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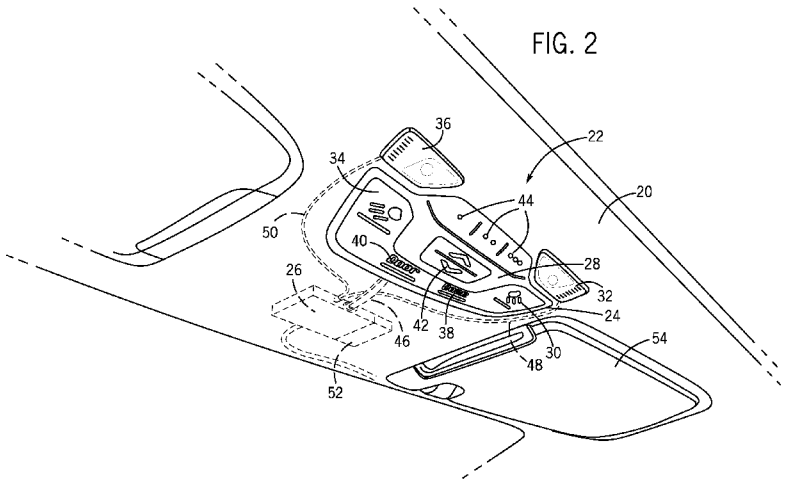
(54) Title: VEHICLE INTERIOR COMPONENT HAVING AN INTEGRAL AND CONFIGURABLE CONTROL ASSEMBLY

FIG. 2



(57) Abstract: A vehicle interior component includes a substrate having a show surface and a rear surface. The vehicle interior component also includes a control assembly having a graphic panel, a sensor assembly, and a controller. The graphic panel includes a first graphical representation of a first control and/or a second graphical representation of a second control. The controller is configured to output a first signal indicative of actuation of the first control in response to receipt of a second signal from the sensor assembly indicative of presence of an activating object proximate to the first graphical representation, and the controller is configured to receive an expansion module configured to enable the controller to output a third signal indicative of actuation of the second control in response to receipt of a fourth signal from the sensor assembly indicative of the presence of the activating object proximate to the second graphical representation.

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VEHICLE INTERIOR COMPONENT HAVING AN INTEGRAL AND CONFIGURABLE CONTROL ASSEMBLY

BACKGROUND

[0001] The invention relates generally to a vehicle interior component having an integral and configurable control assembly.

[0002] Certain vehicle interior components include a control assembly configured to control a variety of systems throughout a vehicle. Typical control assemblies include a control interface, a control module, and a housing configured to retain the control interface and the control module. The control interface may include multiple controls (e.g., buttons, knobs, switches, etc.) and/or multiple indicators (e.g., lights, haptic feedback assemblies, audio assemblies, etc.). The control module is configured to control certain vehicle systems based on corresponding input from the controls. The control module is also configured to drive the indictors to provide feedback to a vehicle occupant. Unfortunately, providing sufficient material (e.g., plastic) to form the housing for the control interface and the control module may significantly increase the manufacturing costs associated with producing the control assembly. In addition, varying the configuration of the control assembly (e.g., due to different vehicle trim levels) typically involves reconfiguring the housing and/or the control interface. As a result, a large number of tools (e.g., injection molding tools) may be employed to facilitate construction of the various housings and/or the various control interfaces, thereby further raising manufacturing costs. Moreover, each control assembly configuration may utilize a different control module. As a result, design costs may be increased due to the process of designing, testing, and validating multiple control modules (e.g., one for each control assembly configuration).

BRIEF DESCRIPTION OF THE INVENTION

[0003] The present invention relates to a vehicle interior component including a substrate having a show surface facing an interior of a vehicle and a rear surface opposite the show surface. The vehicle interior component also includes a control

assembly having a graphic panel, a sensor assembly, and a controller. The graphic panel is fashioned on the substrate such that the graphic panel is visible on the show surface, and the graphic panel includes a first graphical representation of a first control and/or a second graphical representation of a second control. In addition, the controller is configured to output a first signal indicative of actuation of the first control in response to receipt of a second signal from the sensor assembly indicative of presence of an activating object proximate to the first graphical representation, and the controller is configured to receive an expansion module configured to enable the controller to output a third signal indicative of actuation of the second control in response to receipt of a fourth signal from the sensor assembly indicative of the presence of the activating object proximate to the second graphical representation.

[0004] The present invention also relates to a vehicle interior component including a substrate having a show surface facing an interior of a vehicle and a rear surface opposite the show surface. The vehicle interior component also includes a control assembly having a graphic panel and a sensor assembly. The graphic panel is fashioned on the substrate such that the graphic panel is visible on the show surface, and the graphic panel includes a first arrangement of first graphical representations of first controls or a second arrangement of second graphical representations of second controls. The first arrangement of the first graphical representations is different than the second arrangement of the second graphical representations. In addition, the sensor assembly is configured to detect presence of an activating object proximate to each of the first and second graphical representations based on a position of the activating object relative to the graphic panel.

[0005] The present invention further relates to a vehicle interior component including a substrate having a show surface facing an interior of a vehicle and a rear surface opposite the show surface. The vehicle interior component also includes a control assembly having a graphic panel and a sensor assembly. The graphic panel is fashioned on the substrate such that the graphic panel is visible on the show surface, at least a portion of the sensor assembly is positioned behind the rear surface of the substrate, the graphic panel includes a graphical representation of a control, and the

sensor assembly is configured to detect presence of an activating object proximate to the graphical representation of the control.

DRAWINGS

[0006] FIG. 1 is a perspective view of an exemplary vehicle that may include a vehicle interior component having a configurable control assembly.

[0007] FIG. 2 is a perspective view of an embodiment of a vehicle interior headliner having a configurable control assembly.

[0008] FIG. 3 is a cross-sectional view of an embodiment of a configurable control assembly.

[0009] FIG. 4 is an exploded view of the configurable control assembly of FIG. 3.

[0010] FIG. 5 is a cross-sectional view of another embodiment of a configurable control assembly.

[0011] FIG. 6 is an exploded view of a further embodiment of a configurable control assembly having a graphic panel.

[0012] FIG. 7 is a perspective view of an embodiment of a graphic panel that may be used within a configurable control assembly.

[0013] FIG. 8 is a cross-sectional view of another embodiment of a configurable control assembly.

[0014] FIG. 9 is a cross-sectional view of a further embodiment of a configurable control assembly having a graphic panel.

DETAILED DESCRIPTION

[0015] FIG. 1 is a perspective view of an exemplary vehicle 10 that may include a vehicle interior component having a configurable control assembly. As illustrated, the vehicle 10 includes an interior 12 having an instrument panel 14, an armrest 16,

and a center console 18. As discussed in detail below, the vehicle interior 12 includes one or more interior components (e.g., the instrument panel 14, the armrest 16, the center console 18, etc.) having a configurable control assembly. In certain embodiments, the interior component includes a substrate having a show surface facing the interior 12 of the vehicle 10 and a rear surface opposite the show surface. The configurable control assembly includes a graphic panel fashioned on the substrate such that the graphic panel is visible on the show surface. The graphic panel includes graphical representations of controls (e.g., buttons, slides, etc.) that may control various systems throughout the vehicle 10. The control assembly also includes a sensor assembly configured to detect presence of an activating object proximate to each control. For example, when an occupant touches a button, the sensor assembly detects the presence of the occupant finger, thereby facilitating control of the system associated with the button. Such a configuration may obviate electromechanical buttons disposed within a housing of the interior component, thereby enhancing the appearance of the interior component and substantially reducing manufacturing costs.

[0016] FIG. 2 is a perspective view of an embodiment of a vehicle interior headliner 20 having a configurable control assembly 22. As illustrated, the control assembly 22 includes a control interface 24 and a controller 26 (e.g., including a processor and a memory). In certain embodiments, the controller 26 is an electronic controller having electrical circuitry configured to control operation of various vehicle systems. For example, the controller 26 may include processors, storage devices, and memory devices. The processor(s) may be used to execute software, such as lighting control software, remote device control software, and so forth. Moreover, the processor(s) may include one or more microprocessors, such as one or more "general-purpose" microprocessors, one or more special-purpose microprocessors, and/or application specific integrated circuits (ASICS), or some combination thereof. For example, the processor(s) may include one or more reduced instruction set (RISC) processors.

[0017] The storage device(s) (e.g., nonvolatile storage) may include read-only memory (ROM), flash memory, a hard drive, or any other suitable optical, magnetic, or solid-state storage medium, or a combination thereof. The storage device(s) may

store data (e.g., lighting control data, remote device control data, etc.), instructions (e.g., software or firmware for controlling the lighting and/or the remote device, etc.), and any other suitable data. The memory device(s) may include a volatile memory, such as random access memory (RAM), and/or a nonvolatile memory, such as ROM. The memory device(s) may store a variety of information and may be used for various purposes. For example, the memory device(s) may store processor-executable instructions (e.g., firmware or software) for the processor(s) to execute, such as instructions for a lighting control software and/or a remote device control software.

[0018] The control interface 24 includes a graphic panel 28 fashioned on a headliner substrate such that the graphic panel is visible on a show surface of the substrate (e.g., from the perspective of a vehicle occupant). The graphic panel 28 includes graphical representations of various controls. For example, in the illustrated embodiment, the graphic panel 28 includes a first light control button 30 configured to control operation (e.g., selective activation and deactivation) of an adjacent first task light 32. The graphic panel 28 also includes a second light control button 34 configured to control operation (e.g., selective activation and deactivation) of an adjacent second task light 36. By way of example, contact between an occupant finger and the first or second light control button may activate the respective task light, and subsequent contact may deactivate and/or adjust the intensity of the respective task light.

[0019] In the illustrated embodiment, the graphic panel 28 also includes a dome light control button 38, a door light control button 40, sunroof control buttons 42, and remote device control buttons 44. Similar to the task light control buttons, the dome light control button 38 is configured to selectively activate and deactivate a dome light, and the door light control button 40 is configured to selectively activate and deactivate door lighting (e.g., ambient lighting). The sunroof control buttons 42, such as the illustrated directional buttons, are configured to control a position of a sunroof, and the remote device control buttons 44 are configured to control operation of a remote device (e.g., garage door, motorized gate, etc.). As will be appreciated, the graphic panel 28 may include additional graphical representations of additional controls to control other systems within the vehicle 10, such as environmental control

systems, entertainment systems, navigation systems, safety systems, and vehicle system indicators, among others.

[0020] As discussed in detail below, the control assembly includes a sensor assembly configured to detect presence of an activating object (e.g., an occupant finger) proximate to each graphical representation of a corresponding control. For example, in certain embodiments, the sensor assembly is configured to output a signal indicative of presence of an activating object proximate to each of the graphical representations. The controller 26, in turn, is configured to output a signal indicative of actuation of the control associated with the selected graphical representation, thereby controlling the corresponding device/system. In the illustrated embodiment, the sensor assembly is communicative coupled to the controller 26 by a first flexible conductor 46. In addition, the controller 26 is communicatively coupled to the first task light 32 by a second flexible conductor 48, and the controller 26 is communicatively coupled to the second task light 36 by a third flexible conductor 50. The flexible conductors facilitate transmission of the signals from the sensor assembly to the controller, and from the controller to various vehicle devices/systems, such as the task lights. The flexible conductors also enable the controller 26 to be positioned in a variety of locations remote from the sensor assembly and/or the graphic panel. As a result, the thickness of the headliner may be reduced, as compared to configurations in which the controller is mounted directly behind the controls.

[0021] By way of example, if an occupant finger touches, or is positioned adjacent to, the first light control button 30, the sensor assembly detects the presence of the occupant finger proximate to the button 30. The sensor assembly then sends a signal to the controller 26 via the first flexible conductor 46, indicating that an activating object is positioned proximate to the first light control button 30. The controller, in turn, sends a signal to the first task light 32 via the second flexible conductor 48, instructing the first task light 32 to illuminate. Accordingly, the control system 22 facilitates occupant control of various vehicle systems via a control interface 24 integrated within the headliner 20.

[0022] In the illustrated embodiment, the control assembly 22 is configurable to accommodate variations in the number and/or type of controllable devices/systems within the vehicle 10 (e.g., due to variations in trim level). For example, one trim level may include the remote device control system, while another trim level omits the system. The control assembly 22 is configured to accommodate both trim levels without structural modification to the headliner 20, thereby substantially reducing costs associated with reconfiguring the control assembly. For example, if the vehicle 10 includes the remote device control system, a graphic panel 28 is selected that includes the remote device control buttons 44. Conversely, if the vehicle 10 does not include the remote device control system, a graphic panel 28 is selected that does not include remote device control buttons 44. As discussed in detail below, the sensor assembly may be configured to accommodate configurations with and without the remote device control buttons.

[0023] The controller 26 is also configurable to accommodate variations in the functionality of the control assembly. In the illustrated embodiment, the controller 26 is configured to receive an expansion module 52 that enhances the functionality of the controller 26. For example, the graphic panel 28 may be selectable from a first graphic panel that includes a first graphical representation of a first control (e.g., the light control buttons), and a second graphic panel that includes the first graphical representation of the first control (e.g., the light control buttons) and a second graphical representation of a second control (e.g., the remote device control buttons). Without the expansion module, the controller 26 is configured to output a signal indicative of actuation of the first control in response to receipt of a signal from the sensor assembly indicative of presence of an activating object proximate to the first graphical representation. The controller is also configured to receive an expansion module 52 that enables the controller 26 to output a signal indicative of actuation of the second control in response to receipt of a signal from the sensor assembly indicative of the presence of the activating object proximate to the second graphical representation (e.g., via control software stored in a memory of the expansion module 52).

[0024] By way of example, for vehicles that do not include the remote device control system, a graphic panel 28 that does not include the remote device control buttons 44 is selected, and an expansion module 52 configured to provide remote device control functionality to the controller 26 is omitted. Conversely, for vehicles that include the remote device control system, a graphic panel 28 that includes the remote device control buttons 44 is selected, and an expansion module 52 configured to provide remote device control functionality is communicatively coupled to the controller. In certain embodiments, the controller 26 may include an expansion port, and the expansion module 52 may be installed within the port. While a remote device control expansion module is described above, it should be appreciated that the controller may be configured to receive expansion modules configured to provide other functionality, such as control of a sunroof, control of ambient light, and control of an entertainment system, among others. Furthermore it should be appreciated that the controller 26 may be configured to receive multiple expansion modules, and/or each expansion module may be configured to provide multiple additional functions to the controller 26. In certain embodiments, the controller 26 may be configured to receive additional software (e.g., loaded onto a memory of the controller) to enhance the functionality of the controller 26. Because the controller 26 and the control interface 24 are configurable to accommodate variations in the number and/or type of vehicle controls, costs associated with reconfiguring the control assembly 22 are substantially reduced, as compared to control assemblies that include physical controls (e.g., switches, knobs, buttons, etc.) mounted within a housing.

[0025] In the illustrated embodiment, each graphical representation (e.g., the first light control button 30, the second light control button 34, etc.) is applied to the graphic panel 28 (e.g., via a silk screening process, an inkjet printing process, etc.), and the graphic panel is coupled to the show surface of the headliner substrate. Consequently, the visual appearance of the graphical representations may be selected by particularly configuring the application equipment (e.g., printing equipment) to provide the desired graphics. In further embodiments, the graphical representations may be embossed into the show surface of the substrate, thereby providing recesses that represent the controls. Alternatively, the graphic panel 28 may be formed from a

pad (e.g., silicon pad) disposed within a recess in the show surface of the substrate. In such a configuration, the graphical representations may be applied to the pad and/or embossed into the pad. In further embodiments, the graphical representations may be embossed into a show surface of a covering disposed onto the show surface of the substrate.

[0026] As previously discussed, certain vehicle interiors include an overhead housing mounted to the headliner and configured to support a control interface. Because the illustrated embodiment employs a control interface 24 integrated within the headliner 20, the overhead housing is obviated. Consequently, manufacturing costs may be reduced due to a reduction in material (e.g., plastic) associated with overhead housing construction. In addition, because the layout of controls and/or the number of controls may be varied without structural modifications, the cost associated with varying trim levels may be substantially reduced. Furthermore, because the control interface 24 may be positioned in a variety of suitable locations along the headliner 20, accessibility to the control assembly may be enhanced, as compared to embodiments in which the control interface is fixed to the overhead housing. The integration of the control interface within the headliner 20 may also provide a more desirable appearance than an overhead housing having a control interface. While the configurable control assembly 22 is discussed herein with reference to integrating a control interface 24 within a vehicle interior headliner 20, it should be appreciated that alternative embodiments may include a control assembly having a control interface integrated within other components of the vehicle interior 12. For example, in certain embodiments, a sun visor 54, an interior door panel, an instrument panel 14, an armrest 16, and/or a center console 18 may include an integrated control interface of a configurable control assembly.

[0027] FIG. 3 is a cross-sectional view of an embodiment of a configurable control assembly 22. As previously discussed, the control interface 24 of the control assembly 22 is fashioned on the headliner 20. As illustrated, the headliner 20 includes a substrate 56 and a covering 57. The substrate 56 and the covering 57 each include a show surface 58 facing the interior 12 of the vehicle 10 and a rear surface 59 opposite the show surface 58. The substrate 56 may be formed by an injection molding

process and/or a compression forming process, thereby establishing a headliner 20 that maintains a desired shape. The cover 57 may include a foam layer coupled to the substrate 56 (e.g., via an adhesive layer) and a cover stock disposed onto the foam layer (e.g., via an adhesive layer) to establish a desired show surface. In the illustrated embodiment, the control interface 24 is coupled to the show surface 58 of the substrate 56 and positioned within a gap in the covering 57, thereby establishing a substantially smooth/continuous headliner show surface.

[0028] In the illustrated embodiment, the graphic panel 28 is formed from a flexible film, and each graphical representation of a control is applied to (e.g., printed onto, sprayed onto, etc.) a show surface of the flexible film. In addition, the control interface 24 includes a sensor assembly 60 positioned between the graphic panel 28 and the show surface 58 of the substrate 56. As previously discussed, the sensor assembly 60 is configured to detect presence of an activating object (e.g., an occupant finger) proximate to each of the graphical representations on the graphic panel 28. In the illustrated embodiment, the sensor assembly 60 includes a flexible layer (e.g., a flex circuit) and multiple proximity sensors applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer. The proximity sensors are aligned with corresponding graphical representations on the graphic panel 28, thereby enabling the sensor assembly 60 to identify presence of the activating object proximate to each control. For example, if an occupant finger contacts one graphical representation on the graphic panel, the proximity sensor detects the presence of the occupant finger and outputs a signal to the controller 26 indicative of presence of the finger proximate to the control.

[0029] As discussed in detail below, a light emitting layer may be applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer and/or onto one or more of the proximity sensors to provide various indications to a vehicle occupant. For example, a light emitting layer may be aligned with each graphical representation and configured to illuminate while presence of the activating object is detected proximate to the respective control. Accordingly, an occupant receives visual feedback when a control is activated. In certain embodiments, the control assembly 22 includes a haptic feedback system 61 configured to provide haptic feedback in response to

presence of the activating object proximate to one of the graphical representations. For example, when an occupant finger contacts the graphical representation of a control, the occupant may experience haptic feedback, thereby indicating that the control is activated.

[0030] FIG. 4 is an exploded view of the configurable control assembly 22 of FIG. 3. In the illustrated embodiment, the sensor assembly 60 includes a flexible layer 62 (e.g., a flex circuit) and multiple proximity sensors 64 applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer 62. As illustrated, each proximity sensor 64 is substantially aligned with a corresponding remote device control button 44. Accordingly, while an occupant finger, or other activating object, is positioned proximate to one of the remote device control buttons 44, the corresponding proximity sensor 64 detects the presence of the finger and outputs a signal to the controller indicative of finger proximity to the button. While the illustrated embodiment includes remote device control buttons 44, it should be appreciated that the sensor assembly 60 may be configured to detect presence of an occupant finger proximate to other graphical representations of controls, such as the first light control button 30, the second light control button 34, and the sunroof control buttons 42, among others.

[0031] As will be appreciated, various proximity sensor configurations may be applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer to detect the activating object proximate to each button 44. For example, certain embodiments may employ a capacitance sensor which emits a field to detect changes in the dielectric constant caused by any objects falling within the effective range of the field, such as due to the presence of an occupant finger adjacent to a button 44. Specifically, the sensor 64 may be provided with a direct current (DC) or alternating current (AC) electrical signal. The sensor 64 is configured to convert this electrical signal into a field that emanates from the surface of the graphic panel 28. The sensor 64 may then generate an output signal representative of the detected field. This signal is analyzed by the controller 26 to determine whether an object is proximate to the button 44. Alternative embodiments may employ a field effect type capacitance sensor which includes multiple conductive layers to more accurately focus the field.

Field effect sensors may provide greater precision, but lower range compared to traditional capacitance sensors.

[0032] Further embodiments may employ an ultrasonic transducer configured to emit and detect high frequency sound waves. Specifically, the sensor 64 may be provided with a high frequency AC electrical pulse. The sensor 64 is configured to convert this electrical pulse into an acoustical field that emanates from the surface of the graphic panel 28. For example, certain ultrasonic transducers utilize a piezoelectric ceramic layer to convert the high frequency AC pulse into an acoustical pulse that propagates away from the sensor 64. If the field (i.e., acoustical pulse) impacts an object, the acoustical energy is reflected back to the sensor 64. The sensor 64 detects the reflected energy and generates an output signal representative of the detected field (i.e., returned acoustical energy). This signal is analyzed by the controller 26 to determine whether an object is proximate to the button 44.

[0033] Alternative embodiments may employ a radio frequency transducer configured to emit and detect electromagnetic waves. Similar to the ultrasonic transducer, the sensor 64 may be provided with a high frequency AC electrical pulse. The sensor 64 is configured to convert this electrical pulse into an electromagnetic field that emanates from the surface of the graphic panel 28. If the field (i.e., electromagnetic pulse) impacts an object, the energy is reflected back to the sensor 64. The sensor 64 detects the reflected energy and generates an output signal representative of the detected field (i.e., returned electromagnetic energy). This signal is analyzed by the controller 26 to determine whether an object is proximate to the button 44.

[0034] Further embodiments may employ an optical transducer configured to emit and detect infrared, visible and/or ultraviolet light waves. In such embodiments, the sensor 64 may be provided with a DC current. The sensor 64 is configured to convert this electrical current into an optical field that emanates from the surface of the graphic panel 28. For example, the sensor 64 may include a light emitting diode (LED) applied to (e.g., printed onto, sprayed onto, etc.) the show surface of the flexible layer 62. If the field (i.e., light rays) impacts an object, the energy is reflected

back to the sensor 64. The sensor 64 detects the reflected energy and generates an output signal representative of the detected field (i.e., reflected light). This signal is analyzed by the controller 26 to determine whether an object is proximate to the button 44. For example, in certain embodiments, the interference pattern between the transmitted light and the reflected light may be compared to determine a distance between the object and the sensor 64. Furthermore, the frequency of the returned light and the frequency of the transmitted light may be compared to measure the Doppler shift, which may be utilized to determine the velocity of the object relative to the sensor 64. As will be appreciated, various other suitable sensors (e.g., passive infrared, inductance, etc.) configured to detect the presence of an activating object may be employed in alternative embodiments.

[0035] In certain embodiments, the sensor 64 may include a strain gauge applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer 62. In such embodiments, the sensor 64 may be provided with a DC current. The sensor 64 is configured to vary an output voltage of the DC current based on deflection of the flexible layer 62. For example, contact between an occupant finger and the button 44 may deflect the flexible layer 62, thereby varying the voltage output by the sensor 64. The controller 26, in turn, determines whether an object is proximate to the button 44 based on the measured output voltage.

[0036] In addition to the sensor 64, certain embodiments may employ an electromechanical sensor or switch configured to detect presence of an activating object in contact with a graphical representation of a control on the graphic panel 28. For example, the electromechanical switch may be positioned behind the substrate 56 such that a force applied by the activating object to the control engages the switch. Such a configuration may provide tactile feedback to the occupant, thereby providing a positive indication of switch engagement.

[0037] In the illustrated embodiment, the control interface 24 includes three light emitting layers 66 applied to (e.g., printed onto, sprayed onto, etc.) corresponding proximity sensors 64. The light emitting layers 66 are configured to selectively illuminate to convey information to an occupant. For example, if an activating object

is detected adjacent to one of the buttons 44, a corresponding light emitting layer 66 may be illuminated, thereby indicating an operational state of the remote device control system. While three light emitting layers 66 are included in the illustrated embodiment to indicate an operational state of the remote device control system, it should be appreciated that alternative embodiments may include additional indicators associated with other controls of the control interface 22. In addition, it should be appreciated that light emitting layers 66 may be applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer 62 remote from the controls to provide additional information to an occupant, such as fuel status, vehicle door position, and sunroof position, among others. In certain embodiments, the light emitting layer 66 may be formed from an LED paste, which includes multiple LEDs embedded within a liquid resin. The liquid resin is applied (e.g., via a screen printing process, via a spraying process, etc.) to the flexible layer 62 and/or to the proximity sensors 64. As the resin cures, a layer of LEDs is formed on the flexible layer/proximity sensor. Subsequent application of an electrical current to the LED layer induces the LEDs to emit light, thereby providing the desired indication to the vehicle occupant.

[0038] In the illustrated embodiment, the graphical representations of the controls are applied to (e.g., printed onto, sprayed onto, etc.) the show surface of the graphic panel 28, the proximity sensors 64 are applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer 62, and the light emitting layers 66 are applied to (e.g., printed onto, sprayed onto, etc.) the flexible layer 62 and/or the proximity sensors 64. Accordingly, the number, configuration, and/or type of controls may be reconfigured by applying different features onto the graphic panel 28 and the flexible layer 62. By way of example, if the vehicle 10 includes the remote device control system, the remote device control buttons 44 may be applied to the graphic panel 28, and corresponding sensors 64 and/or light emitting layers 66 may be applied to the flexible layer 62. Conversely, if the vehicle 10 does not include the remote device control system, these features may be omitted. As a result, the arrangement, number, and/or type of controls on the control interface 24 may be reconfigured without structural modifications to the corresponding vehicle interior component (e.g., headliner 20). In addition, because the controller 26 may be reconfigured by adding

or removing expansion modules, the control assembly 22 may support a variety of trim levels using common components, thereby substantially reducing design, testing, and installation costs.

[0039] FIG. 5 is a cross-sectional view of another embodiment of a configurable control assembly 22. Similar to the embodiment described above, the control assembly 22 includes a graphic panel 28 fashioned on the substrate 56 such that the graphic panel 28 is visible on the show surface 58, and a sensor assembly 60 configured to detect presence of an activating object (e.g., occupant finger) proximate to a graphical representation of a control. In the illustrated embodiment, at least a portion of the sensor assembly 60 is positioned behind the rear surface 59 of the substrate 56. As illustrated, a printed circuit board 68 having multiple proximity sensors 70 is coupled to the rear surface 59 of the substrate 56. As previously discussed, the proximity sensors 70 may be any suitable type of proximity sensor, such as a capacitive sensor, a radio frequency transducer, and an ultrasonic transducer, among others. In addition, while the proximity sensors 70 are applied to (e.g., printed onto, sprayed onto, surface mounted onto, etc.) a printed circuit board in the illustrated embodiment, it should be appreciated that the proximity sensors may be applied to (e.g., printed onto, sprayed onto, etc.) a flexible layer (e.g., flex circuit) in alternative embodiments.

[0040] In the illustrated embodiment, the sensor assembly 60 also includes a compressible layer 72 disposed between the show surface 58 of the substrate 56 and the graphic panel 28. The compressible layer 72 includes multiple detectable elements 74 positioned adjacent to the graphic panel 28. Each detectable element 74 is aligned with a corresponding proximity sensor 70 on the printed circuit board 68 and a corresponding graphical representation of a control on the graphic panel 28. As will be appreciated, each detectable element 74 may be particularly configured to facilitate detection by a respective proximity sensor. For example, if the proximity sensor is a capacitive sensor, the detectable element may be formed from a material having a large dielectric constant. In addition, if the proximity sensor is an ultrasonic transducer, the detectable element may be formed from a sound-reflecting material. In this configuration, the sensor assembly 60 detects the presence of the activating

object proximate to a graphical representation of a control based on movement of a corresponding detectable element 74 toward a respective proximity sensor 70.

[0041] By way of example, contact between an occupant finger and a graphical representation of a control induces the graphic panel 28 to deflect in the direction 75, thereby compressing the compressible layer 72. As a result, the detectable element 74 aligned with the selected graphical representation moves toward a respective proximity sensor 70 in the direction 75. The proximity sensor 70, in turn, sends a signal to the controller indicative of presence of the occupant finger proximate to the selected graphical representation. In the illustrated embodiment, a thickness of the compressible layer 72 induces the control interface 24 to protrude beyond the show surface of the headliner. However, it should be appreciated that the control interface 24 may be substantially flush with the headliner or recessed within headliner in alternative embodiments.

[0042] FIG. 6 is an exploded view of a further embodiment of a configurable control assembly 22 having a graphic panel 28. In the illustrated embodiment, the sensor assembly 60 includes a multi-dimensional proximity sensor 76 positioned behind the rear surface 59 of the substrate 56 and substantially aligned with the graphic panel 28. The multi-dimensional proximity sensor 76 is configured to detect presence of an activating object proximate to each graphical representation on the graphic panel 28 based on a detected position of the activating object relative to the graphic panel 28. In the illustrated embodiment, the graphic panel 28 includes the first light control button 30 and the second light control button 34. To control the first task light 32, an activating object (e.g., an occupant finger) is positioned proximate to the first light control button 30. The multi-dimensional proximity sensor 76, in turn, outputs a signal indicative of a position of the activating object relative to the graphic panel 28. The controller 26 compares the position of the activating object to a stored position of the first light control button 30. If the position of the activating object substantially corresponds to the position of the first light control button, the controller 26 actuates the first task light 30 (e.g., instructs the first task light to activate.). The second task light 34 may be controlled in a similar manner via the second light control button 34.

[0043] The light control buttons represent a first arrangement 78 of first controls on the graphic panel 28. For example, each light control button may be applied to (e.g., printed onto, sprayed onto, etc.) the show surface of the graphic panel 28. However, as previously discussed, a second arrangement of second controls, different than the first arrangement of first controls, may be applied to (e.g., printed onto, sprayed onto, etc.) the graphic panel. Because the multi-dimensional proximity sensor is configured to detect presence of an activating object proximate to each control based on the position of the activating object relative to the graphic panel, the sensor assembly may accommodate both the first arrangement of first controls and the second arrangement of second controls. As a result, the control assembly 22 may support a variety of trim levels using a common sensor assembly 60, thereby substantially reducing design, testing, and installation costs.

[0044] FIG. 7 is a perspective view of an embodiment of a graphic panel 28 that may be used within a configurable control assembly 22. Similar to the graphic panel 28 described above with reference to FIG. 6, the illustrated graphic panel 28 includes the first light control button 30 and the second light control button 34. However, the illustrated graphic panel 28 also includes the remote device control buttons 44, thereby forming a second arrangement 80 of second controls, different than the first arrangement 78 of first controls.

[0045] By way of example, one trim level may include the remote device control system, while another trim level omits the system. If the vehicle 10 includes the remote device control system, a graphic panel 28 having the second arrangement 80 of second controls is selected, which includes the remote device control buttons 44. Conversely, if the vehicle 10 does not include the remote device control system, a graphic panel 28 having the first arrangement 78 of first controls is selected, which does not include the remote device control buttons 44. Because the multi-dimensional proximity sensor is configured to detect presence of an activating object proximate to a graphical representation of a control based on a position of the activating object relative to the graphic panel 28, a common sensor assembly 60 may be employed within both trim levels, thereby substantially reducing design, testing, and installation costs.

[0046] As previously discussed, the controller 26 is also configurable to accommodate variations in the functionality of the control assembly 22. For example, in certain embodiments, the controller 26 is configured to receive an expansion module that enables the controller 26 to control the remote device control system. Accordingly, without the expansion module, the controller 26 is configured to output a signal indicative of actuation of the task lights in response to receipt of a signal from the sensor assembly indicative of presence of an activating object proximate to the task light buttons. The controller is also configured to receive an expansion module that enables the controller 26 to output a signal indicative of actuation of the remote device control system in response to receipt of a signal from the sensor assembly indicative of the presence of the activating object proximate to the remote device control buttons. In this configuration, the control assembly 22 may accommodate a variety of vehicle configurations (e.g., associated with different trim levels) without structural modifications to the headliner 20, or other vehicle interior component.

[0047] While providing or omitting control of the remote device control system is described above, it should be appreciated that the control assembly 22 may provide or omit control of other vehicle systems/devices. For example, if the vehicle 10 includes a sunroof, the graphic panel 28 may include graphical representations of sunroof controls, and the controller 26 may include a sunroof control expansion module. Conversely, if the vehicle 10 does not include the sunroof, the graphic panel may omit the graphical representations of sunroof controls, and the controller may omit the sunroof control expansion module.

[0048] FIG. 8 is a cross-sectional view of another embodiment of a configurable control assembly. In the illustrated embodiment, the sensory assembly 60 includes an optical sensing device 82 (e.g., a camera, a multi-dimensional infrared detector, etc.) having a field of view 83 directed toward the graphic panel 28. The sensor assembly 60 also includes a proximity sensor 84 positioned behind the rear surface 59 of the substrate 56. The proximity sensor 84 may include any suitable device configured to detect an activating object proximate to, or in contact with, the graphic panel 28, such as a capacitive sensor, a pressure sensor, or an electromechanical switch, among others. In this configuration, the sensor assembly 60 is configured to detect the

presence of the activating object (e.g., the occupant finger) proximate to the graphical representation of a control by optically detecting a position of the activating object relative to the graphic panel 28 while the activating object is proximate to the proximity sensor 84. For example, when the proximity sensor 84 detects an activating object proximate to the graphic panel 28, the optical sensing device 82 outputs a signal to the controller 26 indicative of a position of the activating object relative to the graphic panel 28. The controller 26, in turn, compares the position of the activating object to a respective position of each graphical representation. If the activating object is proximate to a graphical representation, the controller 26 outputs a signal indicative of actuation of the control associated with the selected graphical representation.

[0049] Because the optical sensing device is configured to detect presence of an activating object proximate to each graphical representation based on the position of the activating object relative to the graphic panel, the sensor assembly may accommodate various arrangements of graphical representations on the graphic panel. As a result, the control assembly 22 may support a variety of trim levels using a common sensor assembly 60, thereby substantially reducing design, testing, and installation costs. In the illustrated embodiment, the graphic panel 28 is recessed within the headliner 20. However, it should be appreciated that the graphic panel may be substantially flush with the show surface of the headliner, or the graphic panel may protrude beyond the show surface of the headliner in alternative embodiments.

[0050] FIG. 9 is a cross-sectional view of a further embodiment of a configurable control assembly having a graphic panel. In the illustrated embodiment, the graphic panel 28 is coupled to the rear surface 59 of the substrate 56, and the substrate 56 includes a light transmissive portion 86 (e.g., transparent, translucent, etc.) that enables the graphic panel 28 to be visible on the show surface 58 (e.g., from the perspective of a vehicle occupant). In addition, the covering 57 includes a light transmissive portion 88 (e.g., transparent, translucent, etc.) that enhances the visibility of the graphic panel 28. In alternative embodiments, the covering 57 may be formed from a cover stock (e.g., woven or non-woven fabric) that facilitates light passage (e.g., between fibers of the woven or non-woven fabric) from the show surface 58 of

the substrate 56 to the vehicle interior. In such embodiments, the graphical representations of the controls may not be visible until the graphical representations are illuminated (e.g., via a backlighting system). Furthermore, while the illustrated substrate 56 includes a light transmissive portion 86, it should be appreciated that, in alternative embodiments, the substrate 56 may be formed from a light transmissive material, such as polycarbonate or acrylic.

[0051] In the illustrated embodiment, the sensor assembly 60 is positioned behind the graphic panel 28 relative to the substrate 56, and a lighting assembly 89 is positioned behind the sensor assembly 60. As illustrated, the lighting assembly 89 includes light guides 90 and light sources 92 (e.g., LEDs). The light guides 90 may be formed from any suitable light transmissive material, such as glass or plastic, and may be substantially rigid or flexible. The light guides 90 are configured to transfer light from the light sources 92 to the graphic panel 28 (e.g., via light transmissive portions of the sensor assembly 60), thereby facilitating illumination of graphical elements on the panel 28. While the illustrated embodiment includes three light sources 92 and three light guides 90, it should be appreciated that alternative embodiments may include more or fewer light sources 92 and/or light guides 90. For example, in certain embodiments, each graphical representation of a control may be illuminated by a corresponding light source.

[0052] In alternative embodiments, a single light guide 90 may be employed to illuminate each graphical element of the graphic panel 28. In such embodiments, one or more light sources 92 may be optically coupled to the light guide 90. In addition, the configuration of the light guide 90 may be selected based on the desired controls. For example, the graphic panel 28 may include a first set of graphical representations associated with a first set of controls and a second set of graphical representations associated with a second set of controls. A first light guide 90 may be configured to illuminate the first set of graphical representations without illuminating the second set of graphical representations if the second set of controls is unavailable and/or disabled. In addition, a second light guide 90 may be configured to illuminate the first and second sets of graphical representations if the first and second sets of

controls are available and/or enabled. Accordingly, a single graphic panel 28 may be utilized for multiple control configurations.

[0053] While the light guide(s) 90 are positioned behind the sensor assembly 60 in the illustrated embodiment, it should be appreciated that the light guide(s) 90 may be positioned between the sensor assembly 60 and the graphic panel 28 in alternative embodiments. Moreover, it should be appreciated that, in alternative embodiments, the light guide(s) 90 may be omitted, and the light source(s) 92 may directly illuminate the graphical elements of the graphic panel 28. It should also be appreciated that the light sources 92 may be applied to a printed circuit board positioned behind the sensor assembly 60 or in a remote location behind the substrate 56 (e.g., optically coupled to the graphic panel by the light guide(s) 90, by a fiber optic cable, and/or by any other suitable optical connection).

[0054] While only certain features and embodiments of the invention have been illustrated and described, many modifications and changes may occur to those skilled in the art (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters (e.g., temperatures, pressures, etc.), mounting arrangements, use of materials, colors, orientations, etc.) without materially departing from the novel teachings and advantages of the subject matter recited in the claims. The order or sequence of any process or method steps may be varied or re-sequenced according to alternative embodiments. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention. Furthermore, in an effort to provide a concise description of the exemplary embodiments, all features of an actual implementation may not have been described (i.e., those unrelated to the presently contemplated best mode of carrying out the invention, or those unrelated to enabling the claimed invention). It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation specific decisions may be made. Such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure, without undue experimentation.

CLAIMS:

1. A vehicle interior component, comprising:

a substrate having a show surface facing an interior of a vehicle and a rear surface opposite the show surface; and

a control assembly having a graphic panel, a sensor assembly, and a controller, wherein the graphic panel is fashioned on the substrate such that the graphic panel is visible on the show surface, the graphic panel includes a first graphical representation of a first control, a second graphical representation of a second control, or a combination thereof, the controller is configured to output a first signal indicative of actuation of the first control in response to receipt of a second signal from the sensor assembly indicative of presence of an activating object proximate to the first graphical representation, and the controller is configured to receive an expansion module configured to enable the controller to output a third signal indicative of actuation of the second control in response to receipt of a fourth signal from the sensor assembly indicative of the presence of the activating object proximate to the second graphical representation.

2. The vehicle interior component of claim 1, wherein the graphic panel is selectable from a first graphic panel that includes the first graphical representation of the first control and does not include the second graphical representation of the second control, and a second graphic panel that includes the first graphical representation of the first control and the second graphical representation of the second control.

3. The vehicle interior component of claim 1, wherein the controller is communicatively coupled to the sensor assembly by a flexible conductor.

4. The vehicle interior component of claim 1, wherein the graphic panel comprises a flexible film, and each graphical representation is applied to the flexible film.

5. The vehicle interior component of claim 1, wherein the sensor assembly comprises a multi-dimensional proximity sensor positioned behind the rear surface of the substrate and substantially aligned with the graphic panel.

6. The vehicle interior component of claim 1, wherein the sensor assembly comprises an optical sensing device having a field of view directed toward the graphic panel.

7. The vehicle interior component of claim 1, wherein the sensor assembly comprises a detectable element mounted in front of the show surface and a proximity sensor positioned behind the rear surface, wherein the sensor assembly is configured to output the second signal or the fourth signal upon movement of the detectable element toward the proximity sensor.

8. The vehicle interior component of claim 1, wherein the sensor assembly comprises a flexible layer and a proximity sensor applied to the flexible layer, and the flexible layer is positioned between the show surface of the substrate and the graphic panel.

9. The vehicle interior component of claim 8, wherein a light emitting layer is applied to the flexible layer or to the proximity sensor.

10. The vehicle interior component of claim 1, comprising a haptic feedback system configured to provide haptic feedback in response to detection of the presence of the activating object proximate to the first graphical representation or to the second graphical representation.

11. A vehicle interior component, comprising:

a substrate having a show surface facing an interior of a vehicle and a rear surface opposite the show surface; and

a control assembly having a graphic panel and a sensor assembly, wherein the graphic panel is fashioned on the substrate such that the graphic panel is visible on the

show surface, the graphic panel includes a first arrangement of first graphical representations of first controls or a second arrangement of second graphical representations of second controls, the first arrangement of the first graphical representations is different than the second arrangement of the second graphical representations, and the sensor assembly is configured to detect presence of an activating object proximate to each of the first and second graphical representations based on a position of the activating object relative to the graphic panel.

12. The vehicle interior component of claim 11, wherein the sensor assembly comprises a multi-dimensional proximity sensor positioned behind the rear surface of the substrate and substantially aligned with the graphic panel.

13. The vehicle interior component of claim 11, wherein the sensor assembly comprises an optical sensing device having a field of view directed toward the graphic panel.

14. The vehicle interior component of claim 11, wherein the graphic panel is selectable from a first graphic panel that includes the first arrangement of the first graphical representations, and a second graphic panel that includes the second arrangement of the second graphical representations.

15. The vehicle interior component of claim 11, wherein the control assembly comprises a controller configured to output a first signal indicative of actuation of one of the first controls upon detection of the activating object proximate to a corresponding first graphical representation, and the controller is configured to receive an expansion module configured to enable the controller to output a second signal indicative of actuation of one of the second controls upon detection of the activating object proximate to a corresponding second graphical representation.

16. A vehicle interior component, comprising:

a substrate having a show surface facing an interior of a vehicle and a rear surface opposite the show surface; and

a control assembly having a graphic panel and a sensor assembly, wherein the graphic panel is fashioned on the substrate such that the graphic panel is visible on the show surface, at least a portion of the sensor assembly is positioned behind the rear surface of the substrate, the graphic panel includes a graphical representation of a control, and the sensor assembly is configured to detect presence of an activating object proximate to the graphical representation of the control.

17. The vehicle interior component of claim 16, wherein the sensor assembly comprises a detectable element mounted in front of the show surface and a proximity sensor positioned behind the rear surface, wherein the sensor assembly is configured to detect the presence of the activating object upon movement of the detectable element toward the proximity sensor.

18. The vehicle interior component of claim 16, wherein the sensor assembly comprises a multi-dimensional proximity sensor positioned behind the rear surface of the substrate and substantially aligned with the graphic panel.

19. The vehicle interior component of claim 16, wherein the sensor assembly comprises a proximity sensor positioned behind the rear surface of the substrate.

20. The vehicle interior component of claim 19, wherein the sensor assembly comprises an optical sensing device having a field of view directed toward the graphic panel, and the sensor assembly is configured to detect the presence of the activating object proximate to the graphical representation of the control by optically detecting a position of the activating object relative to the graphic panel while the activating object is proximate to the proximity sensor.

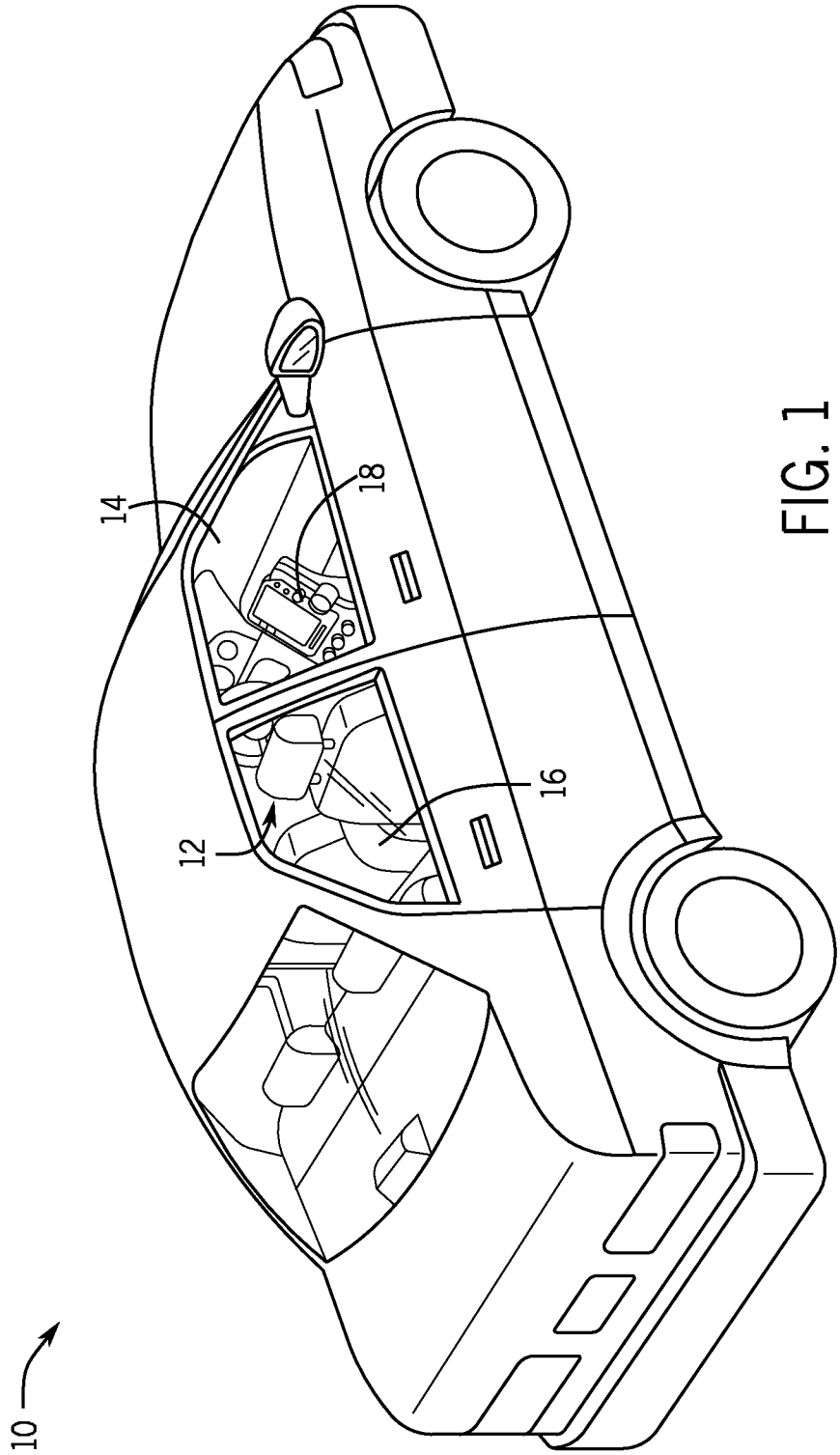
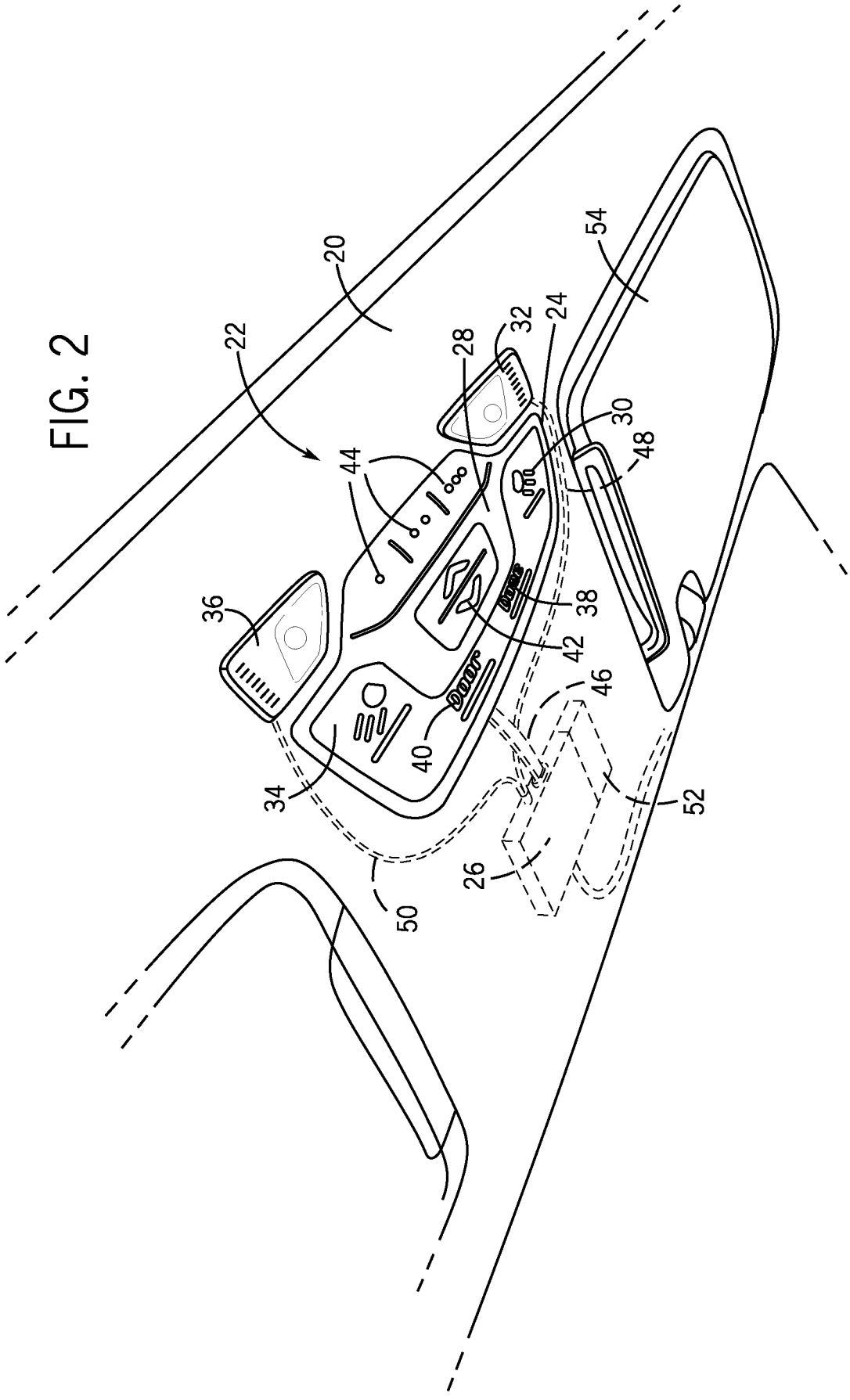


FIG. 1

FIG. 2



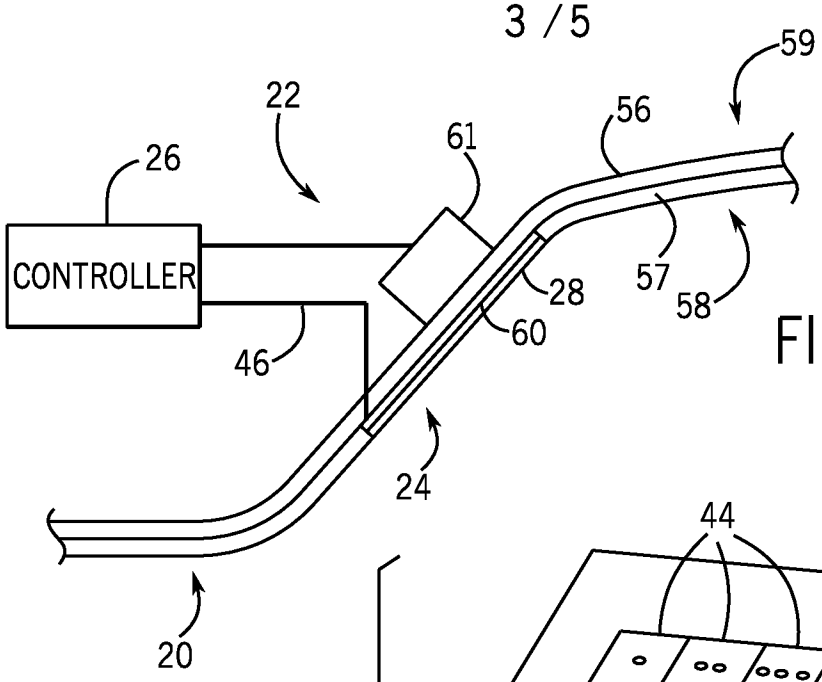


FIG. 3

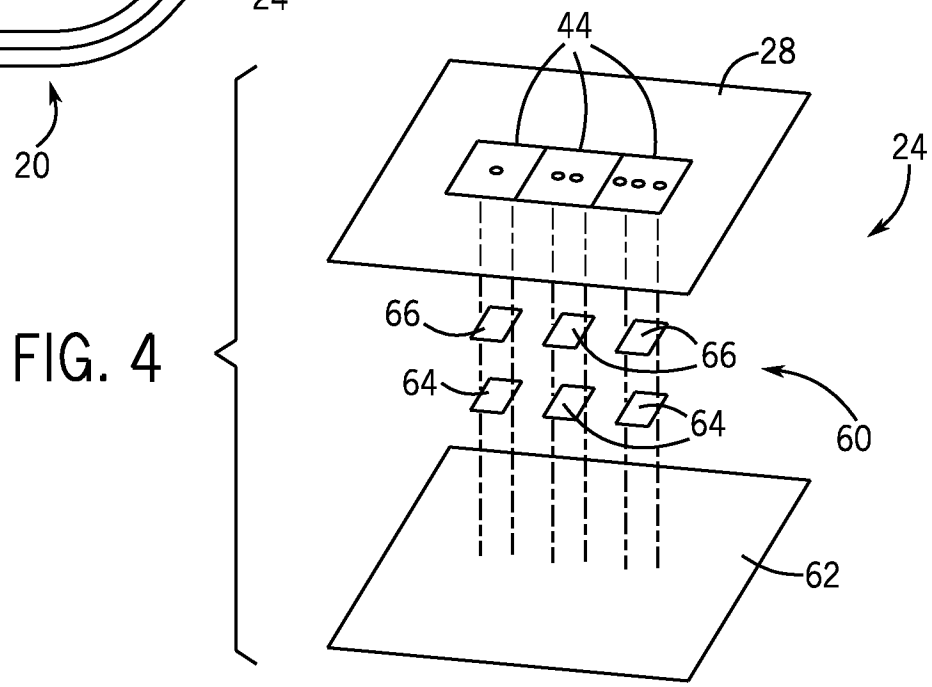


FIG. 4

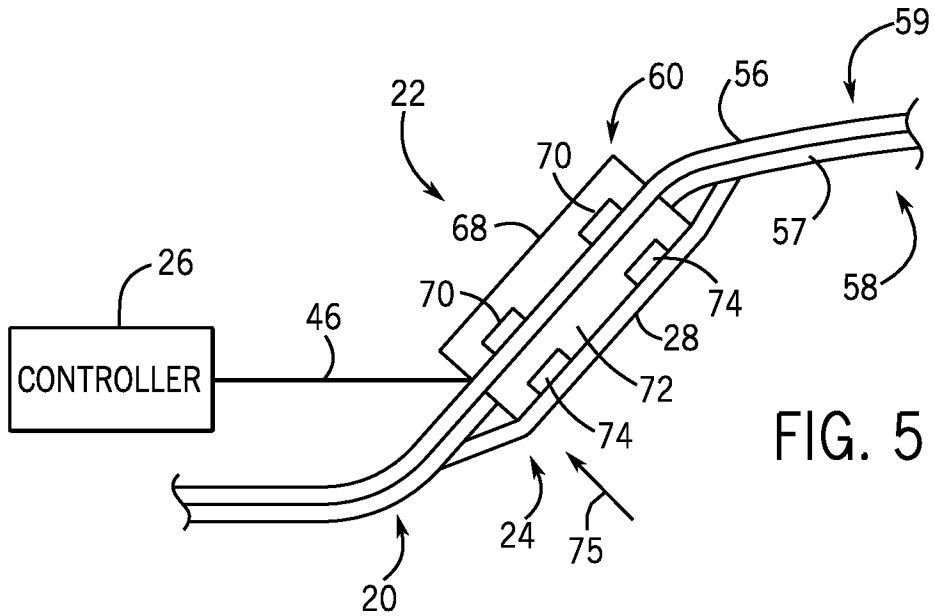


FIG. 5

FIG. 6

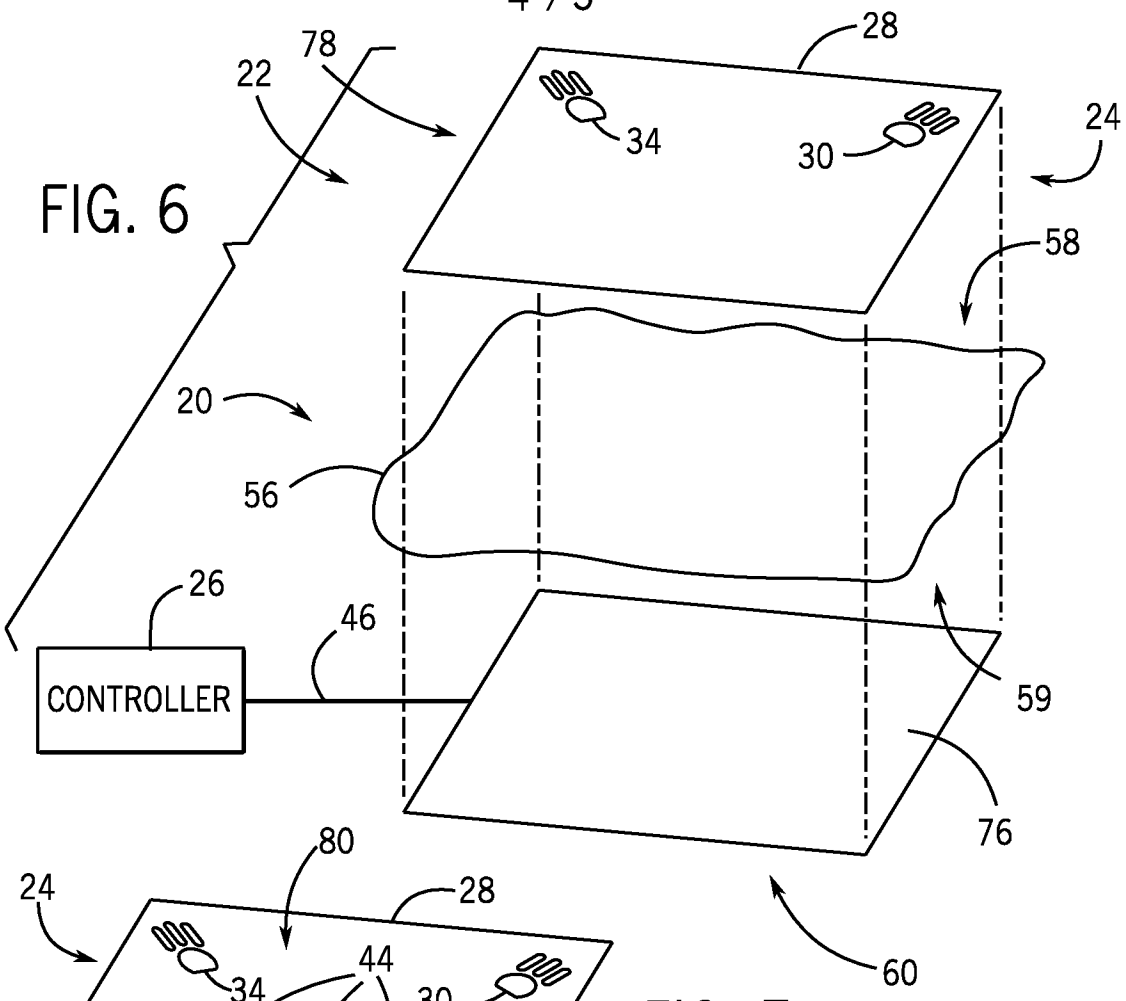


FIG. 7

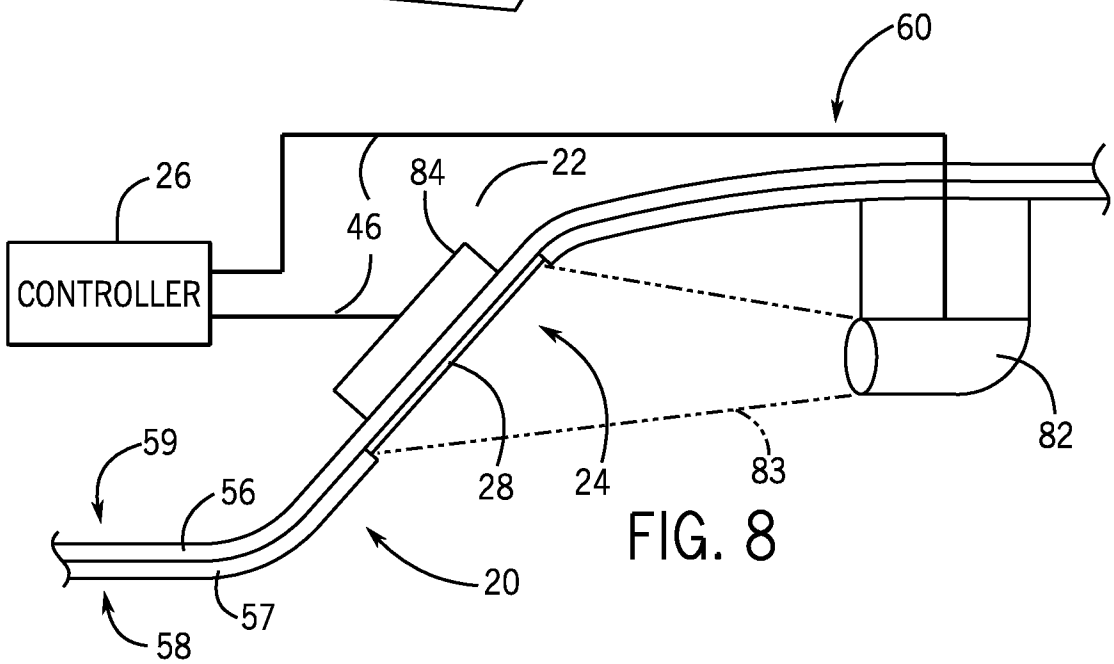


FIG. 8

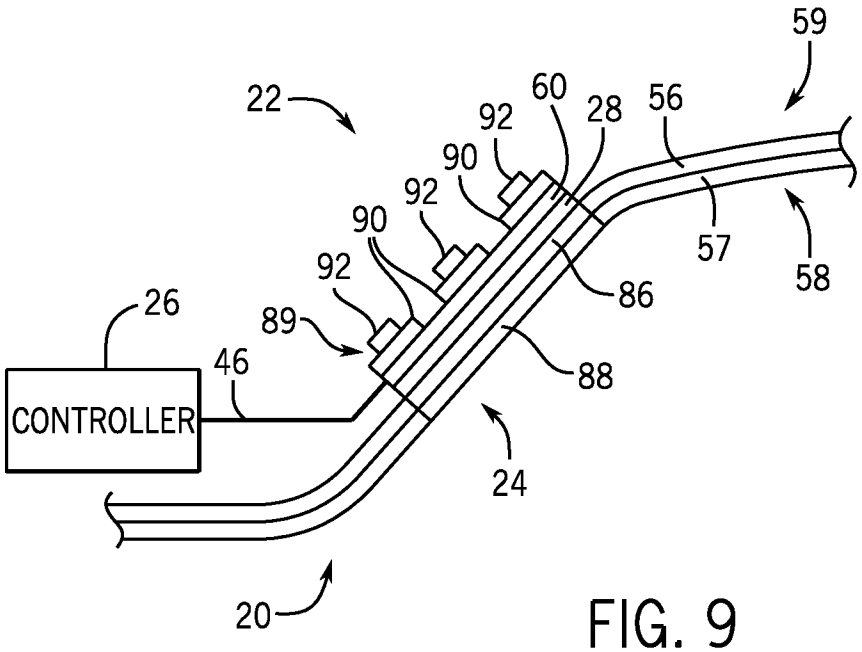


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/020310

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60K37/06 B60Q3/04 B60R13/02
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60K B60Q B60R

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/089092 A1 (JOHNSON CONTROLS TECH CO [US]; HAMELINK ROBERT [US]; MEYERS BRADLEY K) 16 July 2009 (2009-07-16) the whole document	11-20
A	US 2008/265629 A1 (FRY RYAN [US] ET AL) 30 October 2008 (2008-10-30) abstract	1-20
A	WO 03/065084 A1 (DONNELLY CORP [US]) 7 August 2003 (2003-08-07) the whole document	1-20

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

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 July 2014	31/07/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Brachmann, Patrick

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/020310

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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