlet, illustrated as being provided in the second surface edge portion 46 can have a

smooth or textured surface finish to further facilitate distributing the light emitted from the light pipe 12.

[0031] The changing cross-sectional shape of the light pipe 12 can provide means for distributing the light emitted by the light sources 30 more uniformly along at least a portion of the length 60 of the light pipe 12. The changing cross-sectional shape of the light pipe 12 can also provide means for mixing the light emitted from multiple light sources 30 provided on the same light engine 20 prior to the light exiting the light pipe 12. The changing cross-sectional shape of the light pipe 12 can facilitate internal reflection and/or refraction of the light emitted by the light sources 30 within the body of the light pipe 12. This internal reflection and/or refraction can promote distribution of the light within the light pipe 12 along the length 60 as well as promote mixing of the light emitted from multiple light sources 30, which can improve the homogeneity of the light emitted through the light outlet in the second surface edge portion 46 along at least a portion of the length 60.

[0032] The cross-sectional shape of the light pipe 12 can also vary about a plane of symmetry aligned with the vertical axis 62 of the light pipe 12 to facilitate more uniformly distributing light along the length 60 of the light pipe 12. Distributing the light more uniformly along at least a portion of the length 60 of the light pipe 12 and/or mixing the light emitted by the multiple light sources 30 prior to exiting the light pipe 12 can provide a more uniform color and/or brightness profile along the length 60 of the light pipe 12.

[0033] It will be understood that distributing the light along the length 60 of the light pipe 12 is not limited to distributing the light along the full length 60 of the light pipe 12, but also includes distributing the light along a portion of the length 60 of the light pipe 12. The extent to which the light is distributed along the length 60 can be based on multiple factors, non-limiting examples of which include the number and power of light sources, the magnitude of the length 60, and the geometry of the light pipe 12. In one example, the light pipe 12 can be configured such that light emitted by one light engine 20 is distributed along a portion of the length of the light pipe 12 adjacent the light engine 20 coinciding to the portion of the light pipe 12 on side of the plane of symmetry defined by the vertical axis 62.

[0034] In the exemplary embodiment illustrated in Figure 4, when assembled, the light engine 20 is provided on at least the first end portion 40 such that light emitted from the light engine 20 is directed into the light pipe 12 through the light inlet provided in the first end portion 40. The light engine 20 adjacent the second end portion 42 can also

optionally direct light into the light pipe 12 through the light inlet provided in the second end portion 42. The light pipe 12 can be configured to extract light emitted by the light engine 20 through at least the light outlet formed in the second surface edge portion 46. In general, the light pipe 12 can be configured to extract light that enters the light inlets provided in the first and/or second end portions 40, 42 through one or more light outlets provided in one or any combination of the surfaces 44, 46, 50, 52 that intersect the first and second end portions 40, 42. Light that is unintentionally extracted through a light outlet can be blocked by the frame 14 or other surrounding structure or redirected using a reflector provided on the frame 14.

II. Operation

[0035] Referring again to Figure 1, the illumination assembly 10 can be used to illuminate an area adjacent the illumination assembly 10 along the length of the light pipes 12, 12'. In the embodiment of Figure 1, the illumination assembly 10 is configured to illuminate items 18 displayed on the surface 16 below the illumination assembly 10. As discussed above with respect to Figure 4, one or both of the light pipes 12, 12' of the illumination assembly 10 can be configured to extract light emitted by the light engines 20 at the ends of the light pipes 12 along a length 60 of the light pipe 12. The geometry of the light pipe 12 can be configured to distribute the light along at least a portion of the length 60 of the light pipe 12 prior to emitting the light through the light outlet provided in the second surface edge portion 46. The geometry of the light pipe 12 can also be configured to mix the light emitted by the light sources 30 in a given light engine 20, when multiple light sources 30 are used. The optional light pipe 12' can be configured in a similar manner to provide illumination to the items 18 displayed on the shelf 16. In this manner, the illumination assembly 10 can be used to provide illumination to an area with a relatively uniform intensity and color along the length 60 of the light pipe 12 and thus along the length of the adjacent area to be illuminated.

[0036] LEDs are point light sources which can emit light that varies in color and/or intensity along the length dimension of the LED light emission zone. Thus, providing multiple LEDs along the length of a surface to be illuminated can result in an illumination profile that varies in intensity and/or color along the length of the surface. This can be undesirable when illuminating items displayed on the surface, such as in a retail setting, in which uniform lighting along the length of the surface is desired.

[0037] The illumination assembly described herein can use multiple point light sources, such as LEDs, to provide more uniform illumination along the length of an adjacent area. As described above, the geometry of the light pipe 12 can be varied to more uniformly distribute light through a light outlet provided in one of the intersecting surfaces 44, 46, 50, 52 along at least a portion of the length 60 of the light pipe 12. Improving the uniformity of light distribution can also decrease the number and intensity of hot spot reflections and glare along the length of an illuminated area. In addition, the geometry of the light pipe 12 can mix the light emitted by the LEDs in each light engine 20 to compensate for variations in color and/or intensity between each LED. In this manner, the illumination assembly can provide improved homogeneity of intensity, color, and directionality of the light emitted by the illumination assembly along its length.

[0038] The illumination assembly described herein can also be cost effective by providing LEDs only at the ends of the light pipe, rather than along the entire length of the light pipe. The design of the illumination assembly also provides for a modular system in which characteristics of the light pipe can be selected based on the application and used with a given light engine(s). For example, the light pipe can be available in a variety of custom or preset lengths, which can all be assembled with the same light engine. In another example, the geometry and/or other characteristics of the light pipe can be selected based on the desired illumination distribution, brightness, and/or direction. In another example, the light engines can optionally be modular in that the number of light sources in each light engine can be selected based on the application.

[0039] The use of LEDs as the light source in the illumination assembly described herein can also provide energy efficiency compared to a traditional CFL fixture providing similar illumination levels. For a 4 foot length of shelving, the LEDs used in the illumination assembly can provide illumination levels similar to a traditional CFL shelf lighting fixture, while only consuming approximately one-tenth of the watts consumed by the traditional CFL lighting fixture. In addition, the illumination assembly described herein can have a smaller profile than traditional lighting fixtures, utilizing less space. This can be an advantage in a retail setting in which shelf space can be limited.

[0040] Figures 5 and 6 illustrate an illumination assembly 110 that is similar to the illumination assembly 10 of Figures 1-4 except for the manner in which the light pipe 112 is mounted to a surface. Therefore, elements of the illumination assembly 110 similar to those of the illumination assembly 10 are labeled with the prefix 100.

[0041] Still referring to Figures 5 and 6, the light pipe 112 is mounted relative to the surface 116 such that illumination is provided to an area above the surface 116, as illustrated by arrows 170. The illumination assembly 110 can include a frame 114 that partially encompasses the light pipe 112 and secures the light pipe 112 relative to the mounting surface 116. The frame 114 can be secured relative to the surface 116 using any known mechanical and/or non-mechanical fastener, non-limiting examples of which include clamps, retaining clips, adhesives, and an interference or friction fit. The illumination assembly 110 can include at least one light engine 120 provided adjacent one or both of the first and second end portions 140, 142 for emitting light into the light pipe 112.

[0042] The light pipe 112 can be configured to emit light through a light outlet provided in the first surface edge 144 to illuminate an area along the length 160 of the light pipe 112. The light pipe 112 can also optionally be configured to emit light through a light outlet provided in the first surface face portion 150, as illustrated by arrows 172, which can be used to provide backlighting for a sign. The sign may be integrally formed with an adjacent front portion 115 of the frame 114 or the sign may be formed in a separate panel or insert. The sign panel or insert can be inserted either between the adjacent portion of the frame 114 and the first surface face portion 150 or secured to an exterior of the adjacent portion of the frame 114. At least a portion of the front portion 115 of the frame 114 can be at least partially transparent to allow at least a portion of the light emitted through the first surface face portion 150 to be transmitted through the frame 114. In this way, the illumination assembly 110 can optionally be used to provide both area illumination and backlighting in a manner similar to that described in co-pending application, International Application No. PCT/US2015/058792, entitled "Illumination Assembly Providing Backlight and Downlight," filed November 3, 2015, which is hereby incorporated by reference in its entirety.

[0043] The light pipe 112 can be provided with a geometry that varies along at least a portion of its length 160 to distribute and/or mix the light emitted by the light engines 120 along the length 160 of the light pipe 112 in a manner similar to that described above for the illumination assembly 10 of Figure 4. Figures 7-9 illustrate exemplary light pipe geometries which can be used with the light pipe 112 in the illumination assembly 110. Figures 7 and 9 illustrate examples in which the light pipe 112 is in the form of a ramp such that the cross-sectional shape of the light pipe 112 varies continuously along at least a

portion of the length 160 of the light pipe 112. As illustrated in Figure 7, the second surface edge portion 146 can be angled toward the first surface edge portion 144 through which the light 170 is exiting. Alternatively, as illustrated in Figure 9, the first surface edge portion 144 can be angled toward the second surface edge portion 146. In another example, rather than the first or second surface edge portions 144, 146 having an angled straight edge, the first or second surface edge portions 144, 146 can have an arced geometry. In another example, as illustrated in Figure 8, the second surface edge portion 146 can include a series of steps leading toward the first surface edge portion 144.

[0044] In each of the examples of the light pipe geometries of Figures 7-9, the cross-sectional shape of the light pipe 112 is configured to vary along at least a portion of the length 160 of the light pipe 112 to mix and distribute the light through that portion of the light pipe 112 in a manner similar to that described above with respect to the light pipe 12 of Figure 4. Figures 7-9 illustrate only a portion of the length 160 of the light pipe 112. In one example, the portions illustrated in Figures 7-9 correspond to half of the total length of the light pipe 112 and can be repeated in mirror image in the other half, similar to the light pipe 12 of Figure 4. Alternatively, the second half of the light pipe 112 can have a different light pipe geometry than the first half. In still another example, the portion of the light pipe 112 illustrated in Figures 7-9 can correspond to the full length 160 of the light pipe 112. The geometry of the light pipe 112 can be selected based on a variety of factors, non-limiting examples of which include the length of the light pipe, the length of the area to be illuminated, and/or a direction, intensity, and/or color of the light to be emitted.

[0045] Figures 10 and 11 illustrate an illumination assembly 210 that is similar to the illumination assembly 10 of Figures 1-4 except for the manner in which the light pipe 212 is mounted to a surface and the means for distributing the light along at least a portion of the length 260 of the light pipe 212. Therefore, elements of the illumination assembly 210 similar to those of the illumination assembly 10 are labeled with the prefix 200.

[0046] Still referring to Figures 10 and 11, the light pipe 212 is mounted relative to the surface 216 such that illumination is provided to an area above the surface 216 to illuminate items 218 displayed on the surface 216. The illumination assembly 210 can include a frame 214 that partially encompasses the light pipe 212 and secures the light pipe 212 relative to the mounting surface 216. The frame 214 can be secured relative to the surface 216 using any known mechanical and/or non-mechanical fastener, non-limiting examples of which include clamps, retaining clips, adhesives, and an interference or friction

fit. The illumination assembly 210 can include at least one light engine 220 provided adjacent one or both of the first and second end portions 240, 242 for emitting light into the light pipe 112.

[0047] The light pipe 212 can include a plurality of optical aberrations 280 along at least a portion of the length 260 of the light pipe 212 for mixing and/or distributing the light emitted through the light outlet provided in the first surface face portion 250. The optical aberrations 280 can be etched, cut, laser manufactured, molded, or otherwise formed in the light pipe 212 adjacent to or in the first surface face portion 250 of the light pipe 212. The optical aberrations 280 can facilitate distributing the light that enters the light pipe 212 through the first and/or second edge portions 240, 242 along at least a portion of the length 260 of the light pipe 212. In this manner, the optical aberrations 280 can provide more uniform illumination along the length of an adjacent area. The optical aberrations 280 can also facilitate mixing the light emitted by the light engines 220 to compensate for variations in color and/or intensity between each light source in the light engine 220. In this manner, the illumination assembly 210 can provide improved homogeneity of intensity, color, and directionality of the light emitted by the illumination assembly 210 along its length, similar to the illumination assembly 10 of Figures 1-4.

[0048] As illustrated in Figure 11, the optical aberrations 280 can be provided in the light pipe 212 on both sides of the vertical axis 262 as mirror images. Alternatively, the optical aberrations 280 on one side of the vertical axis 262 can be different than those on the other side. The size, shape, and distribution of the optical aberrations 280 can be based on a variety of factors, non-limiting examples of which include the length of the light pipe, the length of the area to be illuminated, and/or a direction, intensity, and/or color of the light to be emitted.

[0049] Figures 12-14 illustrate additional examples of illumination assemblies 310, 410, and 510 that are similar to the illumination assembly 210 except for the manner in which they are mounted and their cross-sectional profile. Therefore, elements of the illumination assemblies 310, 410, and 510 that are similar to the illumination assembly 210 are labeled with the prefix 300, 400, and 500, respectively.

[0050] Referring now to Figure 12, illumination assembly 310 includes a frame 314 that mounts the light pipe 312 adjacent the surface 316 at an angle such that light 370 emitted from the light outlet in the first surface face portion 350 illuminates items 318 displayed on the surface 316 behind the illumination assembly 310. The light pipe 312 can

include optical aberrations similar to those described with respect to the light pipe 212 of Figures 10-11 for mixing and/or distributing the light emitted through the light outlet provided in the first surface face portion 350. The frame 314 can have a cross-sectional profile that generally corresponds to the cross-sectional profile of the light pipe 312.

[0051] Similarly, each of the illumination assemblies 410 and 510 can be configured in a similar manner to illuminate an area behind the illumination assembly. The cross-sectional profile of the light pipes 412, 512 can be configured based on the desired angle of illumination. The frame 414, 514 can also have a cross-sectional profile that generally corresponds to the cross-sectional profile of the light pipe 412, 512.

[0052] While the geometry of the light pipe and the optical aberrations are described separately for mixing and/or distributing the light emitted through the light outlet(s) in the light pipe, it will be understood that the optical aberrations can be used in combination with any of the various light pipe geometries described herein. For example, any of the light pipes 12 and 112 can include optical aberrations 280 mixing and/or distributing light. Similarly, any of the light pipes 212, 312, 412, and 512 can include a geometry in which the cross-sectional shape of the light pipe varies along at least a portion of the length of the light pipe.

III. Conclusion

[0053] The above description is that of current embodiments of the invention. Various alterations and changes can be made without departing from the spirit and broader aspects of the invention as defined in the appended claims, which are to be interpreted in accordance with the principles of patent law including the doctrine of equivalents. To the extent not already described, the different features and structures of the various embodiments of the illumination assemblies 10, 110, 210, 310, 410, and 510 may be used in combination with each other as desired. That one feature may not be illustrated in all of the embodiments is not meant to be construed that it cannot be, but is done for brevity of description. Thus, the various features of the different embodiments of the illumination assemblies 10, 110, 210, 310, 410, and 510 may be mixed and matched as desired to form new embodiments, whether or not the new embodiments are expressly disclosed.

[0054] This disclosure should not be interpreted as an exhaustive description of all embodiments of the invention or to limit the scope of the claims to the specific elements illustrated or described in connection with these embodiments. For example, and without limitation, any individual element of the described invention may be replaced by one or

more alternative elements that provide substantially similar functionality or otherwise provide adequate operation. This includes, for example, presently known alternative elements, such as those that might be currently known to one skilled in the art, and alternative elements that may be developed in the future, such as those that one skilled in the art might, upon development, recognize as an alternative.

[0055] The invention is not limited to the details of operation or to the details of construction and the arrangement of the components set forth in the above description or illustrated in the drawings. The invention may be implemented in various other embodiments and practiced or carried out in alternative ways not expressly disclosed herein.

[0056] The phraseology and terminology used herein are for the purpose of description and should not be regarded as limiting. The use of "including" and "comprising" and variations thereof is meant to encompass the items listed thereafter and equivalents thereof as well as additional items and equivalents thereof. Further, enumeration may be used in the description of various embodiments. Unless otherwise expressly stated, the use of enumeration should not be construed as limiting the invention to any specific order or number of components. Nor should the use of enumeration be construed as excluding from the scope of the invention any additional steps or components that might be combined with or into the enumerated steps or components.

[0057] The disclosed embodiment includes a plurality of features that are described in concert and that might cooperatively provide a collection of benefits. The present invention is not limited to only those embodiments that include all of these features or that provide all of the stated benefits.

[0058] Any reference to claim elements in the singular, for example, using the articles "a," "an," "the" or "said," is not to be construed as limiting the element to the singular.

[0059] Directional terms, such as "front," "back," "vertical," "horizontal," "top," "bottom," "upper," "lower," "inner," "inwardly," "outer" and "outwardly," are used to assist in describing the invention based on the orientation of the embodiments shown in the illustrations. The use of directional terms should not be interpreted to limit the invention to any specific orientation.

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An illumination assembly comprising:
 - a light pipe including a first end portion including a light inlet, a second end portion opposite the first end portion defining a length therebetween, and a first light outlet extending at least a portion of the length between the first end portion and the second end portion;
 - a light engine adapted to direct light into the light inlet, whereby light subsequently exits the light pipe through the first light outlet; and
 - the light pipe including means for distributing the light exiting the first light outlet generally uniformly along at least the portion of the length of the light pipe.
2. The illumination assembly of claim 1 wherein the means for distributing the light includes the light pipe having a cross-sectional shape that varies along the length of the light pipe.
3. The illumination assembly of claim 2 wherein the cross-sectional shape of the light pipe is symmetric about a vertical axis of the light pipe.
4. The illumination assembly of claim 1 wherein the means for distributing the light includes the light pipe including a plurality of optical aberrations.
5. The illumination assembly of claim 1 wherein the light engine is fitted over the first end portion.
6. The illumination assembly of claim 1:
 - wherein the second end portion includes a second light inlet; and
 - further including a second light engine attached to the second end portion and including a light source adapted to direct light into the second light inlet.
7. The illumination assembly of claims 1 wherein the light source comprises at least one light emitting diode (LED).
8. The illumination assembly of claim 1 further comprising a frame including a first mounting element for mounting the illumination assembly adjacent a surface.
9. The illumination assembly of claim 8 wherein the first mounting element mates with a corresponding second mounting element on the surface through at least one of a tongue-and-groove fit, a snap fit, aligned apertures and mechanical fasteners, or combinations thereof.

10. The illumination assembly of claim 9 wherein the frame comprises heat sink, a reflector, or combinations thereof.
11. The illumination assembly of claim 1 further comprising a second surface including a second light outlet for illuminating a sign having a graphic disposed adjacent the second light outlet.
12. The illumination assembly of claim 1 wherein the light engine comprises a plurality of light sources and the means for distributing the light at least partially mixes the light emitted by the plurality of light sources prior to exiting the light outlet.
13. An illumination assembly comprising:
- a light pipe including a first end portion including a first light inlet, a second end portion opposite the first end portion including a second light inlet, and a first light outlet extending at least partially between the first end portion and the second end portion;
 - a first light engine attached to the first end portion adapted to direct light into the first light inlet;
 - a second light engine attached to the second end portion adapted to direct light into the second light inlet;
 - wherein the light pipe is configured to at least partially mix light emitted by the first light engine and the second light engine prior to the mixed light exiting the first light outlet.
14. The illumination assembly of claim 13 wherein the light pipe comprises a cross-sectional shape that varies along the length of the light pipe.
15. The illumination assembly of claim 14 wherein the cross-sectional shape of the light pipe is symmetric about a vertical axis of the light pipe.
16. The illumination assembly of claim 13 wherein the light pipe includes a plurality of optical aberrations disposed in or adjacent the first light outlet at least partially along the length of the light pipe.
17. The illumination assembly of claim 13 wherein the first light engine is fitted over the first end portion and the second light engine is fitted over the second end portion.
18. The illumination assembly of claim 13 wherein the first and second plurality of light sources comprises a light emitting diode (LED).
19. The illumination assembly of claim 13 further comprising a frame including a first mounting element for mounting the illumination assembly adjacent a surface.
20. The illumination assembly of claim 19 wherein the frame comprises heat sink, a reflector, or combinations thereof.

21. The illumination assembly of claim 13 wherein the light pipe further includes a second light outlet for illuminating a sign having a graphic disposed adjacent the second light outlet.

AMENDED CLAIMS
received by the International Bureau on 7 November 2016 (07.11.2016)

1. An illumination assembly comprising:
a light pipe including a first end portion including a light inlet, a second end portion opposite the first end portion defining a length therebetween, and a first light outlet extending at least a portion of the length between the first end portion and the second end portion;
a light engine adapted to direct light into the light inlet, whereby light subsequently exits the light pipe through the first light outlet; and
the light pipe including means for distributing the light exiting the first light outlet generally uniformly along at least the portion of the length of the light pipe,
wherein the means for distributing the light includes the light pipe having a cross-sectional shape that varies along the length of the light pipe.
2. The illumination assembly of claim 1 wherein the cross-sectional shape of the light pipe is symmetric about a vertical axis of the light pipe.
3. The illumination assembly of claim 1 wherein the means for distributing the light includes the light pipe including a plurality of optical aberrations.
4. The illumination assembly of claim 1 wherein the light engine is fitted over the first end portion.
5. The illumination assembly of claim 1:
wherein the second end portion includes a second light inlet; and
further including a second light engine attached to the second end portion and including a light source adapted to direct light into the second light inlet.
6. The illumination assembly of claims 1 wherein the light source comprises at least one light emitting diode (LED).
7. The illumination assembly of claim 1 further comprising a frame including a first mounting element for mounting the illumination assembly adjacent a surface.
8. The illumination assembly of claim 7 wherein the first mounting element mates with a corresponding second mounting element on the surface through at least one of a tongue-and-groove fit, a snap fit, aligned apertures and mechanical fasteners, or combinations thereof.
9. The illumination assembly of claim 19 wherein the frame comprises a heat sink, a reflector, or combinations thereof.
10. The illumination assembly of claim 1 further comprising a second surface including a second light outlet for illuminating a sign having a graphic disposed adjacent the second light outlet.

11. The illumination assembly of claim 1 wherein the light engine comprises a plurality of light sources and the means for distributing the light at least partially mixes the light emitted by the plurality of light sources prior to exiting the light outlet.
12. An illumination assembly comprising:
 - a light pipe including a first end portion including a first light inlet, a second end portion opposite the first end portion including a second light inlet, and a first light outlet extending at least partially between the first end portion and the second end portion, the light pipe having a cross-sectional shape that varies along a length of the light pipe and is symmetric about a vertical axis of the light pipe;
 - a first light engine attached to the first end portion adapted to direct light into the first light inlet;
 - a second light engine attached to the second end portion adapted to direct light into the second light inlet;
 - wherein the light pipe is configured to at least partially mix light emitted by the first light engine and the second light engine prior to the mixed light exiting the first light outlet.
13. The illumination assembly of claim 12 wherein the light pipe includes a plurality of optical aberrations disposed in or adjacent the first light outlet at least partially along the length of the light pipe.
14. The illumination assembly of claim 12 wherein the first light engine is fitted over the first end portion and the second light engine is fitted over the second end portion.
15. The illumination assembly of claim 12 wherein the first and second plurality of light sources comprises a light emitting diode (LED).
16. The illumination assembly of claim 12 further comprising a frame including a first mounting element for mounting the illumination assembly adjacent a surface.
17. The illumination assembly of claim 20 wherein the frame comprises heat sink, a reflector, or combinations thereof.
18. The illumination assembly of claim 12 wherein the light pipe further includes a second light outlet for illuminating a sign having a graphic disposed adjacent the second light outlet.
19. The illumination assembly of claim 7 wherein the frame extends across the length of the light pipe and is adapted to mount the light pipe at the first and second end portions of the light pipe.

20. The illumination assembly of claim 16 wherein the frame extends across the length of the light pipe and is adapted to mount the light pipe at the first and second end portions of the light pipe.

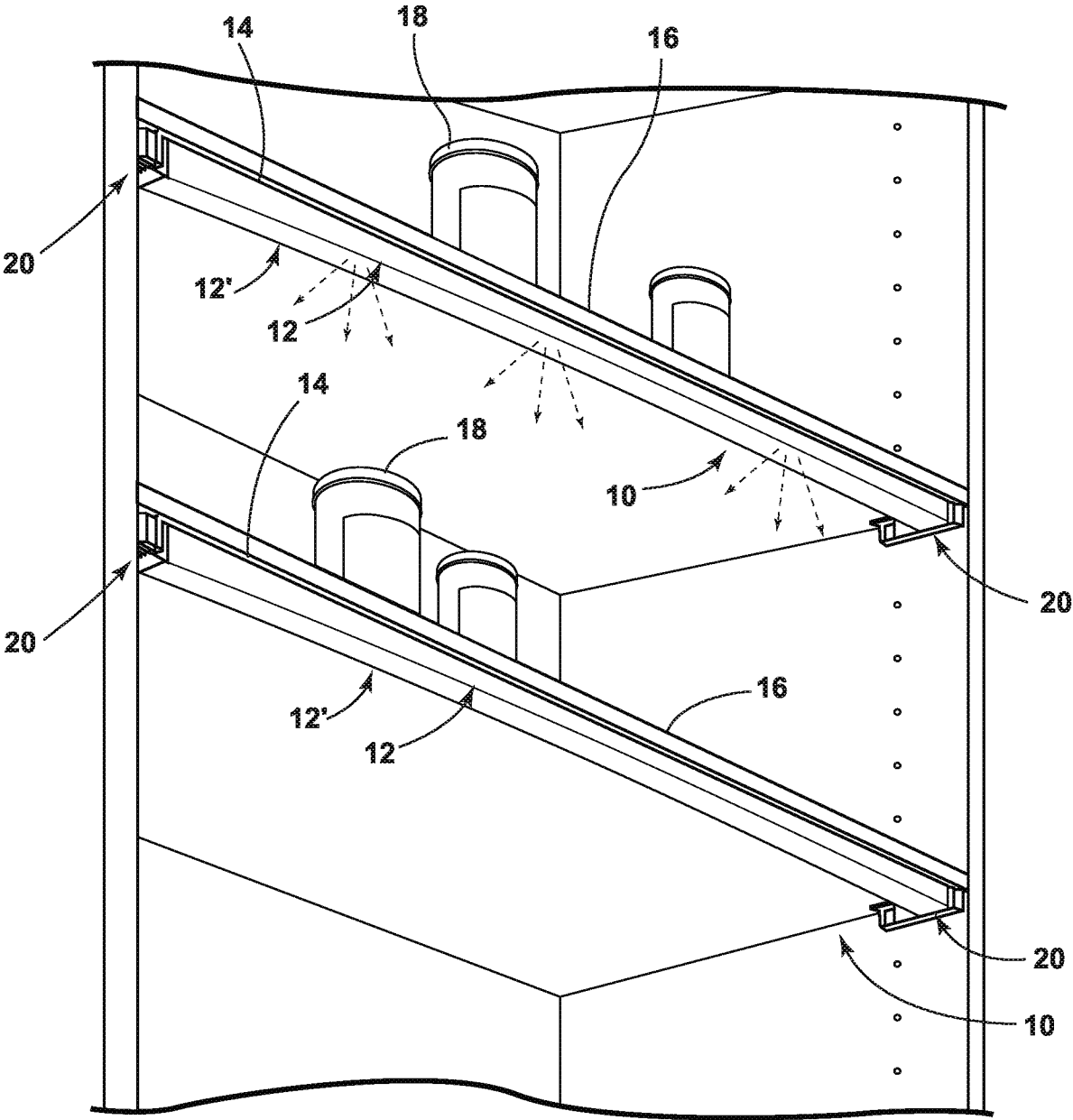


FIG. 1

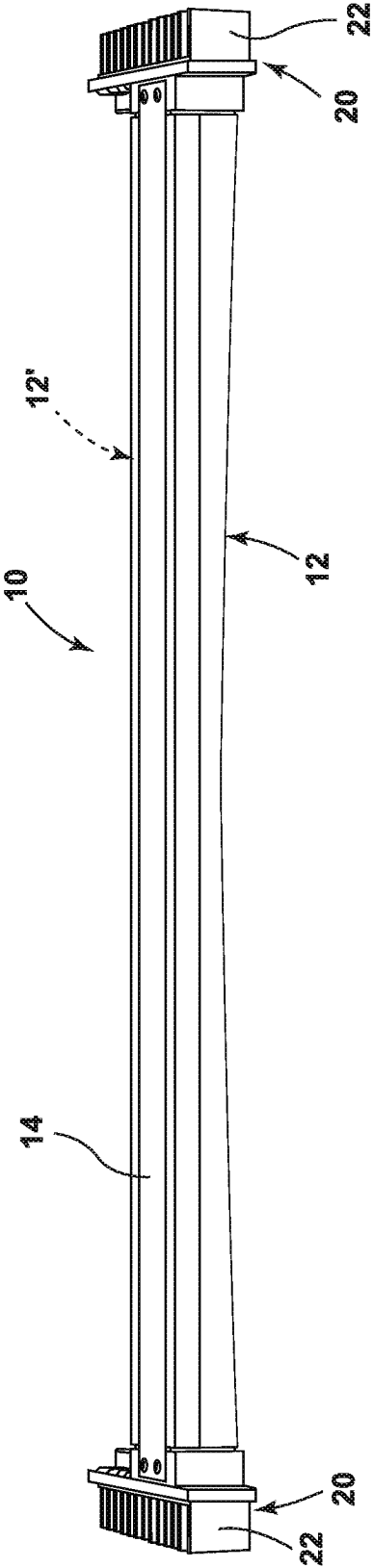


FIG. 2

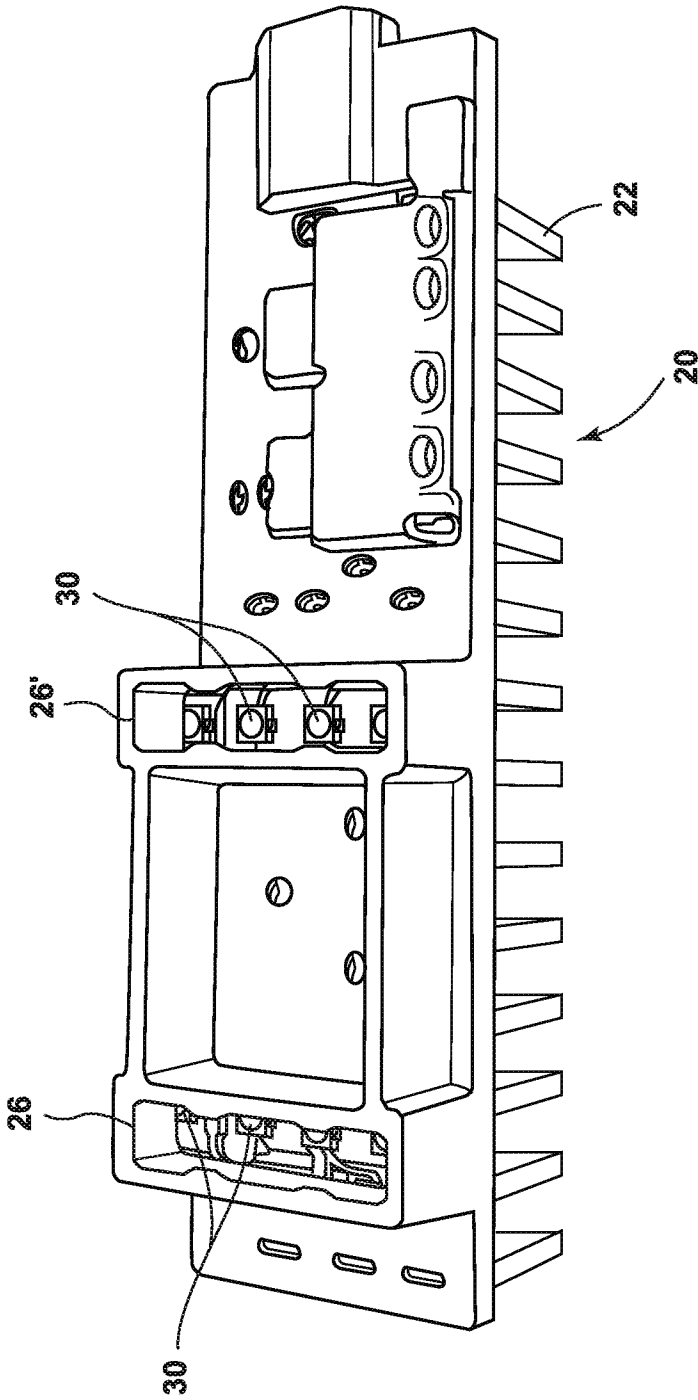


FIG. 3

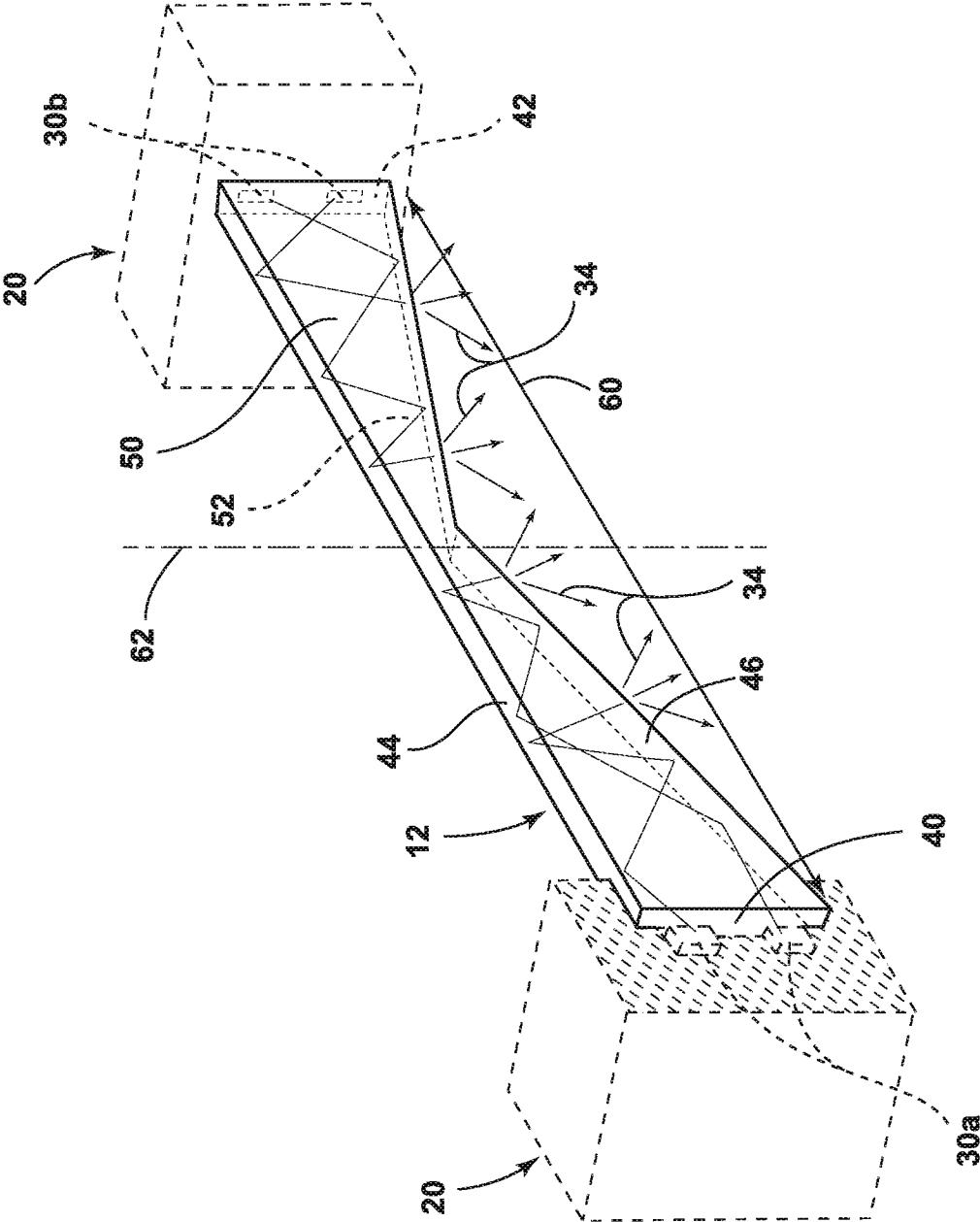


FIG. 4

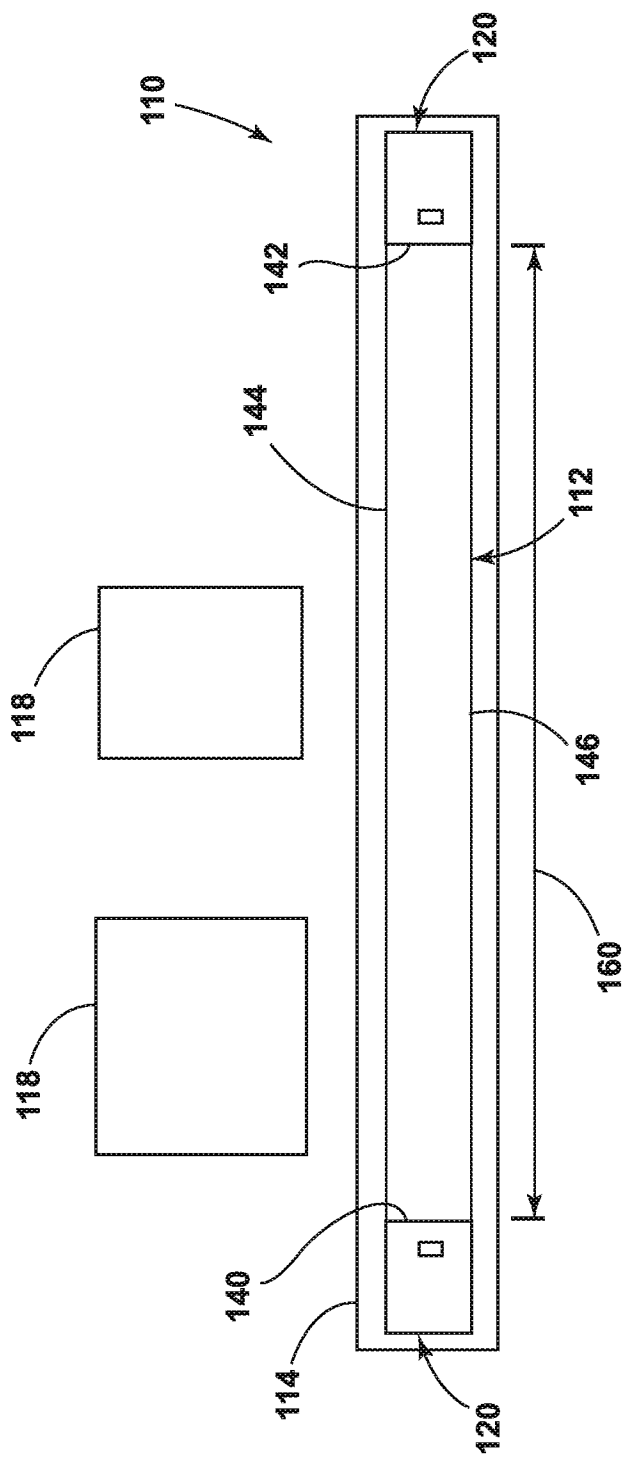


FIG. 5

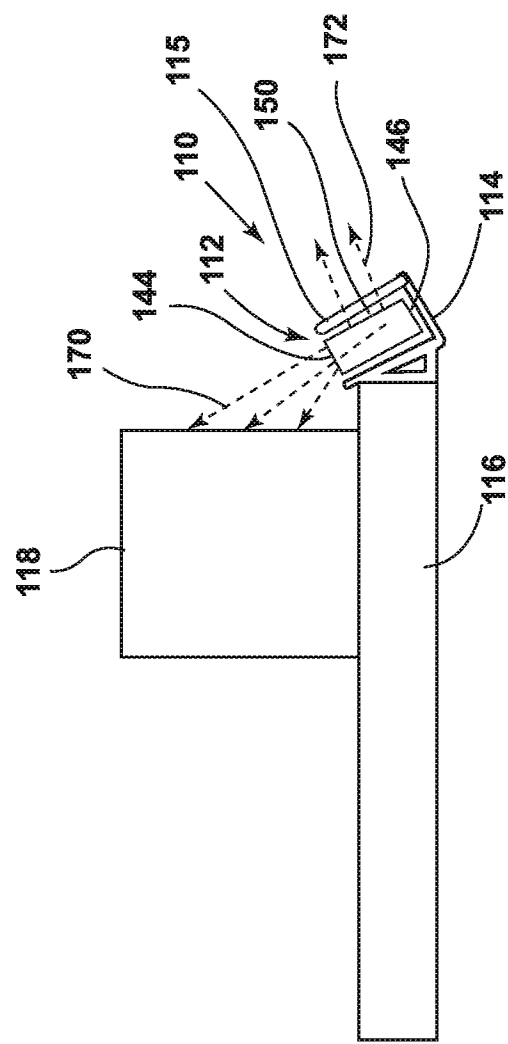


FIG. 6

6/9

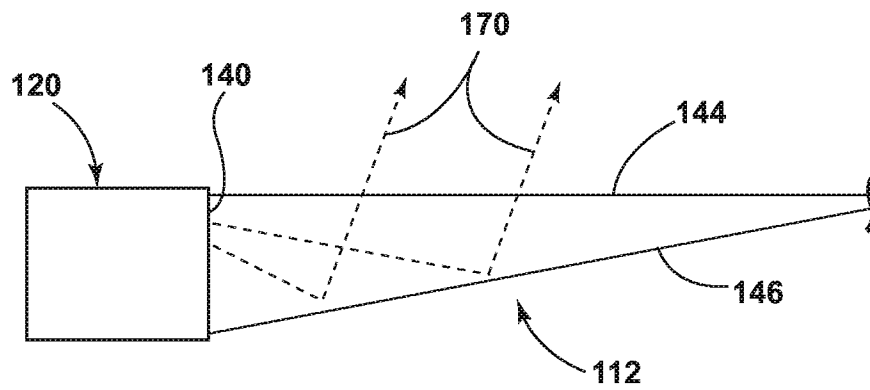


FIG. 7

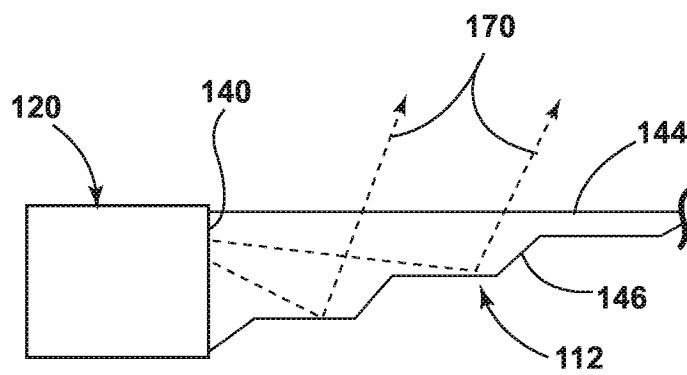


FIG. 8

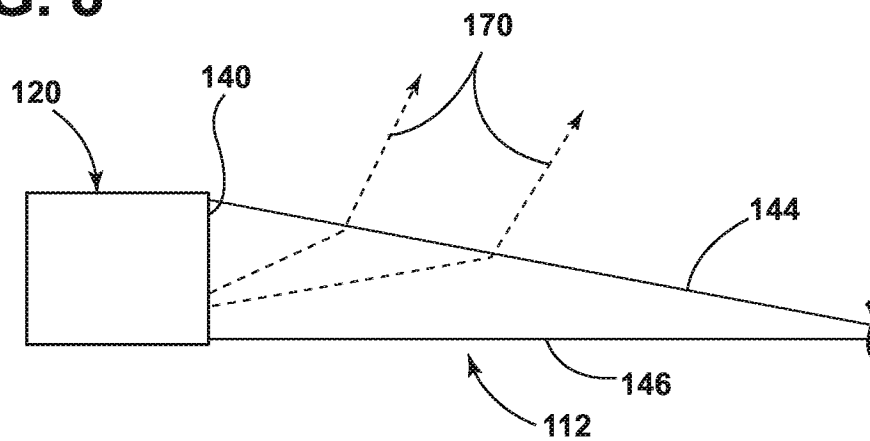


FIG. 9

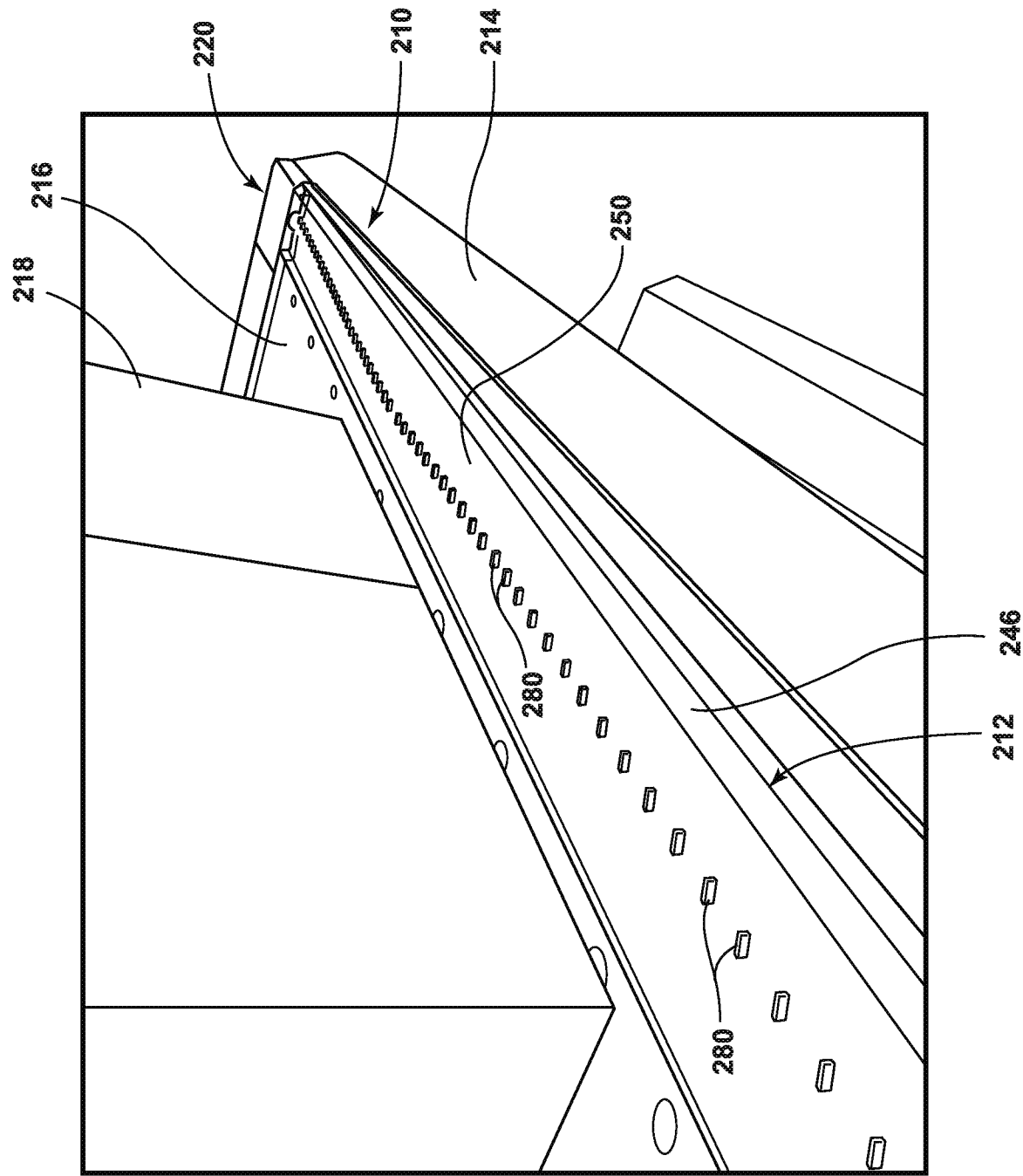
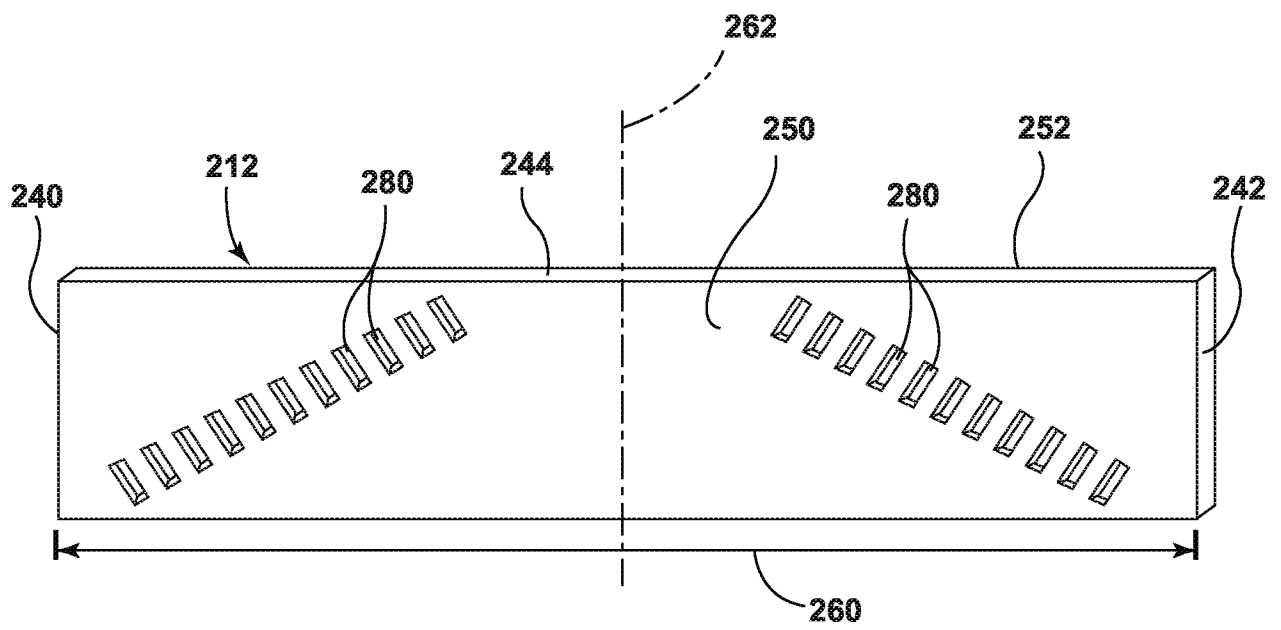


FIG. 10

8/9

**FIG. 11**

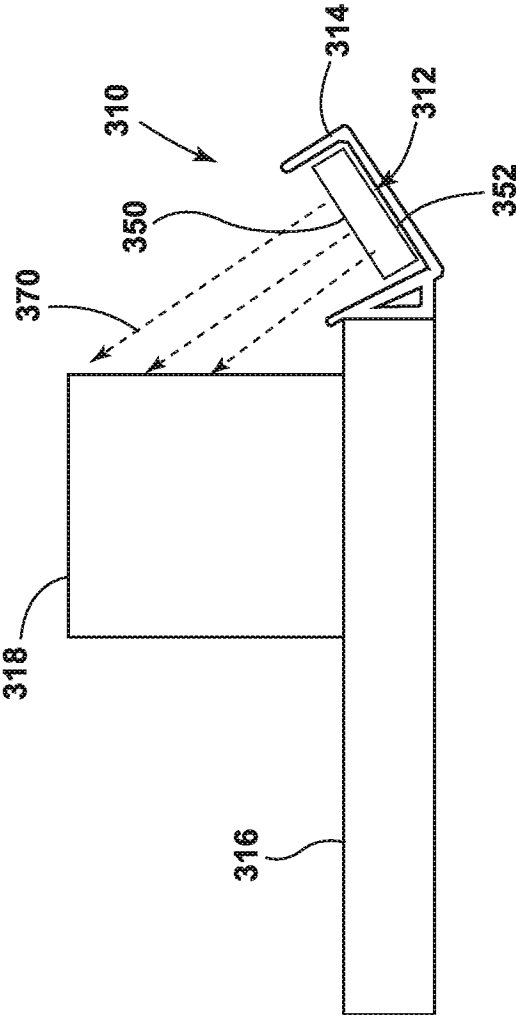


FIG. 12

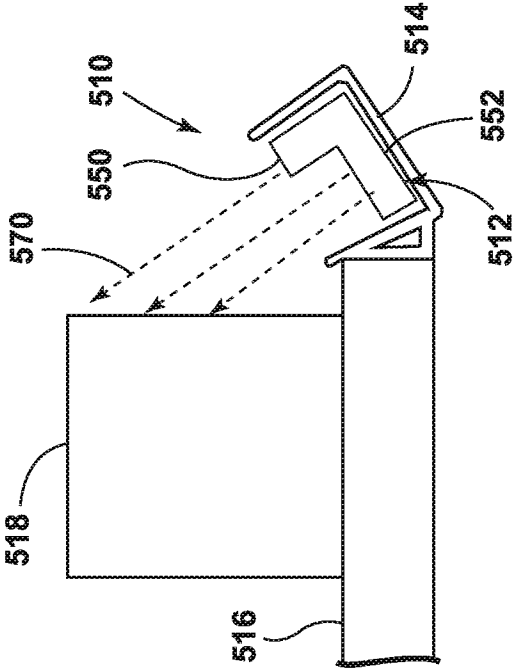


FIG. 14

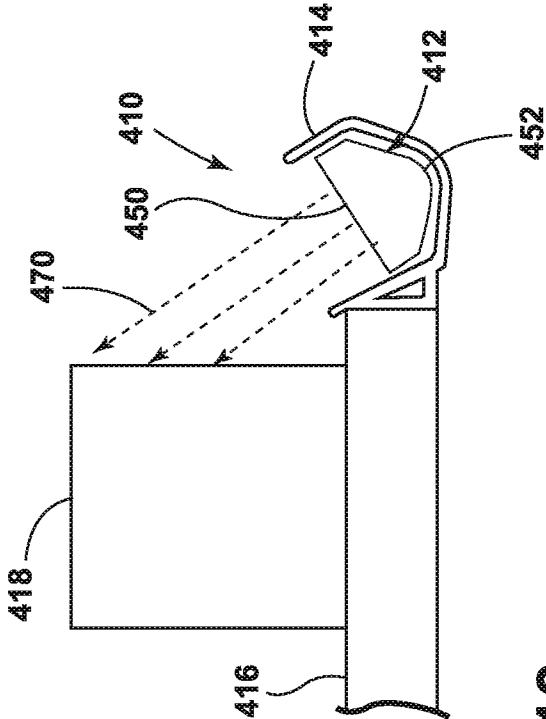


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/36964

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F21V 13/02 (2016.01)

CPC - A61B 1/06; A61B 1/07; F21V 13/02; F21K 9/278; F21K 9/272

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)

IPC(8): F21V 13/02 (2016.01)

CPC: A61B 1/06; A61B 1/07; F21V 13/02; F21K 9/278; F21K 9/272

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

IPC(8): F21V 13/02 (2016.01)

CPC: A61B 1/06; A61B 1/07; F21V 13/02; F21K 9/278; F21K 9/272; USPC:362/551,555,559

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

Patbase, Google Web, Google Scholar Search terms used: Light, guide, pipe, length, outlet, output, uniform, led, oled, engine, circuit, control, process, wall, surface, shelf, shelves, snap fit, mount, attach, fasten, tongue groove, nail, screw, frame, heat sink, reflector, extract, exit, scatter, mix, graphic, sign, poster

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/0016143 A1 (PARKER et al.) 15 January 2015 (15.01.2015), para [0029]-[0030], [0032], [0034], [0038], [0040]-[0041], [0043]-[0044], [0047]-[0048], [0059], [0084],	1-5, 7-10, 12
—		-----
Y		1, 6, 11, 13-21
Y	US 2014/0043847 A1 (YANG et al.) 13 February 2014 (13.02.2014), para [0047], [0049], [0053], [0060], [0062], [0070], [0089], [0097]	1, 6, 13-21
Y	US 2006/0291241 A1 (WOJTOWICZ et al.) 28 December 2006 (28.12.2006), para [0034]	11, 21
A	US 2009/0290375 A1 (GINGRICH, III) 26 November 2009 (26.11.2009), para [0017], [0022],	1-21
A	US 2009/0237958 A1 (KIM) 24 September 2009 (24.09.2009), para [0044], [0061]	1-21

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

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

11 August 2016 (11.08.2016)

Date of mailing of the international search report

08 SEP 2016

Name and mailing address of the ISA/US

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