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(54) **HEAD LAMPS FOR VEHICLES**

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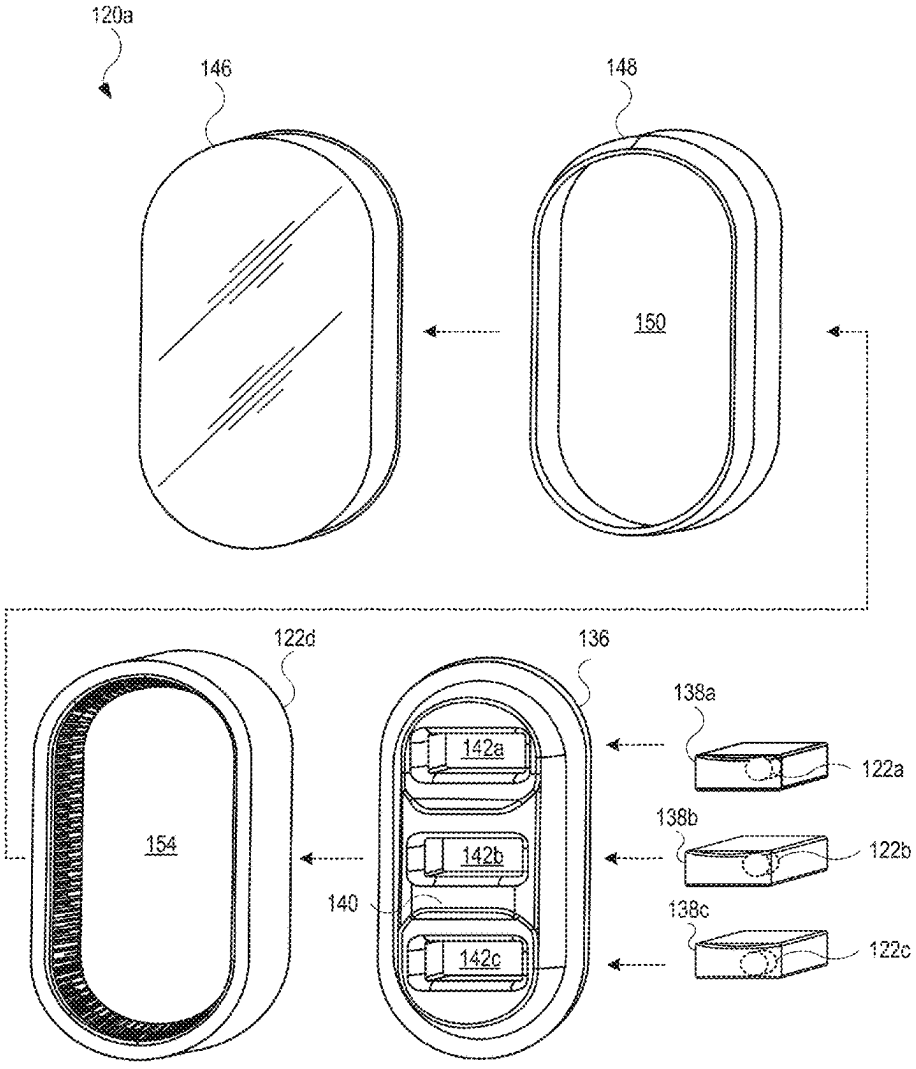
(57) **ABSTRACT**

A head lamp includes projector modules held by a carrier that is designed to move. The carrier may include a bezel with openings for the projector modules. The openings may receive a lens that covers a projector module. The head lamp may include an additional projector module that surrounds, or at least partially surrounds, the bezel and the aforementioned projector modules. The movement of the carrier and the bezel cause the lenses to move, and the movement of the lenses causes articulation of the respective beams of the projector modules.



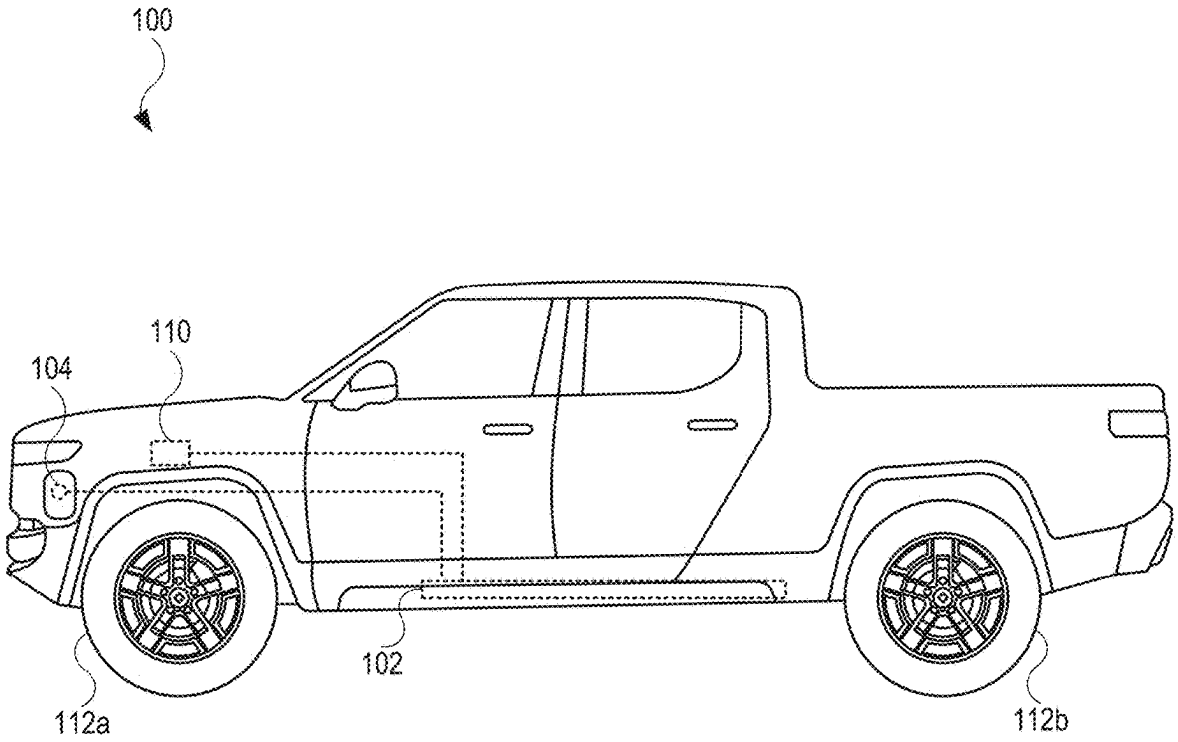



FIG. 1

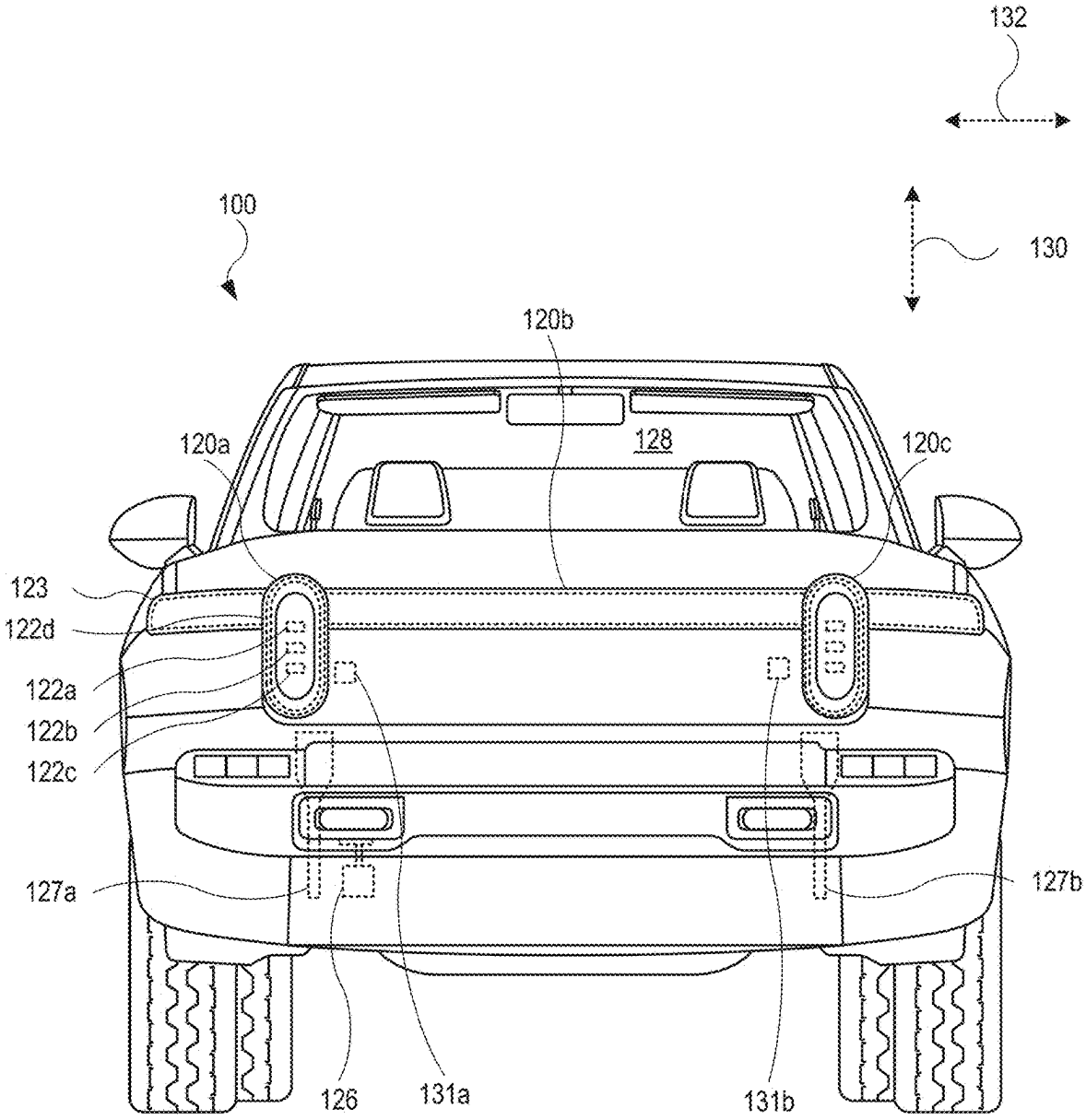

132
100
130
120b
120a
128
120c
123
122d
122a
122b
122c
127a
127b
126
131a
131b

FIG. 2

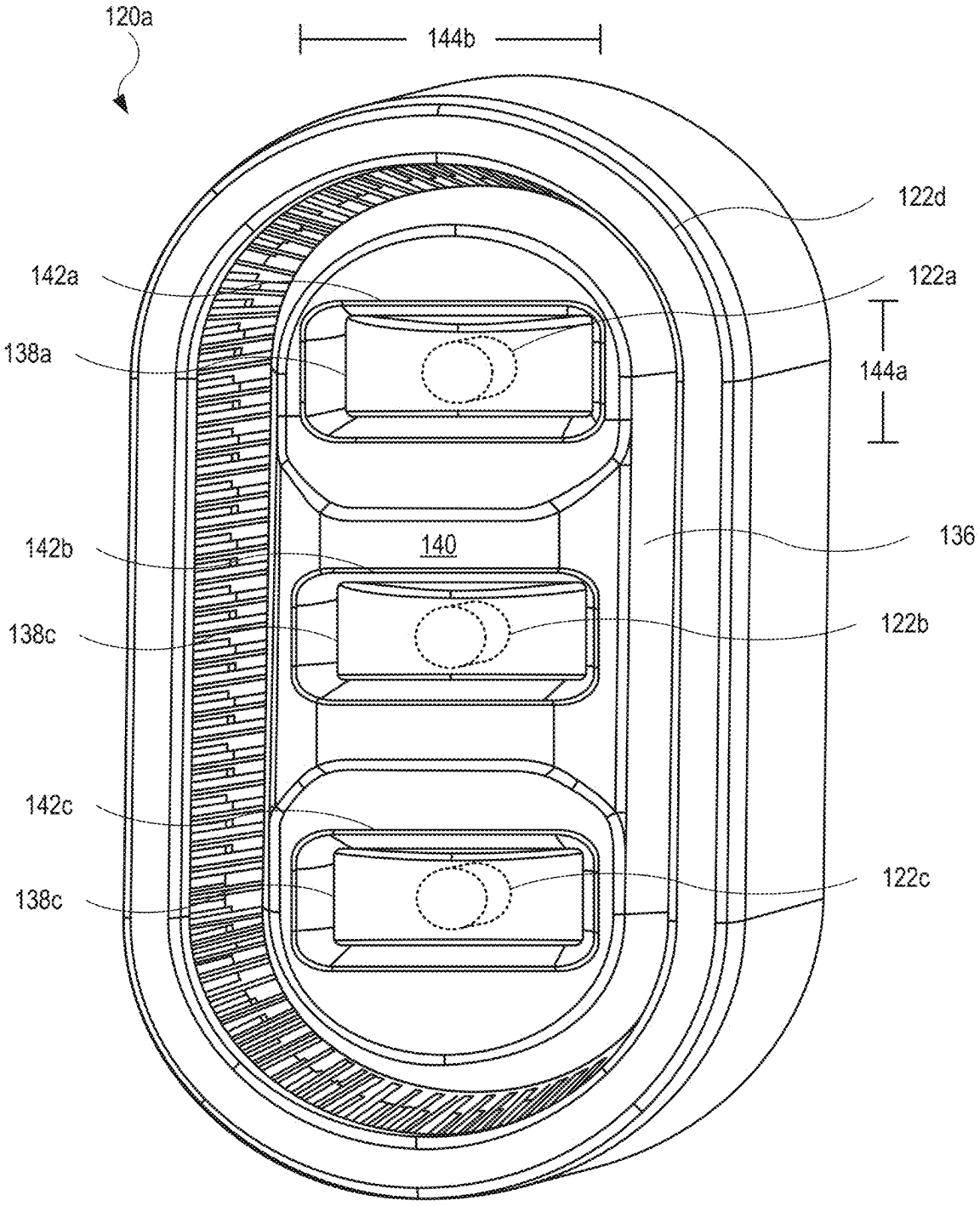

120a
144b
122d
142a
122a
138a
144a
140
136
142b
138c
122b
142c
138c
122c

FIG. 3

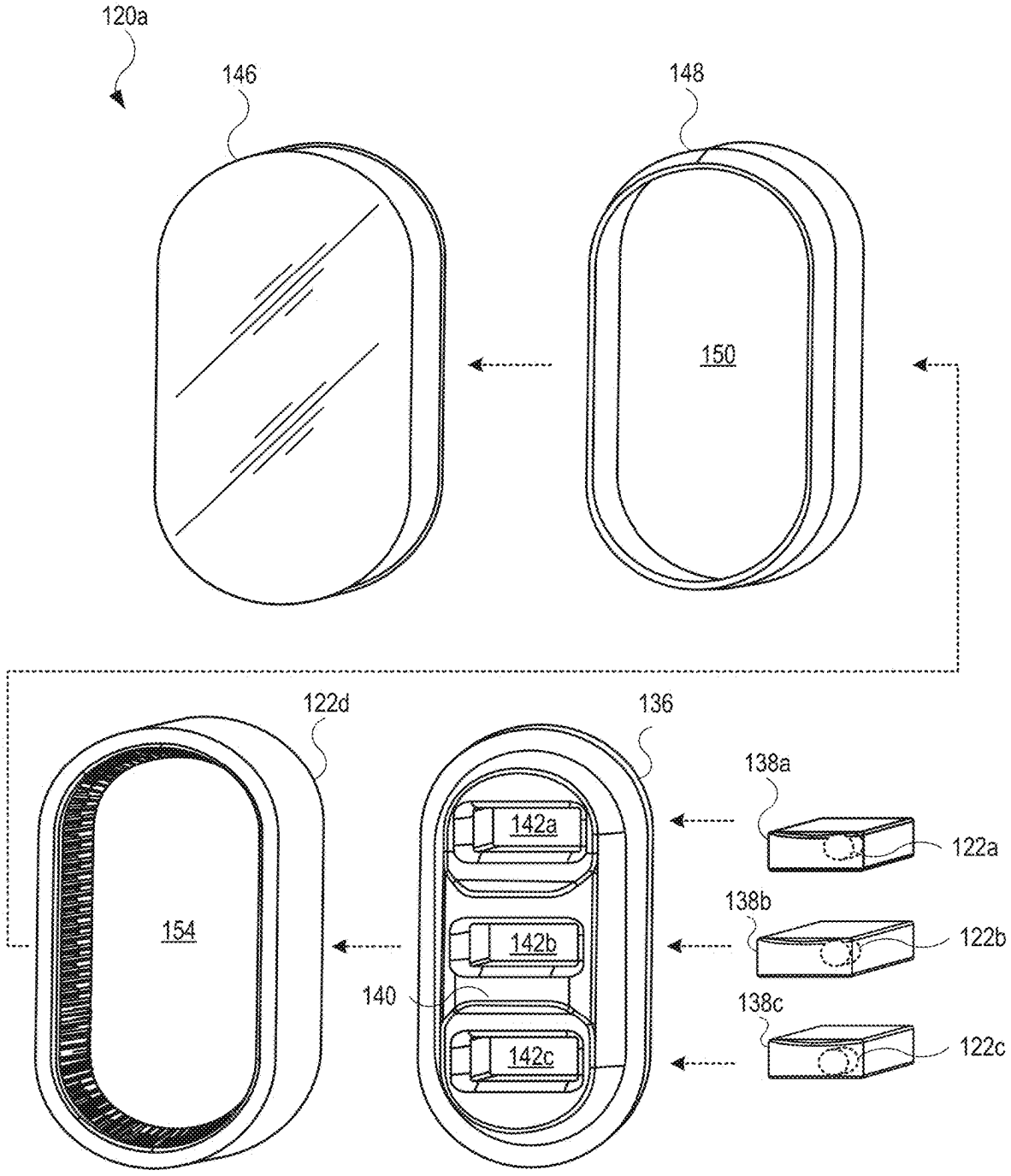

120a
146
148
150
122d
136
154
138a
142a
122a
138b
142b
122b
140
138c
142c
122c

FIG. 4

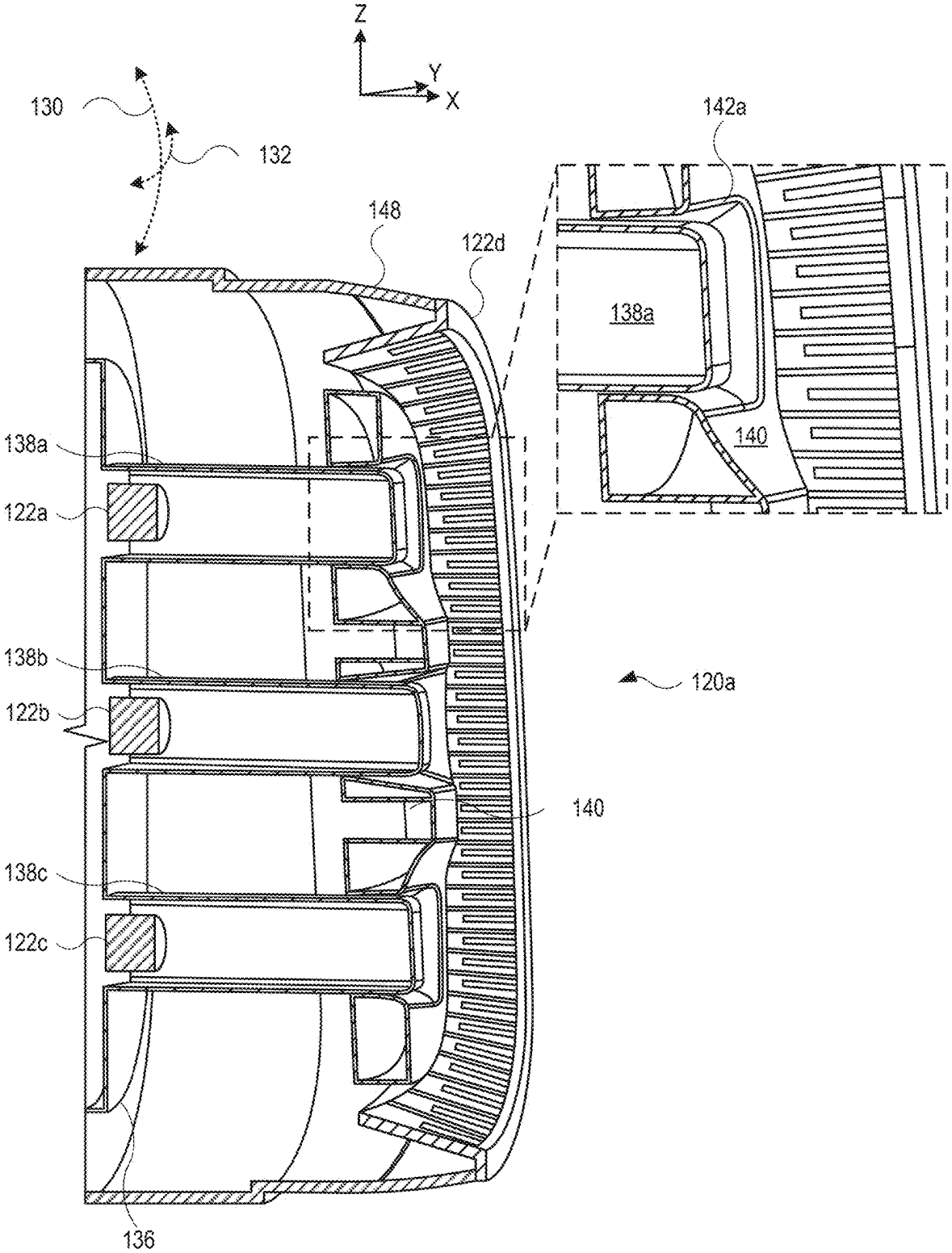

Z
Y
X
130
132
148
122d
142a
138a
140
138a
122a
138b
122b
120a
140
138c
122c
136

FIG. 5

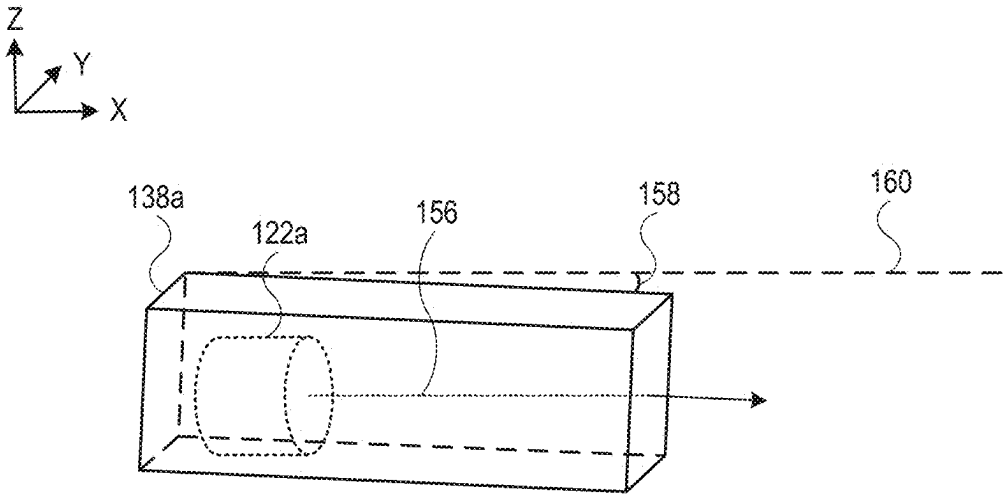



FIG. 6A

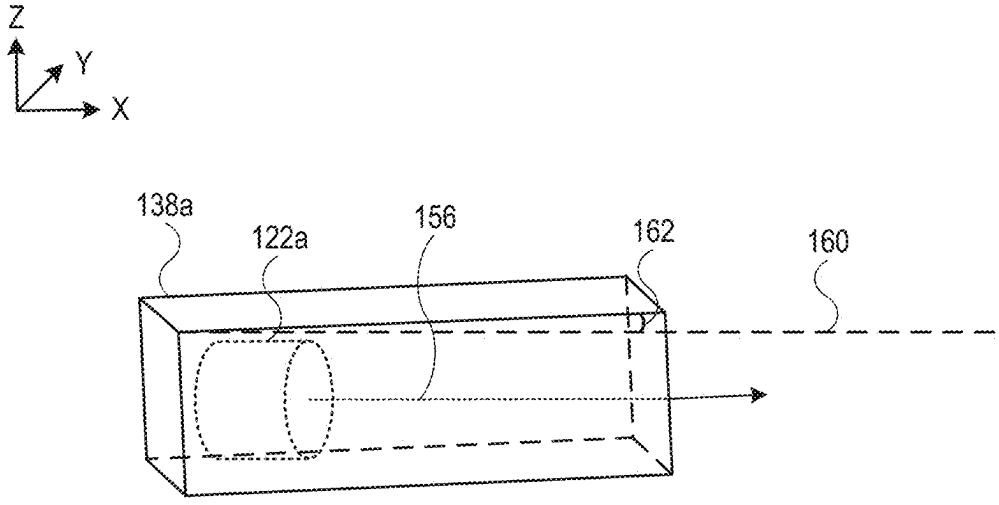



FIG. 6B

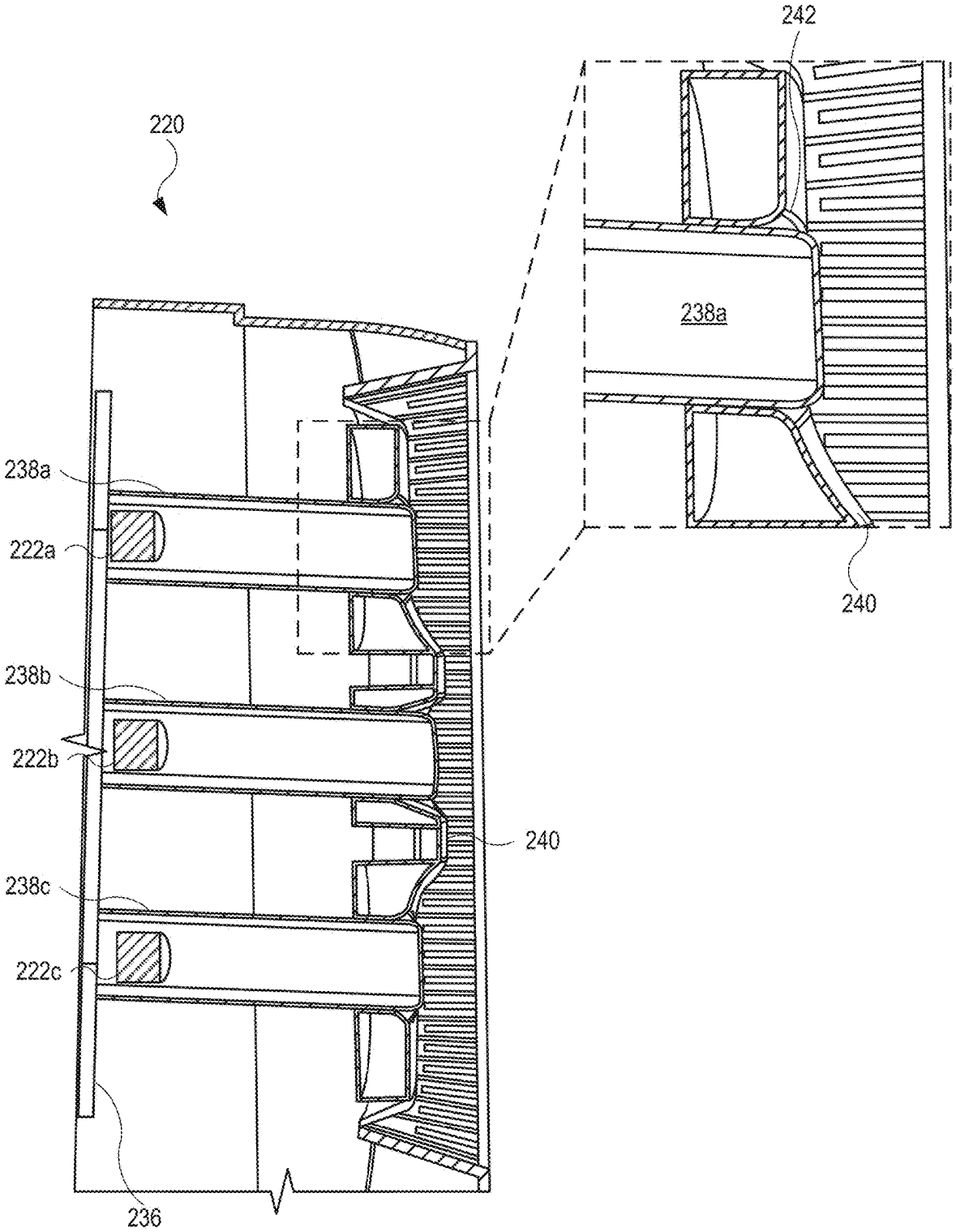



FIG. 7

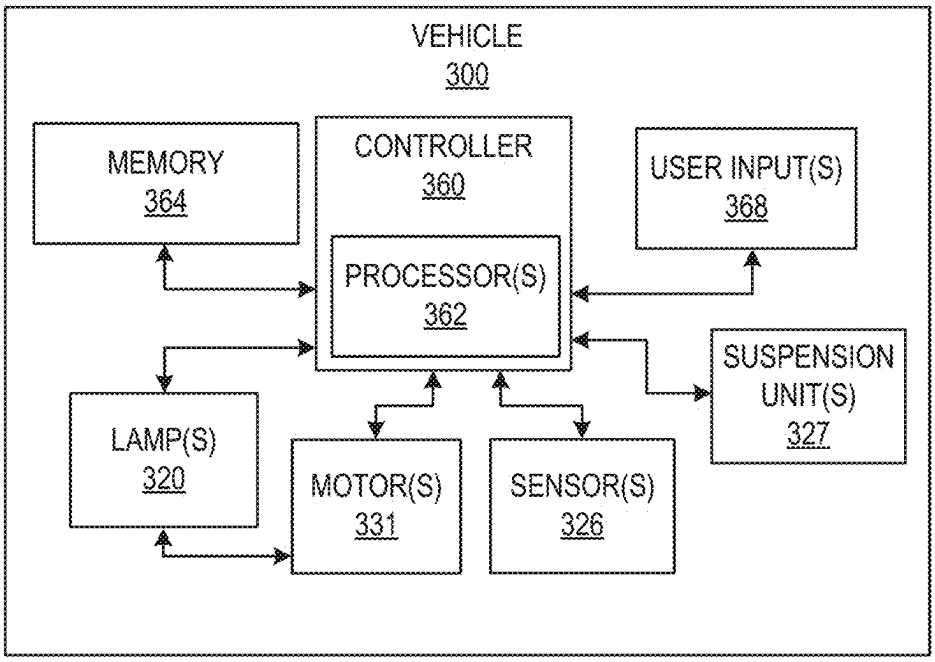

VEHICLE
300
MEMORY
364
CONTROLLER
360
PROCESSOR(S)
362
USER INPUT(S)
368
SUSPENSION
UNIT(S)
327
LAMP(S)
320
MOTOR(S)
331
SENSOR(S)
326

FIG. 8

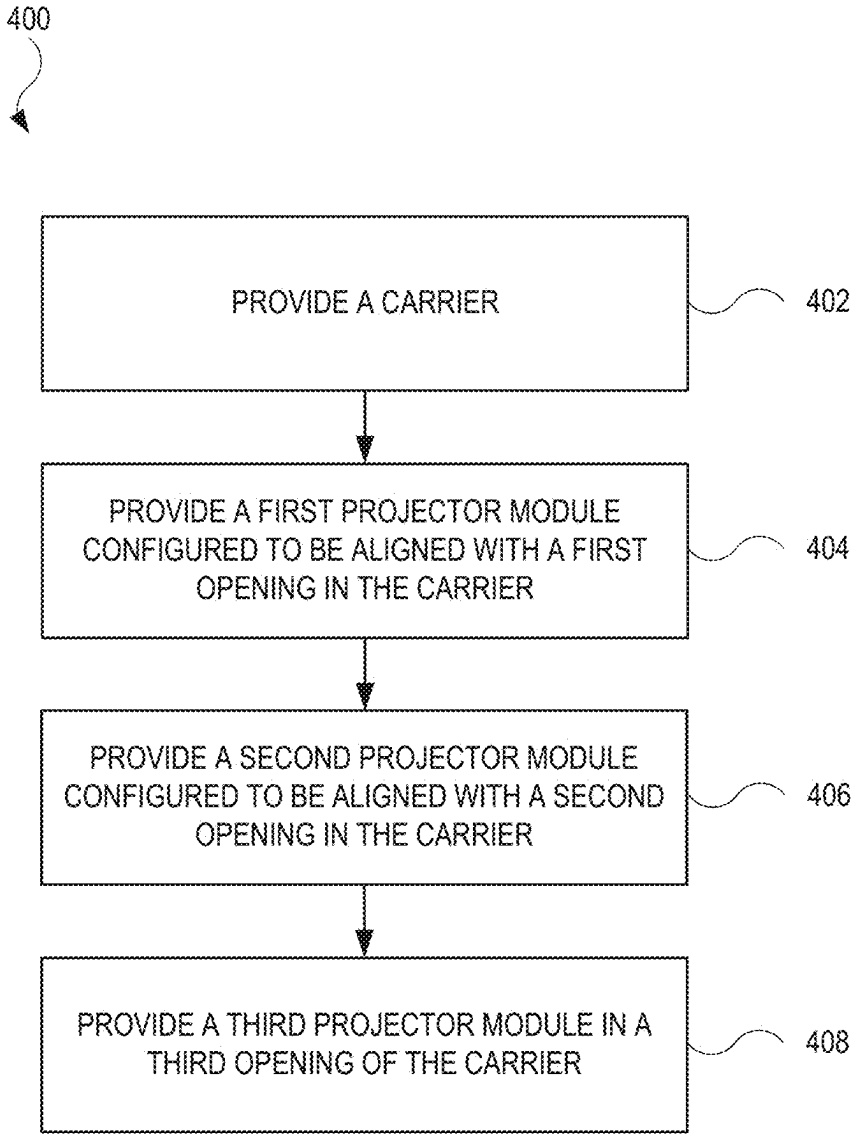

400
PROVIDE A CARRIER
402
PROVIDE A FIRST PROJECTOR MODULE CONFIGURED TO BE ALIGNED WITH A FIRST OPENING IN THE CARRIER
404
PROVIDE A SECOND PROJECTOR MODULE CONFIGURED TO BE ALIGNED WITH A SECOND OPENING IN THE CARRIER
406
PROVIDE A THIRD PROJECTOR MODULE IN A THIRD OPENING OF THE CARRIER
408

FIG. 9

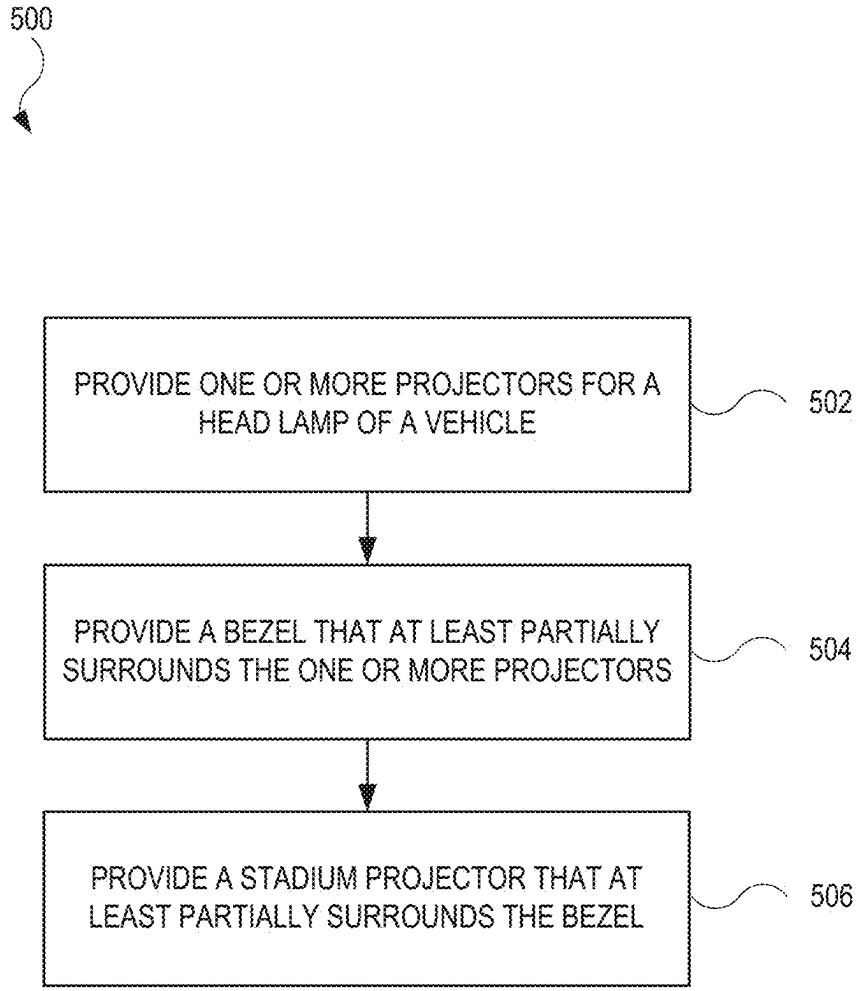

500
PROVIDE ONE OR MORE PROJECTORS FOR A HEAD LAMP OF A VEHICLE
502
PROVIDE A BEZEL THAT AT LEAST PARTIALLY SURROUNDS THE ONE OR MORE PROJECTORS
504
PROVIDE A STADIUM PROJECTOR THAT AT LEAST PARTIALLY SURROUNDS THE BEZEL
506

FIG. 10

# HEAD LAMPS FOR VEHICLES

## CROSS-REFERENCE TO RELATED APPLICATION(S)

**[0001]** This application claims priority to U.S. Provisional Application No. 63/553,597, filed Feb. 14, 2024, titled "HEAD LAMPS FOR VEHICLES", the disclosure of which is incorporated herein by reference in its entirety.

## INTRODUCTION

**[0002]** This application is directed to vehicles, and more particularly, to head lamps of vehicles.

## SUMMARY

**[0003]** Head lamps used with vehicles may provide illumination to assist drivers in seeing the road or landscape in front of the vehicle. Head lamps may include one or more projector modules, as well as lenses held in place by a carrier.

**[0004]** In accordance with one or more aspects of the present disclosure, an apparatus is described. The apparatus may include a carrier configured to hold a first projector module, a second projector module, and a third projector module for a vehicle. The carrier including a bezel configured to surround the first projector module, the second projector module, and the third projector module. The carrier may be at least partially surrounded by a fourth projector module. The carrier may include a single-piece carrier and may be configured to be positioned in a head lamp housing, and the fourth projector module at least partially surrounds the bezel, the first projector module, the second projector module, and the third projector module.

**[0005]** The first projector module and the second projector module may combine to provide a first light intensity in a first mode of operation, and the first projector module, the second projector module, and the third projector module may combine to provide a second light intensity in a second mode, the second light intensity greater than the first light intensity. The second projector module may be positioned between the first projector module and the third projector module, and the second projector module may be adjacent to the first projector module and the third projector module.

**[0006]** The apparatus may further include a first lens configured to cover the first projector module; a second lens configured to cover the second projector module; and a third lens configured to cover the third projector module. The carrier may be movable with respect to the fourth projector module, and based on movement of the carrier, the first lens, the second lens, and the third lens are movable relative to the fourth projector module. The fourth projector module may extend around the first projector module, the second projector module, and the third projector module. The carrier may be configured to move in response to a change in ride height of the vehicle.

**[0007]** In accordance with one or more aspects of the present disclosure, a head lamp is described. The head lamp may include a housing configured to receive: a unitary carrier configured to hold a first projector module and a second projector module, and a third projector module that surrounds the first projector and the second projector. The head lamp may further include a transparent cover coupled with the housing. The transparent cover may overlay the unitary carrier and the third projector module. The unitary carrier may be further configured to carry the third projector module. The unitary carrier may be movable with respect to the third projector module, thereby causing movement of the first projector module and the second projector module. Based on the movement of the unitary carrier, the first projector module may include an adaptive driving projector module.

**[0008]** The first projector module may be positioned in a first opening of the unitary carrier, and the first opening may include a first dimension and a second dimension, the second dimension being at least two times greater than the first dimension. The second projector module may be positioned in a second opening of the unitary carrier, and the second opening may include the first dimension and the second dimension. The unitary carrier may include an oblong shape, each of the first opening and the second opening may include a rectangular shape.

**[0009]** The head lamp may further include a bezel surrounded by the third projector module. The first projector module and the second projector module may align with respective openings of the bezel.

**[0010]** In accordance with one or more aspects of the present disclosure, a vehicle is be described. The head lamp may include a head lamp, including: a unitary carrier configured to hold a first projector module, a second projector module, and a third projector module, and a fourth projector module that surrounds the first projector module, the second projector module, and the third projector module. The head lamp may further include a transparent cover that overlays the unitary carrier and the fourth projector module. Based on movement of the unitary carrier, the first projector module, the second projector module, and the third projector module are movable with respect to the fourth projector module.

**[0011]** The unity carrier may be configured to move in response to a change in movement of the vehicle. The first projector module may be positioned in a first opening of the carrier, the first opening may include a first dimension and a second dimension, the second dimension being at least two times greater than the first dimension, the second projector module and the third projector module are positioned in a second opening and a third opening, respectively, of the carrier, and each of the second opening and the third opening may include the first dimension and the second dimension.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0012]** Certain features of the subject technology are set forth in the appended claims. However, for purpose of explanation, several embodiments of the subject technology are set forth in the following figures.

**[0013]** FIG. **1** illustrates a side view of an example of a vehicle, in accordance with one or more aspects of the present disclosure.

**[0014]** FIG. **2** illustrates a front view of a vehicle, in accordance with one or more aspects of the present disclosure.

**[0015]** FIG. **3** illustrates a perspective view of a lamp, in accordance with one or more aspects of the present disclosure.

**[0016]** FIG. **4** illustrates an exploded view of a lamp, in accordance with one or more aspects of the present disclosure.

**[0017]** FIG. **5** illustrates a partial cross sectional view of a lamp, in accordance with one or more aspects of the present disclosure.

**[0018]** FIG. **6**A and FIG. **6**B illustrate perspective views of a projector module and a lens, showing articulation of a beam of the projector module based on movement of the lens, in accordance with one or more aspects of the present disclosure.

**[0019]** FIG. **7** illustrates a partial cross sectional view of an additional, alternate example of a head lamp, in accordance with one or more aspects of the present disclosure.

**[0020]** FIG. **8** illustrates a block diagram of a vehicle, in accordance with aspects of the present disclosure.

**[0021]** FIG. **9** and FIG. **10** illustrate flow diagrams showing exemplary processes that may be performed for assembling a head lamp, in accordance with one or more aspects of the present disclosure.

**[0022]** An Appendix is also attached with which one or more implementations of the subject technology may be implemented.

## DETAILED DESCRIPTION

**[0023]** The detailed description set forth below is intended as a description of various configurations of the subject technology and is not intended to represent the only configurations in which the subject technology can be practiced. The appended drawings are incorporated herein and constitute a part of the detailed description. An Appendix is also attached with which one or more implementations of the subject technology may be implemented. The detailed description includes specific details for the purpose of providing a thorough understanding of the subject technology. However, the subject technology is not limited to the specific details set forth herein and can be practiced using one or more other implementations. In one or more implementations, structures and components are shown in block diagram form in order to avoid obscuring the concepts of the subject technology.

**[0024]** This disclosure is directed to lamps, including head lamps, for vehicles. Lamps described herein may include one or more projector modules, or simply projectors, that function as light sources. Depending on the desired light intensity (e.g., low-beam, high beam) or driving mode, the number of projector modules illuminated (e.g., generating light) may vary. The lamp may further include a carrier designed to hold the projector modules, including respective lenses covering the modules. The lamp may include an additional projector module (e.g., stadium projector) that surrounds the aforementioned modules. In one or more implementations, the carrier is movable with respect to the additional projector module, thus allowing for articulation of the respective beams (e.g., light beams), including a beam path of the beams, of the projector modules. The articulation of the beams may function to account for build tolerances of the vehicle assembly and/or to change a beam path (e.g., light beam path) for the projector modules when a ride height of the vehicle is adjusted. Additionally, the beams of the projector modules may be articulated to provide adaptive driving beams to account for a change in movement (e.g., driving direction) of the vehicle. Articulation of the beams may be due in part to movement of lens (held by the carrier) or to movement of the projector modules themselves.

**[0025]** FIG. **1** illustrates an example of a vehicle **100**, in accordance with aspects of the present disclosure. In one or more implementations, the vehicle **100** is a sport utility vehicle (SUV). In the exemplary implementation shown in FIG. **1**, the vehicle **100** is a truck. Generally, the vehicle **100** may take the form of any motorized vehicle, including motorized vehicles with an internal combustion engine and/or one or more electric motors. Accordingly, other implementations of the vehicle **100** may include land-based vehicles, such as a car (e.g., sedan, hatchback), a van, or a commercial truck, as non-limiting examples.

**[0026]** The vehicle **100** may include a battery pack **102**. The battery pack **102** may be coupled (e.g., electrically coupled) to one or more electrical systems of the vehicle **100** to provide power to the one or more electrical systems. The vehicle **100** may further include a port **104** (e.g., charge port) designed to receive a cable connector (not shown in FIG. **1**) used to transmit power (e.g., alternating current (AC) power) that is converted to direct current (DC) power to charge the battery pack **102**. The battery pack **102** may couple (e.g., electrically couple) to a drive unit **110**, representative of one or more drive units of the vehicle **100**. While the drive unit **110** is shown as generally being in the front of the vehicle **100**, the drive unit **110** may be located in the rear of the vehicle **100**. When multiple drives units are implemented in the vehicle **100**, at least one drive may be located in the front of the vehicle **100** and at least one drive unit may be located in the rear of the vehicle **100**. Further, when multiple drive units are used, at least one drive unit may be in the front of the vehicle to drive the front wheels (e.g., wheel **112***a*), and at least one drive unit may be in the rear of the vehicle to drive the rear wheels (e.g., wheel **112***b*). The drive unit **110** may include, for example, a motor, an inverter, a gear box, and a differential. In the example shown in FIG. **1**, the drive unit **110** takes the form of an electric motor. In this regard, the drive unit **110** may use energy (e.g., electrical energy) stored in the battery pack **102** for propulsion in order to drive (e.g., rotationally drive) wheels of the vehicle **100**, thus causing movement of the vehicle **100**.

**[0027]** FIG. **2** illustrates a front view of the vehicle **100**, in accordance with one or more aspects of the present disclosure. The vehicle **100** may include several lamps. For example, in one or more implementations, the vehicle **100** includes a lamp **120***a*, a lamp **120***b*, and a lamp **120***c*. Each of the lamps **120***a*, **120***b*, and **120***c* may include one or more projector modules, or projectors, that provide one or more lights sources designed to illuminate and increase visibility for passengers in a cabin **128** of the vehicle **100**. For example, the lamp **120***a* (representative of the lamp **120***c*) includes a projector module **122***a*, a projector module, **122***b*, and a projector module **122***c*. Additionally, the lamp **120***a* may further include a projector module **122***d* that surrounds, or at least partially surrounds, the projector modules **122***a*, **122***b*, and **122***c*. The lamp **120***a* may further include an extended portion **123**, or extension, that provides an additional projector module. Also, the lamp **120***b* may include a projector module (shown, not labeled). Projector modules shown and/or described herein may take the form of an LED or an incandescent bulb, as non-limiting examples. The lamps **120***a* and **120***c* may be referred to as head lights or head lamps, and the lamp **120***b* may be referred to as a center lamp. The vehicle **100** may further include a power supply, such as a battery pack **102** (shown in FIG. **1**), that provides energy (e.g., electrical energy) to illuminate the projector modules **122***a*, **122***b*, **122***c*, and **122***d*, as well as other projector modules shown and/or described in FIG. **2**. However, in one or more implementations, the vehicle **100** includes a separate power source (e.g., 12-Volt battery) to illuminate the aforementioned projector modules.

**[0028]** Additionally, the vehicle **100** may include a sensor **126**. In one or more implementations, the sensor **126** takes the form of a ride height sensor. Accordingly, the sensor **126** may determine a current height (e.g., current ride height) of the vehicle **100** and a change in height of the vehicle **100** relative to, for example, a road or surface on which the vehicle **100** is located. As shown, the sensor **126** is located at, or generally at, a front end of the vehicle **100**. Although not shown, the vehicle **100** may further include a sensor located at, or generally at, a front end of the vehicle **100**, with the sensor including any features and/or characteristics described for the sensor **126**.

**[0029]** The vehicle **100** may include a suspension system, shown as including a suspension unit **127***a* and a suspension unit **127***b* (each representative of one or more additional suspension units), that is capable of adjusting regions of the vehicle **100**, such as the cabin **128** (e.g., space for passengers) and/or a chassis (not shown in FIG. **2**) of the vehicle **100**, in either of two directions indicated by the two-sided arrow **130**. In one or more implementations, each of the suspension units **127***a* and **127***b* takes the form of an air suspension unit or air ride suspension unit, and the suspension system takes the form of an air suspension system. Conversely, in one or more implementations, each of the suspension units **127***a* and **127***b* takes the form of a shock and strut system, and the suspension system takes the form of a standard suspension system.

**[0030]** When the vehicle **100** is moved in either direction of the two-sided arrow **130**, the sensor **126** determines the current height of the vehicle **100**. When the suspension system takes the form of an air suspension system, the lamps **120***a* and **120***b*, including their respective projector modules, may automatically articulate and re-level in response to a change in ride height. Conversely, when the suspension system takes the form of a standard suspension system, the vehicle **100** may use the information (e.g., current height data) provided by the sensor **126** to articulate at least some beams (e.g., light beams) from the respective projector modules of the lamps **120***a* and **120***b*, thus causing a change in direction (e.g., angular direction) of emitted lights from the respective beams. For example, the vehicle **100** may articulate the respective beams the projector modules **122***a*, **122***b*, and **122***c* based on the current ride height (along the two-sided arrow **130**) of the vehicle **100**. In this regard, the vehicle may include a motor **131***a* and a motor **131***b* designed to articulate the lamp **120***a* and the lamp **120***b*, respectively, thus causing a change in direction (e.g., angular direction) of emitted lights from the respective beams of the lamps **120***a* and **120***b*. As non-limiting examples, each of the motors **131***a* and **131***b* may take the form of a DC motor, including a stepper motor or servo motor. The degree or angle at which projector modules **122***a*, **122***b*, and **122***c* project light may vary based upon the ride height of the vehicle **100**. In this regard, when the height of the vehicle increases, the projector modules **122***a*, **122***b*, and **122***c* may be tilted lower (e.g., decreased angle) and conversely, when the height of the vehicle decreases, the projector modules **122***a*, **122***b*, and **122***c* may be tilted higher (e.g., increased angle). Additionally, the sensor **126**, when implemented as a ride height sensor, may be used by the vehicle **100** adjust the ride height of the vehicle **100** while the vehicle **100** is in operation. For example, the vehicle **100** may lower the ride height when the vehicle **100** reaches or exceeds a predetermined speed (e.g., **65** miles per hour). The sensor **126** may be used as an input to the vehicle **100** to determine the current ride height of the vehicle **100**, which may be subsequently used by the vehicle **100** to articulate the respective beams the projector modules **122***a*, **122***b*, and **122***c*.

**[0031]** Moreover, the vehicle **100** may include additional sensors and/or additional received data that determines movement (e.g., direction of travel) of the vehicle **100**. As a result, the vehicle **100** may articulate the respective beams of the projector modules **122***a*, **122***b*, and **122***c* in either direction of the two-sided arrow **132**. As an example, when the vehicle **100** turns left or right, the respective beams of the projector modules **122***a*, **122***b*, and **122***c* may be adjusted to the left or right, respectively, thus providing adaptive driving beams that adjust to the surface on which the vehicle **100** is traveling to be better illuminate the surface in front of the vehicle **100**. Further, mode of operation of the vehicle **100** may change based on a change to the driving mode, with exemplary drive modes including, but not limited to, on-road, off-road, all-purpose, conservative, sport, and snow modes. Based on the selected drive mode for the vehicle **100**, the vehicle **100** may articulate the respective light beams of the projector modules **122***a*, **122***b*, and **122***c* for the selected driving mode.

**[0032]** FIG. **3** illustrates a perspective view of the lamp **120***a*, in accordance with one or more aspects of the present disclosure. The lamp **120***a* may be referred to an apparatus. Accordingly, an apparatus described herein may be implemented in a vehicle (e.g., vehicle **100** shown in FIG. **2**). For purposes of simplicity, the extended portion **123** (shown in FIG. **2**) of the lamp **120***a* is not illustrated. The lamp **120***a* may include a carrier **136** designed to hold several components of the lamp **120***a*. In one or more implementations, the carrier **136** takes the form of a unitary carrier. For example, the carrier **136** may include a single-piece carrier formed from a molded material (e.g., molded plastic material) and taking the form of a unitary carrier. The carrier **136** may hold, or at least provide a space for, the projector modules **122***a*, **122***b*, and **122***c*. Additionally, the carrier **136** may hold a lens **138***a*, a lens **138***b*, and a lens **138***c*. Each of the lenses **138***a*, **138***b*, and **138***c* may include a transparent material, such as a transparent plastic. As shown, the lens **138***a*, the lens **138***b*, and the lens **138***c* cover the projector module **122***a*, the projector module **122***b*, and the projector module **122***c*, respectively.

**[0033]** One or more of the projector modules **122***a*, **122***b*, and **122***c* may illuminate and provide a light beam. Further, the projector modules **122***a*, **122***b*, and **122***c* may illuminate based upon a mode of operation of the vehicle **100** (shown in FIG. **2**). For example, each of the projector modules **122***a* and **122***b* may illuminate to provide a low-beam mode for the vehicle **100** that provide a light intensity in accordance with the illumination of the projector modules **122***a* and **122***b*. Alternatively, each of the projector modules **122***a*, **122***b*, and **122***c* may illuminate to provide a high-beam mode for the vehicle **100** that provide a light intensity in accordance with the illumination of the projector modules **122***a*, **122***b*, and **122***c*, with the high-beam mode providing a greater light intensity than that of the low-beam mode. In one or more implementations, the projector module **122***d* is illuminated independently with respect to the illumination of the projector modules **122***a*, **122***b*, and **122***c*.

**[0034]** The carrier **136** may include a bezel **140**. Each of the projector modules **122***a*, **122***b*, and **122***c* and each of the

lenses **138***a*, **138***b*, and **138***c* may align with a respective opening of the bezel **140**. For example, the bezel **140** may include an opening **142***a*, an opening **142***b*, and opening **142***c*. As shown, the projector module **122***a* and the lens **138***a* align with the opening **142***a*, the projector module **122***b* and the lens **138***b* align with the opening **142***b*, and the projector module **122***c* and the lens **138***c* align with the opening **142***c*. Further, the lens **138***a*, the lens **138***b*, and the lens **138***c* may protrude, or at least partially protrude, through the opening **142***a*, the opening **142***b*, and the opening **142***c*, respectively. In this regard, the carrier **136**, including the bezel **140**, is designed to carry at least the lenses **138***a*, **138***b*, and **138***c*.

**[0035]** As shown, the openings **142***a*, **142***b*, and **142***c* may include a rectangular shape. In this regard, the opening **142***a* (representative of the openings **142***b* and **142***c*) may include a dimension **144***a* (e.g., height) and a dimension **144***b* (e.g., width). In one or more implementations, the dimension **144***a* (e.g., height) is approximately in the range of 15 to 30 millimeters (mm) and the dimension **144***b* is approximately in the range of 55 to 70 mm. The dimension **144***a* may be 20 mm and the dimension **144***b* may be 50 mm. Accordingly, the dimension **144***b* may be at least two times greater than the dimension **144***a*.

**[0036]** Based on the dimension **144***a* of the opening **142***a*, the corresponding dimension (e.g., height) of the lens **138***a* (located in the opening **142***a*) may not be greater than the dimension **144***a*. Moreover, in order to ensure the lens **138***a* fits into the opening **142***a*, the corresponding dimension of the lens **138***a* may be smaller than the dimension **144***a*. Reducing lens height may reduce light out from an optical system (e.g., projector module **122***a*), which leads to loss of beam reach and width (e.g., light beam reach and width from the projector module **122***a*). In order counter the loss of beam reach and width and to achieve or exceed an acceptable safety score from rating institutions, the source lumens in the projector modules (e.g., projector module **122***a*) may be increased. Accordingly, the percent increase in source lumens may be inversely proportional to lens height.

**[0037]** FIG. **4** illustrates an exploded view of the lamp **120***a*, in accordance with one or more aspects of the present disclosure. The lamp **120***a* may include a cover **146**. In one or more implementations, the cover **146** takes the form of a transparent cover, and may be formed from glass, transparent plastic, or a combination thereof, as non-limiting examples. The lamp **120***a* may further include a housing **148**. The housing **148** may include one or more opaque materials, such as a metal(s), opaque plastic, or a combination thereof, as non-limiting examples. In one or more implementations, each of the cover **146** and projector module **122***d* connects, or mates, with the housing **148**. When the lamp **120***a* is assembled, the cover **146** may overlay the housing **148**. Further, the housing **148** may define a space **150** to receive the carrier **136** (including the bezel), the projector modules **122***a*, **122***b*, and **122***c*, and the lenses **138***a*, **138***b*, and **138***c*. In this regard, the cover **146** may overlay the projector modules **122***a*, **122***b*, and **122***c*, the carrier **136**, and the lenses **138***a*, **138***b*, and **138***c*.

**[0038]** Also, the projector module **122***a* may be adjacent to the projector module **122***b*, and the projector module **122***b* may be adjacent to the projector module **122***c*. Two components or structures may be "adjacent" to each other when there is no intervening component or structure, respectively. Further, the lens **138***a* may be adjacent to the lens **138***b*, and the lens **138***b* may be adjacent to the lens **138***c*. Also, the opening **142***a* may be adjacent to the opening **142***b*, and the opening **142***b* may be adjacent to the opening **142***c*.

**[0039]** The projector module **122***d* may include an oblong shape, resembling a stadium. In this regard, the projector module **122***d* may be referred to as a stadium projector module or a stadium projector. Based on the shape, the projector module **122***d* may include a space **154**, or volume, that provides a location for the carrier **136** and the bezel **140**. Accordingly, the projector module **122***d* may define a space (e.g., the space **154**) for at least the bezel **140**. Also, the carrier **136** and the bezel **140** may each include a shape corresponding to that of the projector module **122***d*. In this regard, the carrier **136** and the bezel **140** may each include an oblong shape. Further, when the lens **138***a*, the lens **138***b*, and the lens **138***c* are positioned in the opening **142***a*, the opening **142***b*, and the opening **142***c*, respectively, of the bezel **140**, the projector modules **122***a*, **122***b*, and **122***c* are held by the carrier **136**, and the carrier **136** (including the bezel **140**) is disposed in the space **154**, the projector module **122***d* also provides a space (e.g., the space **154**) for the projector modules **122***a*, **122***b*, and **122***c*, and the lenses **138***a*, **138***b*, and **138***c*. Also, when the lamp **120***a* is assembled, the carrier **136** (including the bezel **140**), the projector modules **122***a*, **122***b*, and **122***c*, and the lenses **138***a*, **138***b*, and **138***c* may be disposed, or at least partially disposed within a space **150** defined by the housing **148**.

**[0040]** FIG. **5** illustrates a partial cross sectional view of the lamp **120***a*, in accordance with one or more aspects of the present disclosure. For purposes of simplicity and illustration, the cover **146** (shown in FIG. **4**) is removed. The lenses **138***a*, **138***b*, and **138***b* may protrude, or at least partially protrude, through the openings **142***a*, **142***b*, and **142***c*, respectively. For example, as shown in the enlarged view, the lens **138***a* protrudes through the opening **142***a*. However, as further shown, the lens **138***a* may be positioned sub-flush with respect an outer surface of the opening **142***a* (e.g., along a face or surface of the bezel **140**). The relationship between the lens **138***a* and the opening **142***a* may represent respective relationships between the lens **138***b* and the opening **142***b*, as well as between the lens **138***c* and the opening **142***c*.

**[0041]** In order to articulate the respective beam paths of the projector modules **122***a*, **122***b*, and **122***c*, the carrier **136** may be configured to move. For example, the carrier **136**, including the bezel **140**, may move in either direction of the two-sided arrow **130** (e.g., about the X-axis of Cartesian coordinates). The movement of the carrier **136** along either direction of the two-sided arrow **130** may cause a corresponding movement of the lenses **138***a*, **138***b* and **138***c*, thus causing the respective beam paths of the projector modules **122***a*, **122***b*, and **122***c* to change. As non-limiting examples, the movement of the carrier **136** may be used to adjust for build tolerances during vehicle assembly, a change in ride height of the vehicle **100** (not shown in FIG. **5**), or a change in the mode of operation (e.g., drive mode) of the vehicle **100**. Additionally, the carrier **136**, including the bezel **140**, may move in either direction of the two-sided arrow **132** (e.g., about the Z-axis). The movement of the carrier **136** along either direction of the two-sided arrow **132** may cause a corresponding movement of the lenses **138***a*, **138***b* and **138***c*, thus articulating the beam path of the projector modules **122***a*, **122***b*, and **122***c* and causing the beam path to move in a corresponding direction. As non-limiting

examples, in response to movement of the vehicle **100**, the carrier **136** may move. The movement of the carrier **136** may be used to adjust the beam path for the projector modules **122***a*, **122***b*, and **122***c* for adaptive driving beams. In this regard, each of the projector modules **122***a*, **122***b*, and **122***c* may be referred to as an adaptive driving projector module.

**[0042]** The projector module **122***d* may couple with the housing **148**. In order articulate the respective beam paths of the projector modules **122***a*, **122***b*, and **122***c*, the carrier **136** (including the bezel **140**) and the lenses **138***a*, **138***b*, and **138***c* may move with respect to, or independently, of the projector module **122***d*. Also, in one or more implementations, based on the articulation of the beam path of the projector modules **122***a*, **122***b*, and **122***c*, by movement of the lenses **138***a*, **138***b*, and **138***c*, respectively, and the carrier **136** (including the bezel **140**), the projector modules **122***a*, **122***b*, and **122***c* may remain stationary. However, in one or more implementations, the projector modules **122***a*, **122***b*, and **122***c* themselves move based on movement of the carrier **136** (including the bezel **140**) and the lenses **138***a*, **138***b*, and **138***c*. In this regard, the projector modules **122***a*, **122***b*, and **122***c* may move relative to the projector module **122***d*.

**[0043]** FIG. **6**A and FIG. **6**B illustrate perspective views of the projector module **122***a* and the lens **138***a*, showing articulation of a beam **156** (e.g., light beam) of the projector module **122***a* based on movement of the lens **138***a*, in accordance with one or more aspects of the present disclosure. The example implementations shown and described in FIGS. **6**A and **6**B illustrate the lens **138***a* moving relative to the projector module **122***a* to articulate the beam **156** generated by the projector module **122***a*. It should be noted that the relationship between the projector module **122***a* and the lens **138***a* shown in FIGS. **6**A and **6**B may be representative of other pairs of projector modules and lenses shown and/or described herein.

**[0044]** Referring to FIG. **6**A, the lens **138***a* is moved by an angle **158**. The angle **158** may be approximately in the range of 3 to 15 degrees with respect to a horizontal line **160**. Based on the movement of the lens **138***a* to the angle **158**, the beam **156** may be articulated by an angle equal to the angle **158**. As shown in FIG. **6**A, the beam **156** is articulated downward (e.g., negatively along the Z-axis).

**[0045]** Referring to FIG. **6**B, the lens **138***a* is moved by an angle **162**. Similar to the angle **158**, the angle **162** may be approximately in the range of 3 to 15 degrees with respect to the horizontal line **160**. Based on the movement of the lens **138***a* to the angle **162**, the beam **156** may be articulated by an angle equal to the angle **162**. As shown in FIG. **6**B, the beam **156** is articulated upward (e.g., positively along the Z-axis).

**[0046]** FIG. **7** illustrates a partial cross sectional view of an alternate example of a lamp **220**, in accordance with one or more aspects of the present disclosure. The lamp **220** may include any components and associated features shown and/or described for the lamp **120***a* (shown in FIGS. **2**-**5**). For example, the lamp **220** may include a projector module **222***a*, a projector module **222***b*, and a projector module **222***c* covered by a lens **238***a*, a lens **238***b*, and a lens **238***c*, respectively. The lamp **220** may further include a carrier **236**, with the carrier **236** having a bezel **240**. The lenses **238***a*, **238***b*, and **238***b* may protrude through respective openings of the bezel **240**. For example, as shown in the enlarged view, the lens **238***a* protrudes through an opening **242** of the bezel. Moreover, the lens **238***a* may protrude beyond an outer surface of the opening **242** of the bezel **240** (e.g., along a face of the bezel **240**). The relationship between the lens **238***a* and the opening **242** may represent respective relationships between the lenses **238***b* and **238***c* and respective openings (shown, not labeled) of the bezel **240**. Additionally, the respective beam paths of the projector modules **222***a*, **222***b*, and **222***c* may be articulated by any manner shown and/or described herein.

**[0047]** FIG. **8** illustrates a block diagram of a vehicle **300**, in accordance with aspects of the present disclosure. The vehicle **100** (shown in FIG. **1**) may include any features shown and/or described herein for the vehicle **300**. The vehicle **300** may include a controller **360**. In one or more implementations, the controller **360** includes one or more processors **362**. The one or more processors **362** may include processing circuitry, such as a central processing unit (CPU), a graphics processing unit (GPU), one or more microcontrollers, one or more micro-electromechanical systems (MEMS) controllers, an application specific integrated circuit (ASIC), an electronic control unit (ECU), or a combination thereof, as non-limiting examples. Additionally, the vehicle **300** may further include memory **364** that stores instructions and/or code, each of which being executable by the one or more processors **362**. The memory **364** may include read-only memory (ROM) and or random access memory (RAM).

**[0048]** The vehicle **300** may further include one or more lamps **320**. The one or more lamps **320** may take the form of one or more head lamps. In this regard, the one or more lamps **320** may include several projector modules designed to provide a light source. The vehicle **300** may further include one or more sensors **326**. As a non-limiting example, the one or more sensors **326** may include a ride height sensor that provide data, to the controller **360**, corresponding to a current ride height of the vehicle **300** (including, for example, a cabin of the vehicle **300**). Additionally, the one or more sensors **326** may include a proximity sensor (e.g., capacitive sensor, photoelectric sensor) designed to determine a position of a carrier (e.g., carrier **136** shown in FIG. **4**) and a bezel (e.g., bezel **140** shown in FIG. **4**) that holds the projector modules of the one or more lamps **320**. The one or more sensors **326** may further include wheel sensors (e.g., proximity sensors) designed to determine a direction of the wheels (e.g., wheels **112***a* and **112***b* shown in FIG. **1**). The one or more sensors **326**, when including wheel sensors, can provide data to the controller **360** indicating the wheels are turning, thus indicating the vehicle **300** is turning. In this regard, current movement (including a current direction of travel of the vehicle **300**) may be determined using the one or more sensors **326**, and the current movement may be used to articulate the respective beams of the projector modules of the one or more lamps **320** and provide adaptive driving beams.

**[0049]** The vehicle **300** may further include one or more suspension units **327** that form in part a suspension system. As non-limiting example, the one or more suspension units **327** may form in part an air suspension system or a standard suspension system. When the one or more suspension units **327** form in part an air suspension system, the controller **360** may provide information (e.g., commands) to the one or more suspension units **327** to adjust the ride height of the vehicle **300**.

**[0050]** The vehicle **300** may further include one or more motors **331**. As non-limiting examples, the one or more motors **331** may include one or more DC motors, including stepper motors, servo motors, or the like. In one or more implementations, the one or more motors **331** receive a command from the controller **360** to adjust a position of the carriers and bezels, thus adjusting the position of a lens and articulating the respective beams of the projector modules of the one or more lamps **320**. The controller **360** may use the data from the one or more sensors **326** to generate the command to the one or more motors **331** and cause the one or more motors to actuate the carrier(s), thus articulating the respective beams of at least some of the projector modules of the one or more lamps **320**.

**[0051]** The vehicle **300** may further include one or more user inputs **368**. As a non-limiting example, the one or more user inputs **368** may include a display, including a touch input display (e.g., capacitive touch input display). The one or more user inputs **368**, when implemented as a display, may provide a user interface for passengers to select a drive mode or a ride height, as non-limiting examples.

**[0052]** FIG. **9** and FIG. **10** illustrate flow diagrams showing exemplary processes that may be performed for assembling a head lamp, in accordance with one or more aspects of the present disclosure. For explanatory purposes, the processes primarily described herein with reference to the lamps (e.g., head lamps) shown and/or described in FIGS. **2-8** and the accompanying portions of this detailed description. However, the processes are not limited to the lamps shown and/or described in FIGS. **2-8**, and one or more blocks (or operations) of the processes may be performed by one or more other components of other suitable moveable apparatuses, devices, or systems. Further for explanatory purposes, some of the blocks of the processes are described herein as occurring in serial, or linearly. However, multiple blocks of the processes may occur in parallel. In addition, the blocks of the processes need not be performed in the order shown and/or one or more blocks of the process need not be performed and/or can be replaced by other operations.

**[0053]** FIG. **9** illustrates a flow diagram showing an example of a process **400** that may be performed for assembling a head lamp, in accordance with one or more aspects of the present disclosure.

**[0054]** At block **402**, a carrier is provided. The carrier may include a bezel and one or more openings, with each opening designed to receive a lens that covers a projector module. Further, the carrier may be implemented as a unitary carrier.

**[0055]** At block **404**, a first projector module is provided and is configured to be aligned with a first opening of the carrier. The first projector module may take the form of a light source.

**[0056]** At block **406**, a second projector module is provided and is configured to be aligned with a second opening in the carrier. The second projector module may take the form of a light source.

**[0057]** At block **408**, a third projector module is provided and is configured to be aligned with a third opening in the carrier. The first projector module, the second projector module, and the third projector module may be surrounded by the bezel of the carrier, and the bezel is configured to be surrounded by a fourth projector module.

**[0058]** FIG. **10** illustrates a flow diagram showing an example of a process **500** that may be performed for assembling a head lamp, in accordance with one or more aspects of the present disclosure.

**[0059]** At block **502**, one or more projectors are provided for a head lamp of a vehicle. The one or more projectors may each take the form of a projector module designed to provide a light source.

**[0060]** At block **504**, a bezel is provided that at least partially surrounds the one or more projectors. The bezel may be part of a carrier designed to hold the one or more projectors.

**[0061]** At block **506**, a stadium projector provided that may at least partially surround the bezel. The stadium projector may include an oblong shape and may define a space to receive the bezel and the one or more projectors.

**[0062]** As used herein, the phrase "at least one of" preceding a series of items, with the term "and" or "or" to separate any of the items, modifies the list as a whole, rather than each member of the list (i.e., each item). The phrase "at least one of" does not require selection of at least one of each item listed; rather, the phrase allows a meaning that includes at least one of any one of the items, and/or at least one of any combination of the items, and/or at least one of each of the items. By way of example, the phrases "at least one of A, B, and C" or "at least one of A, B, or C" each refer to only A, only B, or only C; any combination of A, B, and C; and/or at least one of each of A, B, and C.

**[0063]** When an element is referred to herein as being "connected" or "coupled" to another element, it is to be understood that the elements can be directly connected to the other element, or have intervening elements present between the elements. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, it should be understood that no intervening elements are present in the "direct" connection between the elements. However, the existence of a direct connection does not exclude other connections, in which intervening elements may be present.

**[0064]** The predicate words "configured to", "operable to", and "programmed to" do not imply any particular tangible or intangible modification of a subject, but, rather, are intended to be used interchangeably. In one or more implementations, a processor configured to monitor and control an operation or a component may also mean the processor being programmed to monitor and control the operation or the processor being operable to monitor and control the operation. Likewise, a processor configured to execute code can be construed as a processor programmed to execute code or operable to execute code.

**[0065]** Phrases such as an aspect, the aspect, another aspect, some aspects, one or more aspects, an implementation, the implementation, another implementation, some implementations, one or more implementations, an embodiment, the embodiment, another embodiment, some embodiments, one or more embodiments, a configuration, the configuration, another configuration, some configurations, one or more configurations, the subject technology, the disclosure, the present disclosure, other variations thereof and alike are for convenience and do not imply that a disclosure relating to such phrase(s) is essential to the subject technology or that such disclosure applies to all configurations of the subject technology. A disclosure relating to such phrase(s) may apply to all configurations, or one or more configurations. A disclosure relating to such phrase (s) may provide one or more examples. A phrase such as an

aspect or some aspects may refer to one or more aspects and vice versa, and this applies similarly to other foregoing phrases.

**[0066]** The word "exemplary" is used herein to mean "serving as an example, instance, or illustration". Any embodiment described herein as "exemplary" or as an "example" is not necessarily to be construed as preferred or advantageous over other embodiments. Furthermore, to the extent that the term "include", "have", or the like is used in the description or the claims, such term is intended to be inclusive in a manner similar to the term "comprise" as "comprise" is interpreted when employed as a transitional word in a claim.

**[0067]** All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 U.S.C. § 112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited using the phrase "step for".

**[0068]** The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but are to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more". Unless specifically stated otherwise, the term "some" refers to one or more. Pronouns in the masculine (e.g., his) include the feminine and neuter gender (e.g., her and its) and vice versa. Headings and subheadings, if any, are used for convenience only and do not limit the subject disclosure.

What is claimed is:

**1**. An apparatus, comprising:

a carrier configured to hold a first projector module, a second projector module, and a third projector module for a vehicle, the carrier comprising a bezel configured to surround the first projector module, the second projector module, and the third projector module, wherein the carrier is at least partially surrounded by a fourth projector module.

**2**. The apparatus of claim **1**, wherein:

the carrier comprises a single-piece carrier and is configured to be positioned in a head lamp housing, and

the fourth projector module at least partially surrounds the bezel, the first projector module, the second projector module, and the third projector module.

**3**. The apparatus of claim **1**, wherein:

the first projector module and the second projector module combine to provide a first light intensity in a first mode of operation, and

the first projector module, the second projector module, and the third projector module combine to provide a second light intensity in a second mode, the second light intensity greater than the first light intensity.

**4**. The apparatus of claim **3**, wherein:

the second projector module is positioned between the first projector module and the third projector module, and

the second projector module is adjacent to the first projector module and the third projector module.

**5**. The apparatus of claim **1**, further comprising:

a first lens configured to cover the first projector module;

a second lens configured to cover the second projector module; and

a third lens configured to cover the third projector module.

**6**. The apparatus of claim **5**, wherein:

the carrier is movable with respect to the fourth projector module, and

based on movement of the carrier, the first lens, the second lens, and the third lens are movable relative to the fourth projector module.

**7**. The apparatus of claim **6**, wherein the fourth projector module extends around the first projector module, the second projector module, and the third projector module.

**8**. The apparatus of claim **6**, wherein the carrier is configured to move in response to a change in ride height of the vehicle.

**9**. A head lamp, comprising:

a housing configured to receive:

a unitary carrier configured to hold a first projector module and a second projector module, and

a third projector module that surrounds the first projector and the second projector; and

a transparent cover coupled with the housing, wherein the transparent cover overlays the unitary carrier and the third projector module.

**10**. The head lamp of claim **9**, wherein the unitary carrier is further configured to carry the third projector module.

**11**. The head lamp of claim **9**, wherein the unitary carrier is movable with respect to the third projector module, thereby causing movement of the first projector module and the second projector module.

**12**. The head lamp of claim **11**, wherein based on the movement of the unitary carrier, the first projector module comprises an adaptive driving projector module.

**13**. The head lamp of claim **9**, wherein:

the first projector module is positioned in a first opening of the unitary carrier, and

the first opening comprises a first dimension and a second dimension, the second dimension being at least two times greater than the first dimension.

**14**. The head lamp of claim **13**, wherein:

the second projector module is positioned in a second opening of the unitary carrier, and

the second opening comprises the first dimension and the second dimension.

**15**. The head lamp of claim **14**, wherein:

the unitary carrier comprises an oblong shape,

each of the first opening and the second opening comprises a rectangular shape.

**16**. The head lamp of claim **9**, further comprising a bezel surrounded by the third projector module, wherein the first projector module and the second projector module align with respective openings of the bezel.

**17**. A vehicle, comprising:

a head lamp, comprising:

a unitary carrier configured to hold a first projector module, a second projector module, and a third projector module, and

a fourth projector module that surrounds the first projector module, the second projector module, and the third projector module; and

a transparent cover that overlays the unitary carrier and the fourth projector module.

**18**. The vehicle of claim **17**, wherein based on movement of the unitary carrier, the first projector module, the second projector module, and the third projector module are movable with respect to the fourth projector module.

**19**. The vehicle of claim **17**, wherein the unity carrier is configured to move in response to a change in movement of the vehicle.

**20**. The vehicle of claim **17**, wherein:

the first projector module is positioned in a first opening of the carrier,

the first opening comprises a first dimension and a second dimension, the second dimension being at least two times greater than the first dimension,

the second projector module and the third projector module are positioned in a second opening and a third opening, respectively, of the carrier, and

each of the second opening and the third opening comprises the first dimension and the second dimension.

* * * * *