

LIGHTING SYSTEM FOR MASS-TRANSIT VEHICLES**TECHNICAL FIELD**

5 This invention relates to mass transit vehicle lighting systems; more particularly, it relates to a lighting system for the passenger compartment of a bus using light pipes.

BACKGROUND OF THE INVENTION

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Lighting systems for passenger seating areas in mass-transit vehicles frequently include a plurality of fluorescent lamps arranged in rows. Each row of lamps is commonly enclosed within an elongated channel that forms part of an elongated lamp housing. The elongated channel may be connected to or integrally
15 formed with an elongated display panel for holding advertising cards. A lamp housing of this type will also typically include an elongated translucent or transparent light cover disposed across the open side of the channel to aid in controlling the distribution of light emitted from the lamps.

Together, the lamp housing and display panel make up an elongated
20 light fixture. Such light fixtures are typically manufactured in long sections that mount end-to-end in the cornice areas above the passenger seating areas and above the vehicle side windows in mass-transit vehicles. U.S. Pat. No. 4,574,336 issued March 4, 1986 to Mikalonis and U.S. Pat. No. 4,387,415 issued June 7, 1983 to Domas disclose lighting systems of this type.

25 Fluorescent vehicle lighting systems are inherently difficult to service and require a considerable amount of maintenance. Fluorescent lamps frequently burn out and require replacement. When lighting systems use large numbers of lamps, the odds that one of the lamps will burn out over a given period of time increases. Therefore, the larger the number of lamps that a lighting systems
30 uses, the more often that system will require bulb and ballast replacement.

Lighting systems that use multiple lamps also require multiple lamp sockets and complex wiring harnesses. Wiring harnesses for multiple-lamp lighting systems must connect every lamp socket to an electrical power source. In addition, the lighting fixtures housing the lamps and ballast must be designed to allow easy access for replacing lamps and ballast.

Systems using multiple lamps inherently leave "dark spots" between lamps. Rows of fluorescent lamps oriented end-to-end leave dark spots where the ends of each lamp plug into a socket and no light is emitted. The dark areas between the lamps are difficult to minimize without extending the lengths of the lamps.

When confronted with applications requiring linear light sources, designers have sometimes turned to fiber optics. Advances in fiber optic technology have made it possible to manufacture linear light sources that can efficiently distribute light both laterally from their circumferences as well as longitudinally from their ends. This type of product is known as a "side-light" or "side-fire" optic or a "side-fire" light pipe.

Lumenyte International Corporation manufactures a "side-fire" light pipe that includes a solid acrylic core with either a circular or an oval cross-section. The diameter of the core is approximately one-half of an inch. A Teflon® cladding surrounds the core and has an index of refraction that causes the light pipe to emit light laterally. A clear jacket surrounds the cladding to reflect a certain amount of light back into the core.

Also available from Lumenyte International Corporation is the LUMENYTE® STARBURST™ OPTIC - a side-fire light pipe with small angled cuts along its length. The cuts create optical discontinuities along the length of the light pipe that increase the amount of light emitted laterally. The depth, angle and spacing of these cuts can be varied to customize light distribution to suit a particular application.

The prior art also includes fiber optic lighting systems that have been proposed for use in vehicular applications. An example of a proposed vehicular application of fiber optic technology is described in U.S. Pat. No. 4,947,293 issued to Johnson et al. The Johnson et al. patent discloses a clearance
5 lighting system for a semi trailer cargo container body. The system includes a light source that end-illuminates elongated light-conducting strips. The strips are supported along both sides of a container body and emit light both longitudinally and laterally. Another Johnson patent, U.S. Pat. No. 5,122,933, discloses a similar fiber optic lighting system that includes a message panel. However, the lighting
10 systems disclosed in the later two patents are not adapted to preferentially distribute light into the passenger seating area of a mass transit vehicle.

Another example of a vehicular application for fiber optic technology is disclosed in U.S. Pat. No. 4,740,870 issued to Moore et al. The Moore et al. patent discloses a fiber optic lighting system for boats. The system
15 includes a plurality of "end-fire" fiber optic cables that each receive light at one end from a central light source. The cables conduct light longitudinally to light fixtures located at remote locations within a boat.

Two other examples are disclosed in U.S. Pat. No. 4,811,172 to Davenport et al. and U.S. Pat. No. 5,184,883 to Finch et al. Each of these patents
20 discloses a fiber optic lighting system for motor vehicles. The systems include a light source that end-illuminates a plurality of fiber optic filaments. The filaments conduct the light longitudinally to the vehicle head and tail lamp fixtures.

There remains a need for lighting systems that can supply sufficient illumination to meet lighting requirements in passenger seating areas of
25 mass-transit vehicles while reducing the amount of lamps, wiring and maintenance that current systems require.

SUMMARY OF THE INVENTION

In accordance with this invention a fiber optic lighting system is
30 provided that comprises a light fixture including an elongated lamp-support panel

having a length, an upper surface, a lower surface opposite the upper surface, and a thickness extending between the upper and lower surfaces. An elongated slot extends through the thickness of the lamp-support panel and extends longitudinally along the length of the lamp-support panel between two slot ends. An elongated side-fire light pipe having a light pipe length extending between two light pipe ends is disposed adjacent and generally parallel to the lamp-support panel lower surface. An elongated mounting fin comprising an elongated stem integrally extends from along the light pipe length between the light pipe ends. The elongated stem is disposed within and along the longitudinal slot in the lamp-support panel. The mounting fin additionally comprises a first engagement surface disposed adjacent the stem. The first engagement surface engages the light fixture upper surface to suspend the light pipe below the lamp-support panel without blocking light emitted from the light pipe in a direction away from the lamp-support panel.

To better understand and appreciate the invention, refer to the following detailed description in connection with the accompanying drawings:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a vehicle interior having light fixtures according to the invention;

FIG. 2 is a cross-sectional view of a vehicle schematically showing the lighting pattern from the fixtures according to the invention;

FIG. 3 is a partial-cutaway top view of the vehicle shown in FIG. 1;

FIG. 4 is a cross-sectional end view of a light fixture constructed in accordance with this invention;

FIG. 5 is a cross-sectional end view of a second light fixture embodiment constructed in accordance with this invention;

FIG. 6 is a perspective view of a third light fixture embodiment constructed in accordance with this invention;

FIG. 7 is a cross-sectional end view of a fourth light fixture

embodiment constructed in accordance with this invention;

FIG. 8 is a fragmentary cross-sectional bottom view of an alternative coupling means constructed in accordance with this invention;

FIG. 9 is a fragmentary cross-sectional bottom view of a coupling means constructed in accordance with this invention;

FIG. 10 is a detail view of a light pipe extending between two light sources;

FIG. 11 is a cross-sectional end view of an alternative lamp housing, light pipe and indexing plate;

FIG. 12 is a partial cross-sectional side view of the alternative lamp housing, light pipe and indexing plate;

FIG. 13 is a detail view of the light fixture mounting pin and socket;

FIG. 14 is a perspective view of a light pipe mounting clip constructed according to the invention;

FIG. 15 is a front view of the light engine shown in Fig. 4;

FIG. 16 is a cross-sectional end view of a fifth light fixture embodiment constructed in accordance with this invention;

FIG. 17 is a cross-sectional end view of an alternative face panel;

FIG. 18 is a cross-sectional end view of another alternative face panel;

FIG. 19 is a cross-sectional end view of yet another alternative face panel;

FIG. 20 is a broken-out cross-sectional end view of the roll-in lens connector arrangement shown in FIG. 16;

FIG. 21 is a cross-sectional end view of a variant of the fifth light fixture embodiment constructed in accordance with this invention;

FIG. 22 is a cross-sectional end view of an alternative light pipe mounting arrangement;

FIG. 23 is a perspective view of a light pipe having the alternative mounting arrangement of Fig. 22;

FIG. 24 is an end view of an alternative light pipe mounting clip constructed according to the invention and suspending a light pipe from a support structure with the light pipe and support structure shown in cross-section;

5 FIG. 25 is an end view of another alternative light pipe mounting clip constructed according to the invention and engaging an opening in a support structure, the support structure being shown in cross-section;

FIG. 26 is an end view of light pipe mounting clip of Figure 25 suspending a light pipe from a support structure with the light pipe and support structure shown in cross-section;

10 FIG. 27 is an end view of another alternative light pipe mounting clip holding a light pipe and engaging an opening in a support structure, the light pipe and support structure being shown in cross-section;

FIG. 28 is an end view of the light pipe and mounting clip of Figure 27 with the clip suspending the light pipe from a support structure;

15 FIG. 29 is an end view of another alternative light pipe mounting clip constructed according to the invention and engaging an opening in a support structure, the support structure being shown in cross-section;

FIG. 30 is an end view of the light pipe mounting clip of Figure 29 holding a light pipe, a probe portion of the clip extending part-way through the opening in the support structure, the light pipe and support structure being shown in cross-section;

20 FIG. 31 is an end view of the light pipe mounting clip of Figures 29 and 30 suspending the light pipe from the support structure;

FIG. 32 is a partial-cutaway top view of the vehicle shown in FIG. 1 including light fixtures constructed according to the invention and including two dual-port light engines rather than four single-port light engines;

FIG. 33 is a front view of a dual-port light engine of Figure 32.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A first embodiment of a lighting system for mass-transit vehicles is generally indicated at 20 and 20' in Figs. 1-4. The lighting system 20, 20' is
5 installed in a mass transit vehicle 22 that includes a passenger compartment, generally indicated at 24 in Figs. 1-3. The passenger compartment 24 is defined by two side walls 26, a forward bulkhead 28 and an aft bulkhead 30, a floor 32 and a ceiling 40. The forward bulkhead 28 is located at the forward end of the passenger compartment and the aft bulkhead 30 is located at the aft end. The passenger
10 compartment 24 includes side windows 34 located in the side walls 26. The floor 32 includes an aisle 36 extending along the longitudinal axis of the vehicle 22 between two passenger seating areas 38. The ceiling 40 extends between the side walls 26 from the forward bulkhead 28 to the aft bulkhead 30. The passenger compartment 24 includes two cornice areas defined as the regions where the two
15 side walls 26 join the ceiling 40. Portion 20 of the lighting system is supported in one cornice area and portion 20' is supported in the opposite cornice area. An elongated vehicle duct panel 70 may also be fixed into the cornice area.

Because lighting system portions 20, 20' have the same general construction, only lighting system 20 will be described in detail. As shown in Figs.
20 1, 2 and 3, the lighting system 20 includes an elongated light fixture 42 installed longitudinally in one of the cornice areas in the passenger compartment 24 of the vehicle 22. One light source 74 is mounted at each end of the light fixture 42 adjacent a bulkhead 28, 30. Three elongated light pipes 76, 78, 80 are optically-coupled end-to-end and extend between the two light sources 74. (Other
25 embodiments may, of course, include a greater or a smaller number of light pipes.) The light pipes 76, 78, 80 receive light from the light sources 74, transmit it along their lengths and laterally emit it from along their lengths into the passenger compartment 24. The light fixture 42 also includes an elongated segmented lamp housing 52 that runs parallel to the light pipes 76, 78, 80 and preferentially directs
30 light into the seating area 38 from the light pipes 76, 78, 80. Two coupler means

100 are supported at spaced locations along the lamp housing 52 to slidably support optically-coupled ends 84, 86, 88 of the light pipes 76, 78, 80.

As shown in Fig. 3, the light fixture 42 includes five face panels 44, 46, 48, 50, 50' disposed end-to-end and longitudinally extending above the seating area 38 from the aft bulkhead 30 to the forward bulkhead 28. The three panels include a 12 foot-long forward face panel 44 disposed in the forward end of the passenger compartment 24, a 12 foot-long aft face panel 46 disposed in the aft end of the passenger compartment 24, a center face panel 48 disposed between the forward 44 and aft 46 face panels, a forward access face panel 50 abutting the forward bulkhead 28, and an aft access face panel 50' abutting the aft 30 bulkhead. The length of the center face panel 48 varies according to the length of the passenger compartment 24. Face panels 44, 46 and 48 have generally identical cross-sections as viewed longitudinally down the length of the passenger compartment 24.

As is best shown in Figs. 1 and 2, the segmented lamp housing 52 is longitudinally disposed in the light fixture 42. The segmented lamp housing 52 is made-up of three interconnecting lamp housing segments 52A, 52B, 52C each shaped and aimed to preferentially direct light to the seating area 38 below and to minimize illumination of the aisle 36 and side windows 34. The lamp housing segments are aligned end-to-end to form the segmented lamp housing. Each segment 52A, 52B, 52C of the lamp housing 52 is disposed in one of the face panels 44, 46, 48, 50, 50'. A forward lamp housing segment 52A is disposed in the forward face panel 44, an aft lamp housing segment 52B is disposed in the aft face panel 46, a center lamp housing segment 52C is disposed in the center face panel 48. Each lamp housing segment 52A, 52B, 52C has the shape of a concave channel with a parabolic cross-section. The cross-sectional shape of each lamp housing segment 52A, 52B, 52C may also be elliptical, semi-circular or any other suitable shape. The curved inner surface of each panel segment 52A, 52B, 52C may include a light reflecting, refracting, diffusing or absorbing surface - depending on the amount of illumination desired for a given application.

Each face panel 44, 46, 48 includes a gently-curved display panel 54 and upper and lower grooved borders 56 for holding advertising cards. The lower edges of each face panel 44, 46, 48, 50, 50' include an elongated, downwardly-curved roll-in hook 73 for mounting the panels 44, 46, 48, 50, 50' in another
5 embodiment. In the first embodiment, the hooks 73 serve no purpose.

Each face panel 44, 46, 48, 50, 50' is made as a pultrusion from opaque resin and glass fibers to have an elongated shape of a uniform cross-section along its length. Each segment of the lamp housing 52 is integrally pultruded with one of the face panels 44, 46, 48, 50, 50' to form a unitary piece. As shown in Figs.
10 1, 2, and 4, each lamp housing segment 52A, 52B, 52C is disposed below the bottom edge of the display panel 54 in its respective face panel 44, 46, 48, 50, 50'.

The light fixture 42 encloses and defines an elongated air duct as shown at 68 in Figs. 1, 2 and 4. The face panels 44, 46, 48, 50, 50' serve as the inner walls of the duct 68. The remainder of the duct 68 is defined by the vehicle
15 duct panel 70. Each face panel 44, 46, 48, 50, 50' is fastened along its top and bottom edges to the vehicle duct panel 70. As is shown in Fig. 4, spacers 72 are included between the face panels 44, 46, 48, 50, 50' and the vehicle duct panel 70 to allow conditioned air, either heated or cooled, to pass from the duct 68 into the passenger compartment 24. In other embodiments, the face panels 44, 46, 48, 50,
20 50' may be fastened directly to the side wall 26 of the passenger compartment 24 in a cornice area rather than to a vehicle duct panel 70.

Two single-port light sources, shown at 74 in Figs. 3, 4, 5, 7, 10 and 15, are mounted in the vehicle 22 adjacent the passenger compartment 24. More specifically, one light source 74 is mounted at each end of the fixture 42 with each
25 light source 74 disposed behind one of the two access face panels 50, 50' adjacent the forward 28 and aft bulkheads 30. Each light source 74 includes a cylindrical receptacle 89 configured to receive one end of a light pipe. The light sources 74 are mounted behind the access face panels 50, 50' to allow easy access for maintenance and replacement of light source components such as burned-out bulbs.

In other embodiments, there may be more or fewer light sources 74 and they may be mounted at any location within the vehicle 22. In addition, as shown in Figures 32 and 33, each light fixture 42 may include a single dual-port light source 74k rather than two single-port light sources 74. The dual-port light source 74k includes two receptacles shown at 89kA, 89kB in Figure 33. The receptacles 89kA, 89kB extend in opposite directions from a central lamp housing 75 of the light source 74k. The dual-port light source 74k is supported within the fixture 42 approximately midway along the length of the fixture 42 rather than at opposite ends of the light fixture 42 as with the single-port light sources 74 of Figs. 3, 4, 5, 7, 10 and 15.

As shown in Figs. 4, 5 and 7, the light sources 74 are disposed within the air duct 68 that runs through the fixture 42. In operation, the flow of cool air through the air duct 68 can help the light sources 74 convectively reject heat.

The light sources 74, commonly known as "light engines", are electrically-energized and include halogen illuminators. The illuminators may be quartz-halogen or may use a metal halide illuminator such as that described in United States patent 4,704,660 granted November 3, 1987 to Robbins et al. Such light sources 74 are available from General Electric Company and Lumenyte International Corporation.

The lighting system 20 includes a switch mounted in the vehicle 22 and an electrical energizing circuit that extends from the switch to each light source 74. The switch may be of any suitable type known in the art.

The lighting system 20 includes three elongated light pipes, generally indicated at 76, 78 and 80 in Figs. 1-12 and 15. The light pipes 76, 78, 80 are coupled end-to-end in a series. The series extends longitudinally above the seating area 38 and between two light sources 74 and runs adjacent and parallel to the segmented lamp housing 52.

As is shown in Fig. 3, the three elongated light pipes include a forward pipe 76 supported within the forward face panel 44, a center pipe 78

supported within the center face panel 48 and an aft pipe 80 supported within the aft face panel 46. The forward 76 and aft 80 pipes receive light at one end, transmit the light along their lengths and longitudinally emit it from their other ends while laterally emitting it from along their lengths into the passenger compartment 24.

- 5 The center pipe 78 receives light at both ends from the forward 76 and aft 80 pipes and laterally emits it from along its length into the passenger compartment 24.

In the embodiment of Figures 32 and 33, the center pipe 78 is separated generally in half into first and second elongated center light pipe sections 78kA, 78kB. The center light pipe sections 78kA, 78kB each have an input end
10 optically coupled to one of the two receptacles 89kA, 89kB of the dual-port light source 74k. From the dual-port light source 74k the two center light pipe sections 78kA, 78kB extend in opposite directions above the seating area adjacent the lamp housing.

- When installing the lighting system 20 the light sources 74 are
15 installed before the light pipes 76, 78, 80. Because the forward 76 and aft 80 pipes must be inserted into the cylindrical receptacles 89 in the light sources 74, the light sources 74 must be moved out of the way when the forward 76 and aft 80 pipes are installed. To facilitate light source 74 movement, each light source 74 is supported within the air duct 68 by a mounting bracket 69 that includes elongated mounting
20 holes 71. As shown in Fig. 15, the elongated mounting holes 71 allow the light sources 74 to be slid away from the light pipes 76, 80. After the light pipes 76, 78, 80 are installed, the light sources 74 are slid back inward to engage and optically couple with the forward 76 and aft 80 pipes. Alternatively, the light sources 74 may be pre-mounted to the light pipes and fastened into place after the light pipes
25 76, 78, 80 are installed.

As shown in Fig. 3, the forward 76 and aft 80 light pipes have each have an input end 82 and an output end 84. The center light pipe 78 has a forward input end 86 and an aft input end 88. Each of the input ends 82 of the forward 76 and aft 80 light pipes is optically coupled to one of the two light sources 74. The
30 cylindrical receptacles 89 in the light sources 74 receive the input ends 82. As

shown in Fig. 15, heat-shrink tubing 91 may be used to secure the input ends 82 in the receptacles 89.

The output ends 84 of the forward 76 and aft 80 light pipes are optically coupled to the forward 86 and aft 88 input ends of the center light pipe 78, respectively. The optical couplings between the light pipes 76, 78, 80 allow the forward 76 and aft 80 light pipes to transmit light from the light sources 74 into the center light pipe 78.

Each elongated light pipe 76, 78, 80 is a solid-core semi-rigid fiber optic. The core section of each pipe 76, 78, 80 is made of a soft acrylic. However, other embodiments may use other light-transmissive materials instead of soft-cored semi-rigid optics, e.g., Dupont Lucite® rods having circular cross-sections and diameters of approximately 5/8 of an inch.

The core of each light pipe 76, 78, 80 is encased in a cladding having an index of refraction which causes the cladding to emit light laterally. The cladding is made of Teflon®. However, in other embodiments, the cladding may be made of other materials with similar light dispersing characteristics. A clear, semi-rigid jacket surrounds the cladding to reflect a pre-determined portion of the laterally-emitted light back into the core. As is best shown in Fig. 11, each pipe 76, 78, 80 has an oval cross section oriented to optimally concentrate the lateral emission of light.

A light pipe of the type described above is commonly referred to as an "optic." Optics that include cladding to disperse light laterally are commonly referred to as "side-light" or "side-fire" optics. This type of optical pipe is described in United States patent number 4,957,347 granted September 18, 1990 to Zarian, incorporated herein by reference. Side-light optical pipes are available from Lumenyte Corporation.

To provide controlled distribution of light, each pipe 76, 78, 80 also includes angled cuts 90 disposed along its length as shown in Fig. 10. The cuts 90 create discontinuities in the pipes 76, 78, 80 that increase the amount of light emitted laterally. The cuts 90 have depths, angles & spacing optimized for even

light distribution from along the length of each pipe 76, 78, 80. Side-light optical pipes with cuts or interruptions fabricated into the optic are available from Lumenyte Corporation under the trade name LUMENYTE® STARBURST™ OPTIC.

5 A plurality of mounting clips or hanger devices, shown at 92 in Figs. 4, 5, 6, 7 and 14, extend from the lamp housing 52 to support the light pipes 76, 78, 80 at spaced locations along their lengths and to hold the pipes 76, 78, 80 a predetermined distance from the inner reflective concave surface of the lamp housing 52. As is best shown in Fig. 14, the mounting clips are split-ring force-fit
10 snap-engagement mounting clips. Other embodiments may use other means to support the light pipes 76, 78, 80 such as wire or plastic slings.

 The light fixture 42 also includes an elongated translucent segmented fluted lens, shown at 98 in Figs. 1, 2, 4, 5, 6 and 7. Each of five fluted lens segments 98A, 98B, 98C is formed as a U-shaped channel. The lens segments
15 98A, 98B, 98C, 98D, 98D' are each supported on one of the face panels 44, 46, 48, 50, 50' between a light pipe 76, 78, 80 and the seating area 38. Each lens segment 98A, 98B, 98C, 98D, 98D' brackets and covers a U-shaped lamp housing segment 52A, 52B, 52C to form an enclosed elongated light pipe housing segment with open ends. As shown in Figs. 8 and 9, end fittings 102 are installed in the open
20 ends of each pipe housing segment. The end fittings 102 include holes to allow light pipe passage as is described in detail below. A forward lens segment 98A covers the forward lamp housing segment 52A, a center lens segment 98B covers the center lamp housing segment 52B, an aft lens segment 98C cover the aft lamp housing segment 52C a forward access lens segment 98D covers the forward access
25 lamp housing segment and an aft access lens segment 98D' covers the aft access lamp housing segment. When the face panels 44, 46, 48, 50, 50' are installed and connected together, the pipe housing segments are aligned and joined together into a single dust-resistant light pipe housing that runs the length of the passenger compartment 24.

30 Two coupler means, generally indicated at 100 in Figs. 8 and 9, are

supported at spaced locations along the lamp housing 52 and within the segmented pipe housing to slidably support the optically coupled ends 84, 86, 88 of the light pipes 76, 78, 80. One coupler means 100 is disposed at each location where two light pipe ends 84, 86, 88 are optically coupled. Therefore, each coupler means 100
5 slidably supports two optically-coupled light pipe ends 84, 86, 88 and maintains them in longitudinal optical alignment. Each coupler means 100 facilitates optical light transmission between the light pipes 76, 78, 80 while allowing the light pipes 76, 78, 80 to expand and contract longitudinally.

As shown in Fig. 9, each coupler means includes two face panel end fittings 102. Each face panel end fitting 102 is fixed at the end of a pipe housing
10 section between a lamp housing segment 52A, 52B, 52C and its attached lens segment 98A, 98B, 98C. The end fittings 102 are shaped to fit into the cross-sectional area between the lamp housing 52 and fluted lens 98. The end fittings 102 may be fixed in place by glue or any other suitable fastening means.

15 A tubular receptacle 104 extends longitudinally through each face panel end fitting 102. The tubular receptacles 104 are shaped to receive the ends 84, 86, 88 of the light pipes 76, 78, 80. As shown in Fig. 9, each end fitting 102 includes either a male or a female tubular receptacle 104 to allow adjacent lamp housing segments 52A, 52B, 52C to slide together and telescopically interconnect.

20 An o-ring seal 108 is seated within each tubular receptacle 104. Each o-ring seal 108 slidably and sealingly encircles one of the optically-coupled light pipe ends 84, 86, 88. The seals 108 keep the space between the optically-coupled light pipes 76, 78, 80 free of dust, insects and other contaminants that would otherwise inhibit light transmission.

25 Second, third, fourth, and fifth embodiments of the lighting system are generally indicated at 20a, 20b, 20c, and 20f in Figs. 5, 6, 7 and 16 respectively. Reference numerals with the suffix "a" in Fig. 5, "b" in Fig. 6, "c" in Fig. 7 and "f" in Fig. 16 designate alternative configurations of each element common to the first embodiment described above. Unless otherwise indicated, we intend the
30 description of elements in the first embodiment to apply equally to elements in the

second, third, fourth and fifth embodiments that carry the same reference numerals, but with suffixes "a", "b", "c" or "f".

The second embodiment of the invention includes a plurality of elongated air duct extension panels, generally indicated at 114 in Fig. 5. The extension panels 114 space the face panels 44a, 46a, 48a, 50a, 50a' farther from the passenger compartment side walls 26a to increase the cross-sectional area of the air duct 68a they enclose. As with the face panels, each extension panel 114 is made as a pultrusion from opaque resin and glass fibers to have an elongated shape of a uniform cross-section along its length.

Each extension panel 114 has an elongated groove 118 extending along its outer edge. Where, as in Fig. 5, a vehicle duct panel 70 is installed in the cornice area of the vehicle 22, the elongated groove 118 of each extension panel 114 engages an elongated duct receptacle 116 formed along the lower edge of the vehicle duct panel 70. In applications where no vehicle duct panel 70 is installed, the outer edge fastens or hooks into a side wall receptacle located just above the side windows 34.

An elongated, upwardly-curved roll-in hook 120 is formed along the inner edge of each extension panel 114. An elongated vertical fin 122 extends upward from along the inner edge of each extension panel 114 adjacent the hook 120. A support strap 124 connects to each vertical fin 122 and extends upward to connect to the vehicle duct panel 70 or vehicle ceiling 40.

An elongated angled fin 126 extends upwardly and outwardly from along the inner edge of each extension panel 114 adjacent the hook 120. Each angled fin 126 runs parallel to each corresponding vertical fin 122 defining a wiring harness raceway 128.

The face panels 44a, 46a, 48a, 50a, 50'a in the second embodiment are identical to those in the first embodiment, but are installed differently. To install each face panel 44, 46, 48, 50, 50' according to the second embodiment, an installer first installs the air duct extension panels 114. The installer then hooks the downwardly-curved roll-in hook 73 of each face panel 44, 46, 48, 50, 50' over the

upwardly-curved roll-in hook 120 of each duct extension panel 114. In this way, each face panel pivotally engages the inner edge of a duct extension panel 114. The installer then pivots each face panel 44, 46, 48, 50, 50' upward until its top edge contacts the upper edge of the vehicle duct panel 70. As shown in Figs. 5 and 13, cylindrical sockets 112 are attached along the upper edge of the vehicle duct panel 70. As is also shown in Figs. 5 and 13, at least one latch in the form of a mounting pin 110 is attached to the upper edge of each panel 44, 46, 48, 50, 50' so as to align axially with the cylindrical sockets 112 when each panel 44, 46, 48, 50, 50' is pivoted upward into contact with the vehicle duct panel 70. After pivoting each individual panel upwards, the installer slides each panel 44, 46, 48, 50, 50' laterally so that each of the mounting pins 110 slide into one of the cylindrical sockets 112. The latch need not be in the form of a mounting pin 110, but may be of any configuration that allows an installer to laterally slide each panel 44, 46, 48, 50, 50' into engagement with the vehicle duct panel 70.

The third embodiment of the lighting system 20 shown at 20b in Fig. 6 includes a segmented lamp housing 52b disposed along the top edge of each display panel 54b. The fourth embodiment of the lighting system 20 shown at 20c in Fig. 7 includes a lamp housing 52c' disposed along both the top and bottom edges of each display panel 54c.

The fourth embodiment shown in Fig. 7 uses four light sources 74c instead of two. In this embodiment, two of the four light sources 74c are mounted adjacent the forward bulkhead 28 and the other two light sources 74c are mounted adjacent the aft bulkhead 30.

Figs. 11 and 12 depict an alternative embodiment of the face panels 44, 46, 48, 50, 50' and the segmented lamp housing 52 at 44e, and 52e, respectively. Reference numerals with the suffix "e" in Figs. 11 and 12 designate the alternative configuration of each element common to the first embodiment. Unless indicated otherwise, where reference numerals appear in the description of the first embodiment without a suffix, we intend the description to apply equally to elements in Figs. 11 and 12 indicated by the same reference numeral, but with the

suffix "e".

Figs. 11 and 12 depict an alternative segmented lamp housing 52e with three lamp housing segments representatively indicated at 52Ae. The lamp housing segments are formed separately and attached to their corresponding face panels, representatively indicated at 44. Figs. 11 and 12 show one end of a single exemplary lamp housing segment 52Ae. Each lamp housing segment 52Ae is supported in one of the face panels 44e to pivot about a longitudinal axis. An indexing means 57 is operatively connected between each lamp housing segment 52Ae and the face panel 44e it is mounted on. The indexing means 57 allows an installer to incrementally adjust the direction that each lamp housing segment 52Ae will reflect light into the passenger compartment 24.

The indexing means 57 includes an indexing plate 58 that is fixed to one or both ends of each lamp housing segment 52Ae and pivots with each lamp housing segment 52Ae on a pivot pin 60. The pivot pin 60 extends inward from the face panel 44e. The indexing plate 58 includes a plurality of plate holes 62 and the face panel 44e includes a single indexing hole 64 radially aligned with the plate holes 62 about the pivot pin 60. An indexing pin 66 or bolt is insertable through the indexing hole 64 and any one of the plate holes 62. To change the pivotal position of a lamp housing segment 52Ae, an installer need only remove the indexing pin 66, rotate the lamp housing segment 52Ae and indexing plate 58 until a different plate hole 62 aligns with the indexing hole 64, then insert the indexing pin 66 to lock the indexing plate 58 and lamp housing segment 52Ae against pivoting relative to its associated face panel 44e.

Also in Fig. 11, an alternative structure for supporting the light pipes is representatively shown relative to segment 52Ae of the segmented lamp housing 52e and light pipe segment 76e. Instead of using the split-ring clips for support, light pipe segment 76e includes an elongated mounting fin 94 that integrally and laterally extends from along the length of the light pipe segment 76e. The mounting fins 94 each engage an elongated lamp-support panel 95 centrally disposed along the lamp housing segment 52Ae. Because the mounting fins 94

extend toward the lamp housing segment 52Ae, they are able to support light pipe segment 76e without interrupting lateral light emissions from the light pipe segment 76e into the seating area 38. The mounting fin 94 and its respective light pipe segment 76e are formed as a single unitary piece.

5 The mounting fin 94 has a uniform cross section along its length and includes an elongated stem 182 that extends radially outward from along the length of the light pipe segment 76e. The stem 182 has a uniform width extending between first and second parallel opposite sides. First and second elongated fin engagement surfaces 184, 186 extend laterally outward from along the respective
10 first and second sides of the stem 182. The fin engagement surfaces 184, 186 run longitudinally parallel to the light pipe segment 76e.

To accommodate the fin 94, the lamp-support panel portion 95 comprises first and second elongated panel engagement surfaces 188, 190. The panel engagement surfaces 188, 190 are disposed in a coplanar spaced-apart parallel
15 relationship to form an elongated slot 200 longitudinally disposed along the lamp-support panel portion 95. The slot 200 has a uniform slot width slightly greater than the fin stem width. The panel engagement surfaces 188, 190 face away from the light pipe segment 76e and engage the fin engagement surfaces 184, 186 in a parallel and flush disposition along their respective lengths. This arrangement
20 supports each light pipe segment 76e in an optimal position to direct light into the passenger seating area 38.

In other embodiments, there may be only one rather than two engagement surfaces. The engagement surfaces 184, 186 may be disposed on one or more nubs or other such protrusions extending laterally outward from along the
25 length of the stem 182. The engagement surfaces may alternatively be disposed on one or more depressions formed into the stem 182. The protrusions and depressions may be of any shape capable of supporting the light pipe segment 76e by engaging corresponding engagement surfaces 188, 190 in the lamp-support panel 95.

The fin 94 may have a T-shaped cross-section, as representatively shown in Fig. 11 in relation to lamp housing segment 52Ae and light pipe segment 76e. The T-shaped cross section of the fin 94 allows the fin to slide longitudinally into an elongated longitudinally-extending T-shaped channel 96 formed into the concave inner surface of the lamp-support panel portion 95 of the lamp housing segment 52Ae. The T arrangement is primarily intended for mounting multiple, relatively-short, optically-coupled light pipe segments in lamp segments. Fins on longer light pipe segments would be difficult to slide into such channels 96 due to the amount of friction that would generally be caused when a relatively large amount of fin engagement surface area would contact a relatively large amount of panel engagement surface area.

In practice, the light pipe mounting fin 94 of Fig. 11 is slid end-first and lengthwise into an installed position in the elongated slot 96 with the fin stem 182 disposed between the first 188 and second 190 panel engagement surfaces. In the installed position, the fin engagement surfaces 184, 186 are disposed above the panel engagement surfaces 188, 190 and the light pipe segment 76e is suspended below the slot 200. Lamp housing segment 52Ae of fixture 42e is then installed in a longitudinal disposition in the vehicle passenger compartment 24 above the seating area 38 and the light pipe section 76e is optically coupled to the light source 74. Alternatively, the light fixture 42e may be installed before inserting the light pipe mounting fin 94.

Rather than having a T-shaped cross-section, the fin may have a "Christmas tree"-shaped cross-section, as representatively shown at 94' in Figs. 22 and 23 in relation to lamp housing segment 52A' and light pipe segment 76'. This type of fin 94' is designed to "snap-in" rather than "slide-in" to the slot 200' in a lamp-support panel portion 95' of the lamp housing segment 52A'. This "snap-in" version of the fin 94' includes an elongated apex 202 disposed along the top edge of the stem 182'. A plurality of elongated ramp surfaces 204, 206 taper outward and downward from along the apex 202 and the stem 182' to an outer edge of each of a plurality of fin engagement surfaces 184', 186', forming a plurality of elongated

barbs 208, 210. The elongated barbs 208, 210 allow the fin 94' to be force-fit into a snap-in-type engagement along its length into the slot 200'. This "snap-in" fin configuration 94' is intended for mounting longer light pipe segments 76', that would encounter significant frictional resistance along their lengths if they were slid end-first into a track 96'. The fin 94' may include only one pair of barbs 208, 210.

In practice, the "snap-in" version of the light pipe mounting fin 94' is forced apex-first rather than end-first into the elongated slot 200'. This causes the elongated barbs 208, 210 to first compress inward against the elongated stem 182' and then to snap back outward after passing through the slot 200' into an installed position as shown in Fig. 25. In the installed position, the fin stem 182' is disposed between the first 188' and second 190' panel engagement surfaces, at least two opposing barbs 208, 210 are disposed above the panel engagement surfaces 188', 190' and the light pipe section 76' is suspended below the slot 200'. The lamp housing section 52A' and light fixture 42' are then installed in a longitudinal disposition in the vehicle passenger compartment 24 above the seating area 38, and the light pipe section 76' is optically coupled to the light source 74. The lamp housing section 52A' and light fixture 42' may, alternatively, be installed prior to inserting the light pipe mounting fin 94' into the slot 200'.

The slide-in or snap-in light pipe installation features may be included in any of the lamp housings in any of the light fixture embodiments described in this specification. Any of the lamp housing embodiments that this specification describes may be modified to include an elongated slot 200 for receiving a light pipe mounting fin 94, 94' in either a slide-in or a snap-in engagement.

Four additional light pipe mounting clip or hanger device embodiments are generally indicated at 220, 220x, 220y, 220z in Figures 24-31, respectively. The additional hanger device embodiments are representatively shown relative to segment 52Ae of the segmented lamp housing 52e of light fixture 42, and also relative to light pipe segment 76e. Reference numerals with the suffix "x" in Figures 25 and 26, the suffix "y" in Figures 27 and 28 and the suffix "z" in

Figures 29-31 designate the alternative configuration of each element common to the embodiment of Figure 24. Unless the description indicates otherwise, where the description uses a reference numeral to refer to an element in Figure 24, I intend that portion of the description to apply equally to elements in Figures 25-31 indicated by the same reference numeral with the suffix "x", "y" or "z", respectively.

As with the hanger device 92 shown in Fig. 14, a plurality of the hanger devices 220, 220x, 220y, 220z are used to suspend a light pipe 76e. The hanger devices 220, 220x, 220y, 220z are configured to suspend a light pipe 76e from a supporting structure such as the lamp-support panel 52Ae or reflector panel in, for example, the light fixture 42 described above. Each hanger device 220, 220x, 220y, 220z includes a strip or band 222 of resilient material formed to include a lower hoop 224 and a connector comprising an upper probe portion 226.

The lower hoop 224 is configured to wrap around the circumference of the light pipe 76e to be suspended. The lower hoop 224 shown in the drawings is semi-circular but may, in other embodiments, be other shapes that may or may not complement various light pipe cross-sectional shapes.

The upper probe portion 226 is configured to fasten the hanger device 220, 220x, 220y, 220z to the lamp-support panel 52Ae. The upper probe portion 226 is configured to engage one of a plurality of corresponding openings such as hanger receptacles 228 in the lamp-support panel 52Ae. The upper probe portions 226 thus suspend the remainder of the hanger devices 220, 220x, 220y, 220z and the light pipe 76e from the lamp-support panel 52Ae.

The lower hoop 224 and the upper probe portion 226 of each hanger device 220, 220x, 220y, 220z are formed from metal or plastic as a single unitary piece. When formed from metal the hanger devices 220, 220x, 220y, 220z may each comprise a single strip of spring steel that has been bent to form the lower hoop 224 and upper probe portions 226. When formed from plastic the hanger devices 220, 220x, 220y, 220z may be injection molded. The hanger devices 220, 220x, 220y, 220z may also comprise a plastic material that is at least translucent

and that may be transparent. The use of translucent or transparent material reduces the amount of light that the hanger devices 220, 220x, 220y, 220z will block as the light radiates from a side-fire light pipe 76e passing through the hanger devices 220, 220x, 220y, 220z.

- 5 Each hanger device 220, 220x, 220y, 220z is configured to allow its upper probe portion 226 to compress sufficiently to pass upward through a hanger receptacle 228 and then to spring back toward a relaxed shape or configuration after passing through the hanger receptacle 228. When relaxed, the shape of the probe portion 226 of the connector device allows the probe portion 226 to engage a
- 10 portion of an upper surface 230 of the lamp-support panel 52Ae and/or a rim 232 that defines the hanger receptacle 228. The relaxed shape of the probe portion 226 also resists being pulled back downward through the hanger receptacle 228.

- In the hanger device 220, 220x, 220y, 220z embodiment shown in Figure 24 the upper probe portion 226 comprises an arcuate lobe 234. The arcuate lobe
- 15 234 and lower hoop 224 together form a closed arcuate band 222 having a peanut-shaped outline. In other words, the band 222 has the general shape of a pair of opposing lobes integrally merging at a pinched region 236. The arcuate lobe 234 is broader than the hanger receptacle 228 in the lamp-support panel 52Ae but is
- 20 laterally compressible to a small enough size to fit through the hanger receptacle 228. The lobe 234 may be compressed to this extent by forcing it upward through a hanger receptacle 228. In addition, or as an alternative, the arcuate lobe 234 may be laterally compressed by squeezing the lower hoop 224. Because the lower hoop
- 25 224 and arcuate lobe 234 are formed as a single unitary piece or band 222, squeezing or laterally compressing the lower hoop 224 will also cause the arcuate lobe 234 to laterally compress.

- In the embodiment shown in Figures 25 and 26, the lower hoop 224x includes a circumferential gap 238 configured to receive the light pipe 76e in snap-in engagement. The gapped hoop 224x has an inverted "U" shape with the distal ends of the "U" splayed outward to facilitate light pipe insertion. The gap
- 30 238 extends from an approximate four o'clock position to an approximate eight

o'clock position of the lower hoop 224x.

As shown in Figures 25 and 26 the upper probe portion 226x of this hanger device embodiment 220x comprises a mounting fin generally indicated at 240. The mounting fin 240 includes a stem 242 having a rectangular cross-section and extending integrally upward from the lower hoop 224x of the hanger device 220. The stem 242 is disposable within the hanger receptacle 228 in the lamp-support panel 52Ae.

The mounting fin 240 additionally includes first and second lower engagement surfaces 244 disposed adjacent the stem 242 and on laterally opposite sides of the stem 242. The engagement surfaces 244 are configured to engage the upper surface 230 of the lamp-support panel 52Ae once the mounting fin 240 has been pushed through the hanger receptacle 228 and to thereby suspend the light pipe 76e below the lamp-support panel 52Ae.

The fin 240 also includes an apex that defines a fin upper edge 246. A pair of ramp surfaces 248 taper outward and downward from the apex 246 to an outer edge of each of the fin engagement surfaces 244 to form the top surfaces of a pair of barbs 250.

The stem 242 is narrower than the hanger receptacle 228 by an amount sufficient to allow the barbs 250 to fit through the hanger receptacle 228 together with the stem 242 by folding downward against the stem 242. The barbs 250 are forced to fold downward against the stem 242 when the barbs 250 are pushed through the hanger receptacle 228. The barbs 250 are sufficiently resilient to spring outward or "deploy" once the fin 240 is through the hanger receptacle 228 and the receptacle rim 232 is no longer constraining the barbs 250. The barbs 250 deploy into a position where the engagement surfaces 244 engage the upper surface 230 of the lamp-support panel 52Ae as shown in Figure 26. In other words, the barbs 250 are configured so that they cannot easily be drawn back down through the hanger receptacle 228 from the deployed position.

As is representatively shown in Figures 25 and 26 for a single hanger device, a plurality of the hanger devices 220x may be used to install a

light pipe 76e in a light fixture 42 by first inserting the upper edges 246 of the hanger device fins 240 upward into corresponding ones of the hanger receptacles 228 in the lamp-support panel 52Ae. The fin upper edges 246 are inserted such that the fin ramp surfaces 248 engage the rims 232 that define the hanger receptacles 228 in the lamp-support panel 52Ae. The fins 240 are then forced through the hanger receptacles 228.

As each fin 240 passes through its corresponding hanger receptacle 228, it contacts the rim 232 as shown in Figure 25. Continued upward motion of the fin 240 through the receptacle 228 then causes the elongated barbs 250 to fold or compress inward against the stem 242 of the fin 240. Once the barbs 250 have passed through the hanger receptacle 228 they spring back outward and spread-out across the hanger receptacle 228 with the fin engagement surfaces 244 resting on the upper surface 230 of the lamp-support panel 52Ae as shown in Figure 26.

Finally, a light pipe 76e is snapped into the lower hoop 224x of each hanger device 220x by pushing the light pipe 76e sideways through the gap 238 in the lower hoop 224x of each hanger device 220x. As the light pipe 76e passes through each hoop 224x, it causes each hoop 224x to expand. Once the light pipe 76e has passed completely through each hoop 224x, each hoop 224x contracts or "snaps-back" around and grips the light pipe 76e as shown in Figure 26. Alternatively, the light pipe 76e may be snapped into place through the gaps 238 in the lower hoops 224x of the hanger devices 220x before pushing the fins 240 through the hanger receptacles 228.

In the embodiment shown in Figures 27 and 28, opposite ends 252 of the band 222y are drawn together and crossed to form the lower hoop 224y. The upper probe portion 226y comprises opposite terminal lengths or prongs 254 of the band 222y. The prongs 254 extend diagonally upward and outward from a cross point 256 where the two prongs 254 cross each other. Each prong 254 additionally includes an engagement surface 256 that is configured to engage the upper surface 230 of the lamp-support panel 52Ae and/or the rim 232 when the upper probe

portion 226y has been moved through the hanger receptacle 228 in the lamp-support panel 52Ae.

As shown in Figure 28, the band 222y has a relaxed state or configuration in which the prongs 254 are crossed and the distance between the
5 crossed ends 252 of the band 222y is greater than a distance measured across the hanger receptacle 228 between opposing edges of the rim 232. In the relaxed state, the lower hoop 224y has a diameter generally less than or equal to a diameter of the light pipe 76e to be suspended in the hoop 224y. When the diameter of the hoop
10 224y in the relaxed state is smaller than that of the light pipe 76e, it causes the lower hoop 224y to maintain a constricting force around the light pipe 76e when the light pipe 76e is inserted through the hoop 224y.

As is representatively shown in Figures 27 and 28 for a single hanger device 220y, a plurality of the hanger devices 220y may be used to install a light pipe 76e in a light fixture 42 by first expanding the lower hoop 224y of each
15 hanger device 220y such that the upper ends 252 of the probe prongs 254 of each device move close enough together to pass into respective hanger receptacles 228 in the lamp-support panel 52Ae. The upper ends 252 of the probe prongs 254 of each hanger device 220y are then passed through their respective hanger receptacles 228.

Once the probe prongs 254 have been pushed completely through their respective
20 hanger receptacles 228, the lower hoops 224y of the hanger devices 220y are allowed to contract back toward the pre-expanded or relaxed position or configuration shown in Figure 28. In the relaxed configuration shown in Figure 28, the upper ends 252 of the probe prongs 254 are spread far enough apart to engage opposing sides of the rims 232 defining the hanger receptacles 228 and the lower
25 hoops 224y close around and "grip" the light pipe 76e.

The light pipe 76e may be inserted through the lower hoops 224y either before installing the hanger devices 220y or after installing the hanger devices 220y. In either case, the light pipe 76e is inserted axially through the lower hoops 224y of the hanger devices 220y.

30 When the probe prongs 254 are inserted into the hanger receptacles 228,

they may be inserted only part way through to where the prong ends 252 spread laterally to engage opposite edges of the rim 232 as shown in Figure 27. With the ends 252 of the probe prongs 254 engaging the rim 232 in this manner, the lower hoop is held in an enlarged state or configuration that allows the light pipe 76e to be easily slid through. Once the light pipe 76e has been inserted through the lower hoops 224y of the hanger devices 220y, the prongs 254 of the probes are pushed the rest of the way through their respective hanger receptacles 228. This allows the prongs 254 to spring outward above the hanger receptacles 228 and allows the lower hoops 224y to correspondingly constrict and "grip" the light pipe 76e.

10 In the embodiment shown in Figures 29-31, each prong 254z extends diagonally upward and outward from the cross point to a point where it then forms a detent 258. The detent portion 258 of the prong 254z is configured to positively engage opposite edges of the hanger receptacle rim 232 when the upper probe portion 226z has been moved partially through the hanger receptacle 228. The prongs 254z are laterally inwardly compressible to a compressed position or configuration shown in Figure 30. The compressed position allows the prongs 254z to pass through the hanger receptacle 228.

Each detent 258 comprises a generally vertical intermediate section or portion of one of the prongs 254z. The intermediate section of each prong 254z integrally extends in a generally vertically upward direction from an upper end of a diagonally extending portion 260 of that prong 254z. The intermediate section of each of the prongs 254z is bent or otherwise formed to have a generally arcuate shape. The intermediate sections therefore have respective generally convex or humped surfaces 262 that face inward toward each other and respective generally concave or cupped surfaces 264 that face outward. The outward-facing concave surfaces 264 are configured to engage the opposite edges of the hanger receptacle 228 when the upper probe portion 226z has been moved partially through the hanger receptacle 228.

I intend the word concave, as used in the above paragraph, to describe any configuration that provides an indentation or depression of any shape and depth

sufficient to resist upward and downward movement of the hanger device 220z when the outward-facing concave surface of the intermediate prong 254z sections are engaged with the hanger receptacle rim 232. In other embodiments, the detent 258 may have any one of a number of different configurations capable of engaging
5 opposite edges of a hanger receptacle 228 or other opening in a support structure.

Each prong 254z also includes a diagonally inwardly and upwardly extending upper ramp 266 that integrally extends from an upper end of the intermediate portion of the prong 254z. Each upper ramp 266 has an upper engagement surface configured to aid in guiding the upper probe portion 226z into
10 the hanger receptacle 228 when the prongs 254z are moved toward each other. As shown in Figures 29 and 30, the upper ramp portion 266 of each prong 254z initially presents a small cross section that easily fits into the hanger receptacle 228 as the hanger device 220z is pushed upward. As the hanger device 220z is advanced further upward the ramp portions 266 of the two prongs 254z slide
15 upward past the rim 232 of the hanger receptacle 228, compressing the prongs 254z laterally toward each other.

As is representatively shown in Figures 29-31 for a single hanger device 220z, a plurality of the hanger devices 220z may be used to install a light pipe 76e in a light fixture 42 by first placing the upper engagement surfaces of the
20 ramp portions 266 of each of the prongs 254z in contact with opposing sides of a rim 232 defining a corresponding hanger receptacle 228 in the lamp-support panel 52Ae. Each hanger device 220z is then pushed upward causing the prongs 254z to move inward toward each other as they slide upward along opposing sides of the rim 232. Each hanger device 220z is then pushed further upward until the detent
25 portions 258 of the prongs 254z engage opposing sides of the corresponding rim 232 and the lower hoop 224z is expanded sufficiently to receive the light pipe 76e.

The light pipe 76e is then axially inserted through the expanded lower hoops 224z of the hanger devices 220z. With the light pipe 76e suspended in the lower hoops 224z, the hanger devices 220z are then pushed farther upward until
30 the detent portions 258 of the prongs 254z of each hanger device 220z disengage

from the respective rims 232, move upward through the respective hanger receptacles 228 and splay upward and outward over the lamp-support panel 52Ae as the lower hoops 224z close inward around the light pipe 76e.

5 An alternative coupler means is shown at 100d in Fig. 8. Reference numerals with the suffix "d" in Fig. 8 designate the alternative configuration of each element common to the first embodiment. Unless indicated otherwise, where the description of the first embodiment refers to an element with a reference numeral having no suffix, we intend the description to apply equally to elements in Fig. 8 indicated by the same reference numeral, but with the suffix "d".

10 In the alternative embodiment depicted in Fig. 8, the coupling means 100d includes a cylindrical clamp member 106. The clamp member 106 surrounds the tubular receptacles 104d of adjacent end fittings 102d and binds them end-to-end. In this alternative embodiment, the end fittings 102d are identical to one another and the tubular receptacles 104d are longer than in the first
15 embodiment.

The fifth embodiment of the invention includes a plurality of light fixtures of like construction which are representatively illustrated by the single light fixture generally indicated at 42f in Fig. 16. The lighting fixture 20f of the fifth embodiment is similar in most respects to that of the second embodiment described
20 above with several exceptions, e.g., the fifth embodiment is adapted to accommodate either fluorescent lamps or fiber optic light pipes.

The representative lighting fixture 20f is mounted in the cornice area of the vehicle above the seating area 38 and includes a representative face panel, generally indicated at 44f in Fig. 16. The face panel 44f includes an upper edge 130
25 adapted to connect to the vehicle ceiling 40. As with the second embodiment, the light fixture 42f encloses and defines a portion of an elongated air duct 68f and includes an air duct extension panel, generally indicated at 114f in Fig. 16. The air duct extension panel 114f is adapted to mount between the vehicle side wall 26f and the face panel 42f to space the face panel 42f from the side wall 26f. The air
30 duct extension panel 114f has an inner edge 132 adapted to connect to a lower edge

136 of the face panel 42f, and an outer edge 134 adapted to connect to the vehicle side wall 26f.

5 The face panel 42f and duct extension panel 114f are each pultruded as unitary members from resin and glass fibers so as to have elongated shapes with uniform cross sections along their respective lengths. A lamp housing, generally indicated at 52f in Fig. 16, is integrally formed as a unitary piece with the face panel 42f and is disposed adjacent and generally parallel to the face panel lower edge 136.

10 The lamp housing 52f includes an elongated concave portion 138 that opens in the direction that the fixture will provide light to the seating area 38. The lamp housing 52f is disposed adjacent and generally parallel to the face panel lower edge 136 and the duct extension panel inner edge 132. This allows the lamp housing 52f to project light from a position spaced laterally from the side windows 34f and vertically from the ceiling 40. Because the lamp housing 52f is spaced
15 from the windows 34f, its position minimizes side window illumination and reflective glare. Because the lamp housing 52f is spaced from the ceiling 40, its position is closer to the seating area 38 thus maximizing seating area illumination and reducing the amount of light dispersed into the aisle 36 and other portions of the passenger compartment 24.

20 A male pivotal connector member 73f is disposed along the face panel lower edge 136. The male pivotal connector member 73f pivotally connects the face panel 42f to the air duct extension panel 114f. A female pivotal connector member 120f is disposed along the duct extension panel inner edge 132. The female pivotal connector member 120f receives the male pivotal connector member
25 73f in a "roll-in"-type engagement.

A suspension member 124f provides support for the duct extension panel 114f from the vehicle ceiling 40 or other overhead structures. The suspension member 124f has a lower end that connects to the duct extension panel 114f adjacent the inner edge 132, and an upper end that connects to the vehicle ceiling 40
30 or structures attached to the ceiling 40.

An elongated lens, generally indicated at 98f in Fig. 16, is supported between the lamp housing 52f and the seating area 38. The lens 98f is formed as a U-shaped channel with first and second laterally opposite lens edges. The first lens edge includes a "roll-in"-type male lens connector member 140. The male lens connector member 140 pivotally mounts the lens 98f to the face panel 42f adjacent the first of two laterally opposite lamp housing edges that border the elongated concave portion 138 of the lamp housing 52f. A female lens connector member, shown at 142 in FIGS. 16-20, is integrally formed in the face panel 42f adjacent the first lamp housing edge. The female pivotal lens-connector member 142 includes a receptacle 144 that receives the male lens connector member 140 in a "roll-in"-type engagement.

A catch 146 is disposed along the second lens edge and has the shape of a laterally-elongated prong. A corresponding detent 148 is integrally formed in the face panel 42f adjacent the second housing edge and receives the catch 146 in a "snap-fit"-type engagement. This allows the lens 98f to be snapped into a closed position over the lamp housing concave portion 138.

The "roll-in" lens connector members 140, 142 and "snap-fit" catch 146 and detent 148 arrangement help prevent dust from entering the lamp housing 52f. The male lens connector member 140 has the shape of a laterally-elongated hook. Moreover, the snap connection between the catch 146 and the detent 148 is dust-resistant. The "roll-in" lens connector members 140, 142 and "snap-fit" catch 146 and detent 148 arrangement help prevent dust from entering the lamp housing 52f along either of the laterally opposite lens edges. A line-contact may be formed between the lens connector members 140, 142 to further reduce dust intrusion. The line contact may be provided along a line where the lip of the female pivotal lens-connector member 142 contacts the male connector member 140. Alternatively, the line contact may be provided along a line where the lip of the male connector member 140 contacts the female connector member 142.

An upper advertising card holder 152, comprising a grooved border, extends integrally outward from the face panel 42f. The upper advertising card

holder 152 lies adjacent and parallel to the face panel upper edge 130. A lower advertising card holder 154 similarly includes a grooved border that lies adjacent and parallel to the face panel lower edge 136 and in opposition to the grooved border of the upper advertising card holder 152. The upper 152 and lower 154
5 advertising card holders are positioned to hold an advertising card between them.

An upper mounting flange 156 is formed adjacent the face panel upper edge 130. The mounting flange 156 includes fastener openings that receive fasteners to connect the face panel 42f to the ceiling 40. The fastener openings are located between the upper 152 and lower 154 advertising card holders so that a card
10 installed between the advertising card holders 152, 154 will cover the fastener openings 158 and provide a more aesthetically-pleasing appearance. As shown in Fig. 16, the mounting flange 156 is formed into a channel shape with a triangular cross-section. The mounting flange 156, or mounting "channel", has a channel lower wall 160 that lies flush with the face panel 42f and a channel upper wall 162
15 designed to contact the vehicle ceiling 40. The mounting channel 156 includes two types of fastener openings: a series of spaced interior fastener holes 164 and an exterior fastener access slot 166. The fastener access slot 166 extends through the mounting channel lower wall 160 and provides tool and fastener access to the mounting channel interior. The interior fastener holes 164 extend through the
20 mounting channel upper wall 162 and receive and engage the fasteners as they are installed through the mounting channel 156 and into the vehicle ceiling 40.

For vehicle applications that do not use advertising cards, a plug strip may be provided to fill the fastener slot 166. The plug strip 168 may be snap-fit, glued in place or fastened by any other suitable method.

25 The face panel 42f has a panel back surface and the lamp housing 52f has a housing back surface that each face upward toward the vehicle ceiling 40 following installation. A first elongated retainer tab 170 integrally extends longitudinally along the entire length of the lamp housing 52f and laterally from the housing back surface toward the panel back surface. A second elongated retainer
30 tab 172 integrally extends longitudinally along the entire length of the face panel

42f and laterally from the panel back surface toward the first retainer tab 170. The first 170 and second 172 retainer tabs cooperate with the lamp housing 52f and face panel 42f back surfaces to partially enclose and define a wiring harness raceway 174. The retainer tabs 170, 172 laterally extend toward one another leaving a longitudinal slot that runs between them along their entire lengths. The slot provides an elongated access opening for an installer to push wires or wire bundles through and into the raceway as shown at 180 in Fig. 16.

The fixture includes at least one end cap, generally indicated at 176 in Fig. 16, mounted within the lamp housing concave portion 138. The end cap 176 has peripheral edges that engage the lamp housing concave portion 138 and the light cover. The end cap 176 also includes a through-hole 178 shaped to receive a fluorescent bulb socket.

Possible variations on the fifth embodiment of the present invention include a light fixture 42f with a female lens roll-in connector member 142 that is integrally formed in a portion of the lamp housing 52f rather than the face panel 44f so that the male lens connector member 140 may mount to a portion of the lamp housing 52f adjacent and parallel to the first lamp housing edge instead of to the face panel 44f. Also, the "snap-in" lens attachment detent 148 may be integrally formed in or attached to the lamp housing 52f rather than the face panel 44f.

In another possible variation on the fifth embodiment, the end cap 176 may include a through-hole shaped to receive a light pipe rather than a fluorescent bulb socket. Where light pipes are optically-coupled to one another and are supported end-to-end through a series of adjacent lighting fixtures, the end cap 176 may also comprise a portion of a coupler adapted to slidably support the optically-coupled ends of two adjacent light pipes. Examples of couplers of this type are shown at 100d and 100 in Figs. 8 and 9, respectively. To support the light pipe at spaced locations along its length, a plurality of mounting clips or holes for receiving mounting clips may be included in the lamp housing 52f. An example of such a mounting clip is shown at 92 in Fig. 14.

In another variation on the fifth embodiment, the face panel 44f is modified for use without a duct extension panel 114f. For attachment directly to a vehicle side wall 26f or other associated structures, the face panel 44f may be modified at its lower edge as shown at 136g, 136h, 136i in Figs. 17, 18 and 19, respectively. The upper edge 130 may also be modified as shown in Fig. 18. Figs. 17, 18 and 19 show different upper 130 and lower 136 edge configurations suited to particular vehicle applications. Other combinations of the upper 130 and lower 136 edges shown in Figs. 16, 17, 18, 19 may be used to adapt a face panel 44 to fit various vehicle interior configurations. For example, the upper edge 130h shown in Fig. 18 may be included on the face panel 44f of Fig. 16.

In still another possible variation on the fifth embodiment, each lamp housing 52f is integrally formed as a unitary piece with a duct extension panel 114f instead of a face panel 42f. A light fixture constructed according to this variation on the fifth embodiment is shown at 42j in Fig. 21. As shown in Fig. 21, each elongated lamp housing 52j is pultruded along with an air duct extension panel 114j as a single unitary piece. Each lamp housing 52j is formed in a position adjacent and generally parallel to the air duct extension panel inner edge 132j. Also according to this variation, each face panel 44j is rotatably and detachably connected to a corresponding duct extension panel inner edge 132j along the face panel lower edge 136j to allow the face panel 44j to be removed without removing the lamp housing 52j. Alternatively, each face panel 44j may be rotatably connected to a corresponding duct extension panel inner edge 132j without being readily detachable. According to this alternative construction, the face panel 44j could be rotated downward to gain access to the area above the light fixture 42j without being disconnected from the duct extension panel inner edge 132j.

The seam 212j formed where each face panel lower edge 136j and each duct extension panel inner edge 132j meet is disposed between upper 152j and lower 154j advertising card holders. In this position, an advertising card positioned between the holders 152j, 154j will hide the seam 212j between each interconnected face panel 44j and duct extension panel 114j.

According to this variation of the fifth embodiment, the upper mounting flange 156j of each face panel 44j and the outer edge mounting flange 214j of each duct extension panel 114j are formed as shown in Fig. 21. Alternatively, the upper mounting flanges 156j and outer edge mounting flanges 214j may be formed in any one of a number of different configurations adapted to conform to the ceiling and wall configurations of various mass transit vehicle passenger compartments.

Reference numerals with the suffix "g" in Fig. 17, "h" in Fig. 18, "i" in Fig. 19 and "j" in Fig. 21 designate alternative configurations of each element common to the fifth embodiment described above. Unless otherwise indicated, we intend the description of elements in the fifth embodiment to apply equally to elements shown in Figs. 17, 18, 19 and 21 that carry the same reference numerals, but with suffixes "g", "h", "i" or "j".

This is an illustrative description of the invention using words of description rather than of limitation. Obviously, many modifications and variations of this invention are possible in light of the above teachings. Within the scope of the claims, one may practice the invention other than as described.



We claim:

1. A fiber optic lighting system comprising:

5 a light fixture including an elongated lamp-support panel having a length, an upper surface, a lower surface opposite said upper surface, and a thickness extending between said upper and lower surfaces;

an elongated slot extending through said thickness of said lamp-support panel and extending longitudinally along said length of said lamp-support panel between two slot ends;

10 an elongated side-fire light pipe having a light pipe length extending between two light pipe ends, said light pipe disposed adjacent and generally parallel to said lamp-support panel lower surface; and

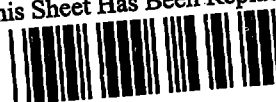
an elongated mounting fin comprising an elongated stem integrally extending from along said light pipe length between said light pipe ends, said
15 elongated stem disposed within and along said longitudinal slot in said lamp-support panel, said mounting fin additionally comprising a first engagement surface disposed adjacent said stem, said first engagement surface engaging said light fixture upper surface to suspend said light pipe below said lamp-support panel without blocking light emitted from said light pipe in a direction away from said
20 lamp-support panel.

2. A lighting system as defined in claim 1 wherein said mounting fin and said light pipe are a single unitary piece.

25 3. A lighting system as defined in claim 1 wherein said fin includes a second engagement surface extending laterally outward from said stem in a direction generally opposite to that of said first engagement surface.

30 4. A lighting system as defined in claim 3 wherein said first and second engagement surfaces are elongated and extend from along said length of

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said stem and parallel to said light pipe.

5. In a mass-transit vehicle having a passenger compartment with side windows, an aisle extending along the longitudinal axis of the vehicle and a passenger seating area on one side of the aisle, a lighting system for preferentially illuminating the seating area and minimizing the illumination of the aisle and side windows, said lighting system comprising:

a light fixture including an elongated lamp housing longitudinally disposed in the passenger compartment above the seating area for preferentially directing light into the seating area;

a light source mounted in the vehicle adjacent said passenger compartment;

an elongated light pipe having an input end optically coupled to said light source to receive light therefrom, said light pipe extending from said light source into the passenger compartment and longitudinally extending above the seating area adjacent said lamp housing, said light pipe being adapted to conduct light along its length while laterally emitting light from along its length into the passenger compartment; and

an elongated mounting fin integrally and laterally extending from along said length of said light pipe to an elongated fin upper edge, said mounting fin adapted to engage said light fixture and support said light pipe without blocking light emitted from said light pipe into said seating area.

6. A lighting system as defined in claim 1 wherein said mounting fin and said light pipe are a single unitary piece.

7. A lighting system as defined in claim 1 wherein said mounting fin has a uniform cross section along its length and includes:

an elongated stem extending laterally outward from along said length of said light pipe, said stem having a uniform width extending between first

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and second parallel opposite side walls; and

first and second elongated fin engagement surfaces extending perpendicularly outward from along said respective first and second stem side walls and running longitudinally parallel to and facing said light pipe;

5 and where said light fixture includes:

first and second elongated panel engagement surfaces disposed in a coplanar spaced-apart parallel relationship to form an elongated slot longitudinally disposed along said lamp housing, said slot having a uniform slot width slightly greater than said stem width, said panel engagement surfaces facing away from said
10 light pipe and engaging said fin engagement surfaces in a parallel and flush disposition along their respective lengths.

8. A lighting system as defined in claim 7 wherein said fin includes:

an elongated apex defining said fin upper edge; and

15 a pair of elongated ramp surfaces tapering outward and downward from along said apex to an outer edge of each of said fin engagement surfaces to form a pair of elongated barbs.

9. A lighting system as defined in claim 8 wherein said fin includes a
20 plurality of said elongated barbs.

10. A lighting system as defined in claim 1 wherein said elongated light pipe comprises a solid-core semi-rigid side-light fiber optic.

25 11. A lighting system as defined in claim 10 wherein said light pipe includes angled cuts spaced along its length and where said cuts have depths, angles & spacing optimized for even light distribution from along its length.

12. In a mass-transit vehicle having a passenger compartment with a
30 ceiling, side walls, cornice areas, side windows, an aisle extending along a

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longitudinal axis of the vehicle and a passenger seating area on one side of the aisle, a lighting system for preferentially illuminating the seating area and minimizing the illumination of the aisle and side windows, said lighting system comprising:

5 a lighting fixture mounted in the cornice area above the seating area, said fixture comprising a face panel having an upper edge and a lower edge, said upper edge adapted to be supported by the vehicle ceiling;

said fixture additionally comprising an air duct extension panel adapted to mount between the vehicle side wall and said face panel to space the face panel from the side wall, said air duct extension panel having an inner edge
10 connected to said face panel lower edge, and an outer edge connected to the vehicle side wall; and

an elongated lamp housing fixed to said air duct extension panel in a position adjacent and generally parallel to said air duct extension panel inner edge, said face panel being detachably connected to said duct extension panel inner edge
15 along said face panel lower edge to allow said face panel to be removed without removing said lamp housing.

13. A lighting system as defined in claim 12 wherein said lighting fixture includes an upper advertising card holder disposed adjacent said face panel
20 upper edge and a lower advertising card holder disposed adjacent said face panel lower edge.

14. A lighting system as defined in claim 13 wherein said light fixture includes a seam formed between said face panel lower edge and said duct extension
25 panel inner edge and where said seam is disposed between said upper and lower advertising card holders.

15. A lighting system as defined in claim 12 wherein said lamp housing includes an elongated concave portion opening in the direction that the fixture will
30 provide light.



16. A lighting system as defined in claim 12 wherein said face panel and duct extension panel are each pultruded as unitary members so as to have elongated shapes with uniform cross sections along their respective lengths.

5 17. A lighting system as defined in claim 16 wherein said face panel includes a male pivotal connector flange disposed along said bottom edge, said male pivotal connector flange adapted to pivotally connect said face panel to said air duct extension panel; and where said duct extension panel includes a female
10 pivotal connector flange disposed along said inner edge, said female pivotal connector flange adapted to receive said male pivotal connector flange in a "roll-in"-type engagement.

18. A lighting system as defined in claim 16 wherein said fixture
15 includes a suspension member having a lower end connected to said duct extension panel adjacent said inner edge, said suspension member having an upper end adapted to connect to the vehicle ceiling.

19. A lighting system as defined in claim 16 wherein said light fixture
20 includes an elongated lens supported between said lamp housing and the seating area.

20. A lighting system as defined in claim 16 wherein said face panel
includes a top mounting flange formed adjacent said top edge, and said duct
25 extension panel includes an outer edge mounting flange formed adjacent said outer edge.

21. A lighting system as defined in claim 16 wherein said light fixture
encloses and defines an elongated air duct.



22. In a mass-transit vehicle having a passenger compartment with a ceiling, side walls, cornice areas, side windows, an aisle extending along a longitudinal axis of the vehicle and a passenger seating area on one side of the aisle, a lighting system for preferentially illuminating the seating area and minimizing the illumination of the aisle and side windows, said lighting system comprising:

a lighting fixture mounted in the cornice area above the seating area, said fixture comprising a face panel having an upper edge and a lower edge, said upper edge adapted to be supported by the vehicle ceiling;

said fixture additionally comprising an air duct extension panel adapted to mount between the vehicle side wall and said face panel to space the face panel from the side wall, said air duct extension panel having an inner edge connected to said face panel lower edge, and an outer edge connected to the vehicle side wall; and

an elongated lamp housing fixed to said air duct extension panel in a position adjacent and generally parallel to said air duct extension panel inner edge, said face panel being pivotally connected to said duct extension panel inner edge along said face panel lower edge to allow said face panel to be rotated downward to open said light fixture without removing said lamp housing.

23. A lighting system as defined in claim 22 wherein said lighting fixture includes an upper advertising card holder disposed adjacent said face panel upper edge and a lower advertising card holder disposed adjacent said face panel lower edge.

24. A lighting system as defined in claim 23 wherein said light fixture includes a seam formed between said face panel lower edge and said duct extension panel inner edge and where said seam is disposed between said upper and lower advertising card holders.

25. A method for installing a light pipe in a light fixture, the light



fixture including an elongated lamp-support panel having a length, an upper surface, a lower surface opposite the upper surface, and a thickness extending between the upper and lower surfaces, an elongated slot extending through the thickness of the lamp-support panel and extending longitudinally along the length
5 of the lamp-support panel between two slot ends, an elongated side-fire light pipe having a light pipe length extending between two light pipe ends, an elongated mounting fin comprising an elongated stem integrally extending from along the light pipe length between the light pipe ends, the mounting fin additionally comprising a first engagement surface disposed adjacent the stem; said method
10 including the steps of:

longitudinally inserting the fin stem into one end of the slot; and
sliding the mounting fin longitudinally into an installed position
where the fin stem is disposed within and along the length of the slot, the first
engagement surface of the fin engages the light fixture upper surface and the light
15 pipe is suspended below the lamp-support panel.

26. A method for installing a light pipe in a light fixture, the light fixture including an elongated lamp-support panel having a length, an upper surface, a lower surface opposite the upper surface, and a thickness extending
20 between the upper and lower surfaces, an elongated slot extending through the thickness of the lamp-support panel and extending longitudinally along the length of the lamp-support panel between two slot ends; an elongated side-fire light pipe having a light pipe length extending between two light pipe ends, an elongated mounting fin comprising an elongated stem integrally extending from along the
25 light pipe length between the light pipe ends, the mounting fin further including an elongated apex defining a fin upper edge and a pair of elongated ramp surfaces tapering outward and downward from along the apex to an outer edge of each of two fin engagement surfaces to form elongated barbs; said method including the steps of:

30 laterally inserting the fin upper edge into the slot along the length of

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the slot with the elongated fin ramp surfaces engaging the lower surface of the lamp support panel; and

forcing the light pipe mounting fin into the elongated slot so that the elongated barbs first compress inward against the elongated stem and then snap
5 back outward after passing through the slot to retain the light pipe in an installed position with the fin stem disposed in the slot with the barbs spread-out over and above the slot and the light pipe suspended below the slot.

27. A light pipe hanger device for suspending a light pipe from a
10 supporting structure in, for example, a light fixture; the device comprising:

a band comprising resilient material including a lower hoop configured to wrap around the light pipe to be suspended;

a connector attached to the lower hoop and configured to fasten the hanger device to the supporting structure; and

15 the improvement comprising:

the connector comprising an upper probe portion integrally extending from the lower hoop and configured to engage an opening in the supporting structure to suspend the hanger device and the light pipe from the supporting structure.

20

28. A light pipe hanger device as defined in claim 27 in which the lower hoop and the upper probe portion are a single unitary piece.

29. A light pipe hanger device as defined in claim 27 in which the
25 device includes a resilient portion configured to allow the upper probe portion to compress sufficiently to pass upward through the opening and to spring back toward a relaxed shape that allows the probe portion to engage a rim defining the opening in the supporting structure and to resist being pulled back downward through the opening.

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30. A light pipe hanger device as defined in claim 27 in which the lower hoop is a band of the resilient material.

5 31. A light pipe hanger device as defined in claim 28 in which the device comprises a length of spring metal bent to form the lower hoop and upper probe portions.

32. A light pipe hanger device as defined in claim 27 in which the device comprises a plastic material.

10

33. A light pipe hanger device as defined in claim 32 in which the device comprises a plastic material that is at least translucent.

34. A light pipe hanger device as defined in claim 28 in which the upper probe portion comprises an arcuate lobe, the arcuate lobe and lower hoop together forming a closed arcuate band having the general shape of a pair of opposing lobes integrally merging at a pinched region, the arcuate lobe being broader than the opening in the supporting structure, the arcuate lobe being laterally compressible to fit through the opening when pushed upward through the opening.

20

35. A light pipe hanger device as defined in claim 27 in which the lower hoop includes a circumferential gap configured to receive the light pipe in snap-in engagement

25 36. A light pipe hanger device as defined in claim 27 in which the upper probe portion comprises a mounting fin that includes a stem extending integrally upward from the lower hoop of the light pipe hanger, the stem being disposable within the opening in the supporting structure, the mounting fin additionally including a first engagement surface disposed adjacent the stem, the



first engagement surface configured to engage the supporting structure once the mounting fin has been pushed through the opening.

37. A light pipe hanger device as defined in claim 36 in which the fin includes a second engagement surface disposed adjacent the stem, the first and second engagement surfaces disposed on laterally opposite sides of the stem, the second engagement surface configured to engage the supporting structure once the mounting fin has been pushed through the opening.

38. A light pipe hanger device as defined in claim 37 in which:
the fin includes an apex defining a fin upper edge; and
a pair of ramp surfaces, each ramp surface tapering outward and downward from the apex to an outer edge of each of the fin engagement surfaces to form a pair of barbs.

39. A light pipe hanger device as defined in claim 38 in which the stem is sufficiently narrower than the opening to allow the barbs to fit through the opening with the stem by folding against the stem.

40. A light pipe hanger device as defined in claim 28 in which opposite ends of the band are drawn together and crossed forming the lower hoop, the upper probe portion comprising opposite terminal lengths of the band extending diagonally upward and outward from a cross point where the two terminal lengths cross, each terminal length additionally including an engagement surface configured to engage the supporting structure when the upper probe portion has been moved through the opening in the supporting structure.

41. A light pipe hanger device as defined in claim 40 in which the band has a relaxed state in which the terminal lengths are crossed, the distance



between the crossed ends of the band being greater than a distance across the opening.

42. A light pipe hanger device as defined in claim 41 in which the lower hoop in its relaxed state has a diameter less than a diameter of a light pipe to be suspended in the hoop.

43. A light pipe hanger device as defined in claim 40 in which each terminal length extends diagonally upward and outward from the cross point then forms a detent configured to engage opposite edges of the opening when the upper probe portion has been moved partially through the opening, the terminal lengths being inwardly compressible to a compressed position that allows the terminal lengths to pass through the opening in the supporting structure.

44. A light pipe hanger device as defined in claim 43 in which each detent comprises a generally vertical section of one of the terminal lengths that integrally extends in a generally vertically upward direction from an upper end of the diagonally extending portion of that terminal length.

45. A light pipe hanger device as defined in claim 44 in which the generally vertical section of each terminal length includes a generally arcuate intermediate portion, the intermediate portions of each hanger device having respective generally convex surfaces that face inward toward each other, the intermediate portions having respective generally concave surfaces that face outward and are configured to engage the opposite edges of the opening when the upper probe portion has been moved partially through the opening.

46. A light pipe hanger device as defined in claim 45 in which each terminal length of the band includes a diagonally inwardly and upwardly extending upper ramp that integrally extends from an upper end of the intermediate portion of



the terminal length, each upper ramp having an engagement surface configured to aid in guiding the upper probe portion into the opening.

47. A fiber optic lighting system comprising:

5 a light fixture including an elongated lamp-support panel having a length, an upper surface, a lower surface opposite the upper surface, and a thickness extending between the upper and lower surfaces;

an opening extending through the thickness of the lamp-support panel;

10 an elongated light pipe having a light pipe length extending between two light pipe ends, the light pipe disposed adjacent and generally parallel to the lamp-support panel lower surface; and

a light pipe hanger device comprising a band of resilient material including a lower hoop configured to wrap around the light pipe and an upper probe
15 portion integrally extending from the lower hoop and configured to engage the opening in the lamp-support panel.

48. A method for installing a light pipe in a light fixture, the light fixture including an elongated lamp-support panel having a length, an upper
20 surface, a lower surface opposite the upper surface, and a thickness extending between the upper and lower surfaces, an opening extending through the thickness of the lamp-support panel and a light pipe hanger comprising a lower hoop having a gap configured to receive the light pipe in snap-in engagement and an upper probe in the form of a fin configured to engage the opening through insertion into the
25 opening; the method including the steps of:

inserting the fin upper edge upward into the opening in the lamp-support panel with the fin ramp surfaces engaging a rim defining the opening in the lamp support panel;

30 forcing the fin through the opening such that contact with the rim causes the elongated barbs to first compress inward against the elongated stem and





to then spring back outward after passing through the opening with the barbs spread-out across the opening; and

snapping a light pipe into the lower hoop by pushing the light pipe sideways through the gap in the lower hoop.

5

49. A method for installing a light pipe in a light fixture, the light fixture including an elongated lamp-support panel having a length, an upper surface, a lower surface opposite the upper surface, and a thickness extending between the upper and lower surfaces, an opening extending through the thickness of the lamp-support panel and a light pipe hanger comprising a lower hoop configured to wrap around the light pipe and an upper probe including a pair of prongs configured to engage the opening through insertion into the opening; the method including the steps of:

expanding the lower hoop of the hanger such that the upper ends of the probe prongs move close enough together to pass through the opening in the lamp-support panel;

inserting the upper ends of the probe prongs through the opening;

releasing the lower hoop to allow the hoop to contract back toward a pre-expanded/relaxed position in which the upper ends of the probe prongs are spread far enough apart to engage opposing sides of a rim defining the opening and suspending the hanger from the lamp-support panel;

inserting the light pipe axially through the lower hoop.

50. A method for installing a light pipe in a light fixture, the light fixture including an elongated lamp-support panel having a length, an upper surface, a lower surface opposite the upper surface, and a thickness extending between the upper and lower surfaces, an opening extending through the thickness of the lamp-support panel and a light pipe hanger comprising a lower hoop configured to wrap around the light pipe and an upper probe including a pair of prongs configured to engage the opening through insertion into the opening; the



method including the steps of:

placing the prongs in contact with opposing sides of a rim defining the opening in the lamp-support panel;

5 pushing the hanger device upward until the prongs engage opposing the sides of the rim and the lower hoop is expanded sufficiently to receive the light pipe;

inserting the light pipe axially through the expanded lower hoop of the hanger device; and

10 pushing the hanger device farther upward until the prongs disengage from the rim, move upward through the opening and splay upward and outward over the lamp-support panel as the lower hoop closes inward around the light pipe.

51. The method of claim 50 in which:

15 the step of placing the prongs in contact with opposing sides of the rim includes the additional step of placing an upper engagement surface of a ramp portion of each prong in contact with opposing sides of the rim; and

the step of pushing the hanger device farther upward includes the additional step of pushing the hanger device upward until detent portions of the prongs disengage from the rim.

20

52. In a mass-transit vehicle having a passenger compartment with side windows, an aisle extending along the longitudinal axis of the vehicle and a passenger seating area on one side of the aisle, a lighting system for preferentially illuminating the seating area and minimizing the illumination of the aisle and side
25 windows, said lighting system comprising:

a light fixture including an elongated lamp housing longitudinally disposed in the passenger compartment above the seating area for preferentially directing light into the seating area;

a dual-port light source mounted in the vehicle;

30 first and second elongated light pipes, each having an input end



5 optically coupled to said light source to receive light therefrom, said light pipes extending from said light source in generally opposite directions above the seating area adjacent said lamp housing, said light pipes being adapted to conduct light along their respective lengths while laterally emitting light from along their respective lengths into the passenger compartment.

10 53. A lighting system as defined in claim 52 further including an elongated mounting fin integrally and laterally extending from along said length of said light pipe to an elongated fin upper edge, said mounting fin adapted to engage said light fixture and support said light pipe without blocking light emitted from said light pipe into said seating area.

15 54. A lighting system as defined in claim 53 wherein said mounting fin and said light pipe are a single unitary piece.

55. A lighting system as defined in claim 53 wherein said fin includes a second engagement surface extending laterally outward from said stem in a direction generally opposite to that of said first engagement surface.

20 56. A lighting system as defined in claim 55 wherein said first and second engagement surfaces are elongated and extend from along said length of said stem and parallel to said light pipe.

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