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Mccready et al.

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(54) **STOWABLE PEDAL ASSEMBLY**

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B60W 50/10	(2012.01)
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USPC 701/23

See application file for complete search history.

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(57) **ABSTRACT**

A vehicle includes a computer including a processor and a memory storing instructions executable by the processor to identify a vehicle being in an autonomous drive mode. The computer includes instructions to detect a user request to change the drive mode from the autonomous drive mode to a manual drive mode. The computer includes instructions to move the brake pedal from the stowed position to the deployed position in response to the user request to change the drive mode. The computer includes instructions to prompt a user to validate the brake pedal being in the deployed position. The computer includes instructions to change from the autonomous drive mode to the manual drive mode in response to the user validating deployment of the brake pedal.

18 Claims, 7 Drawing Sheets

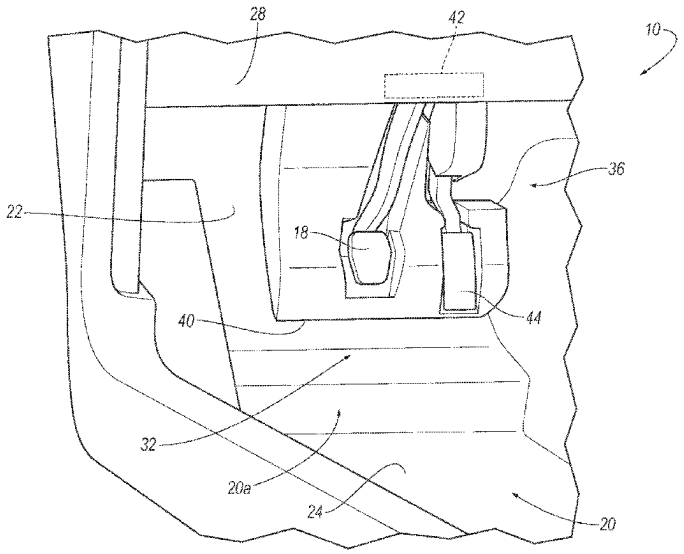

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FIG. 1

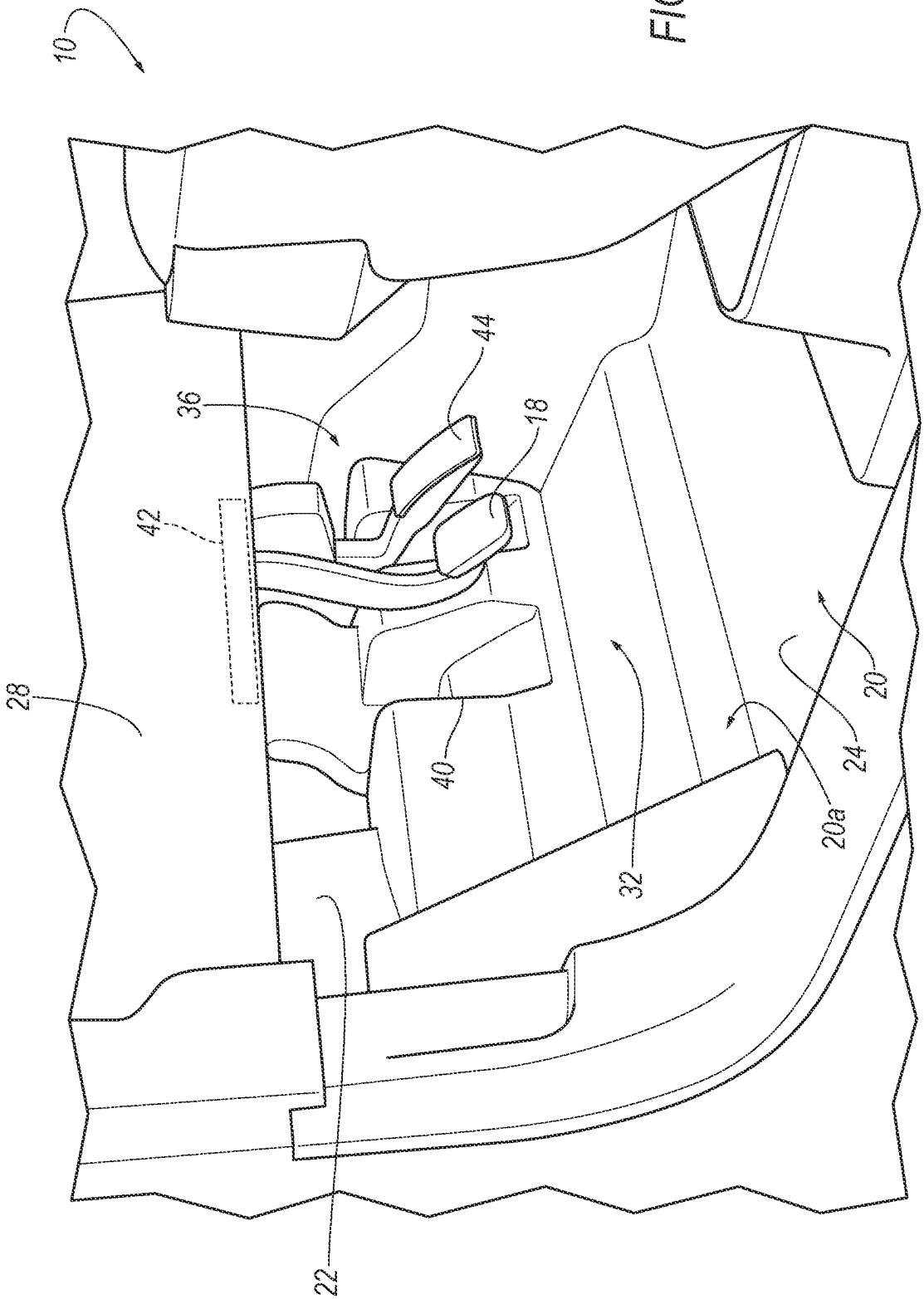
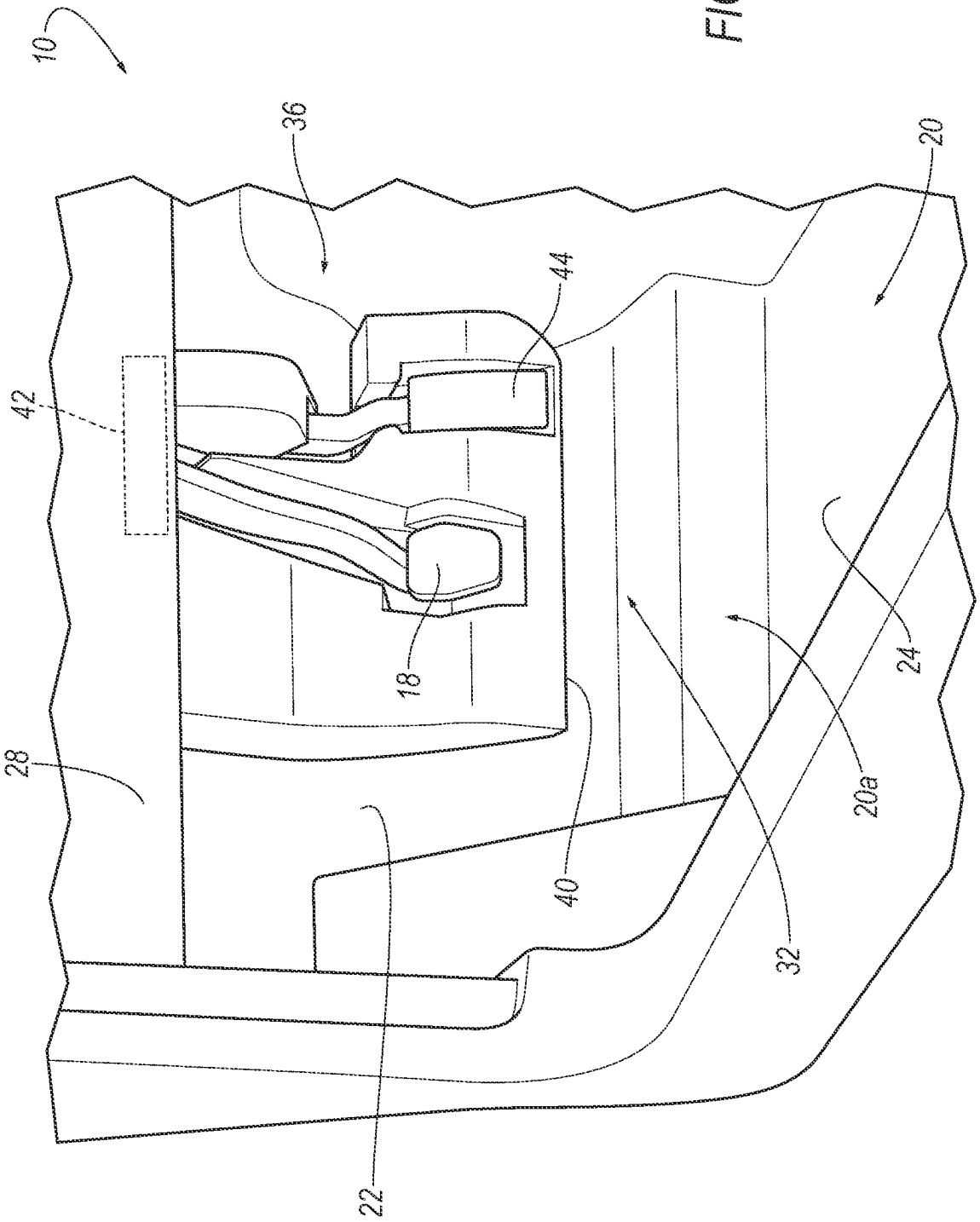


FIG. 2



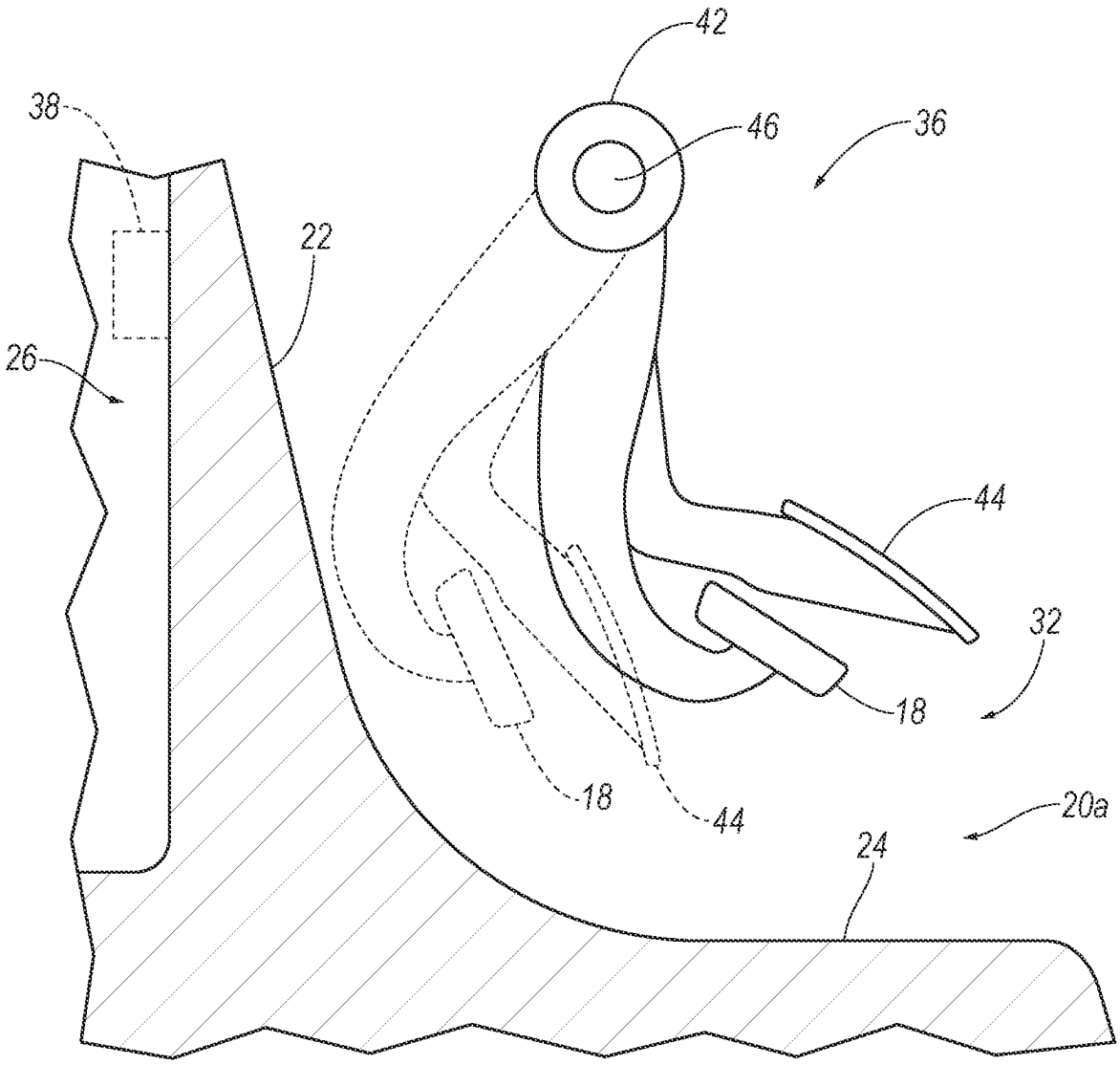


FIG. 3

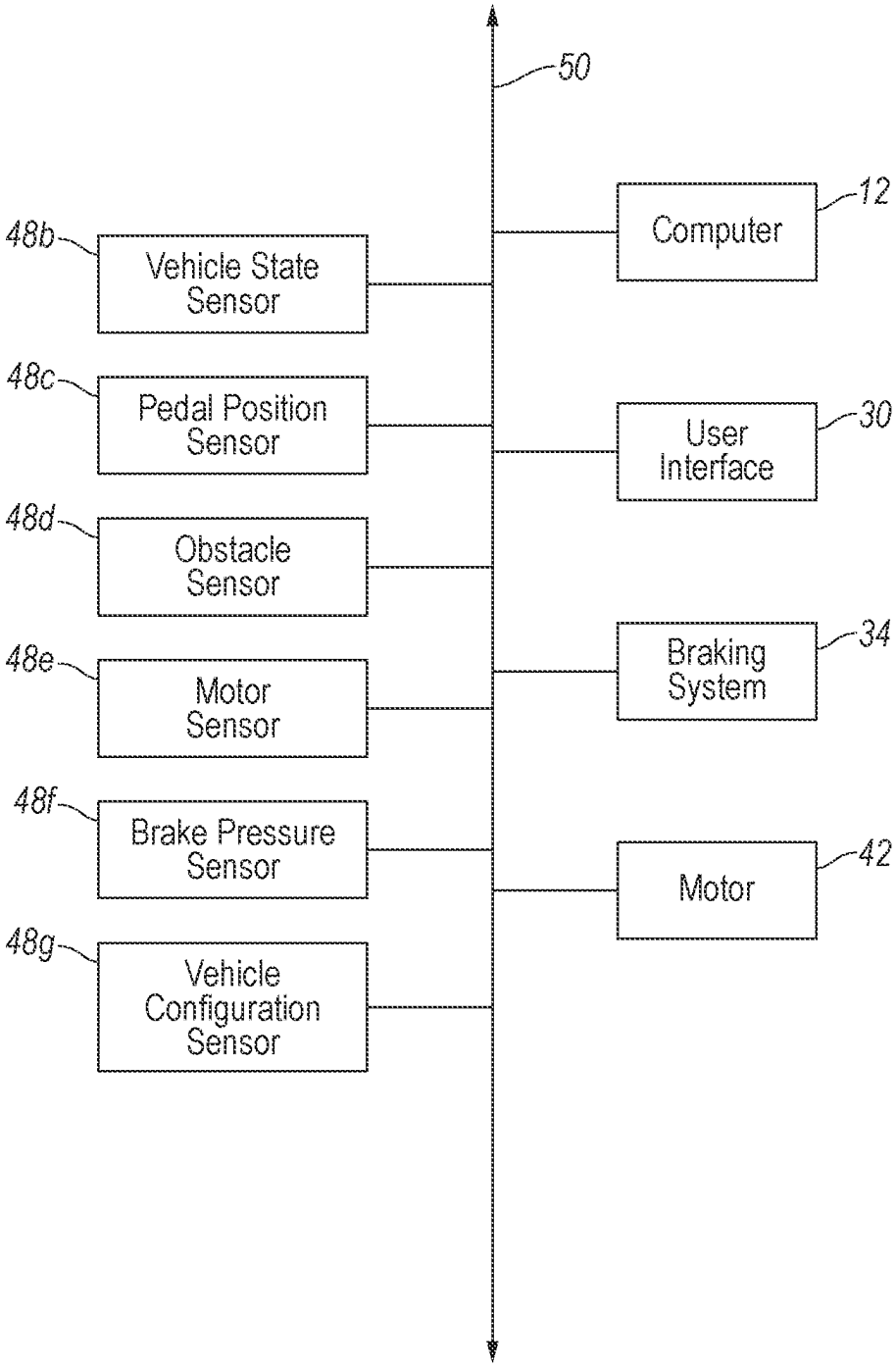

50
Computer
12
48b
Vehicle State Sensor
48c
Pedal Position Sensor
User Interface
30
48d
Obstacle Sensor
48e
Motor Sensor
Braking System
34
48f
Brake Pressure Sensor
Motor
42
48g
Vehicle Configuration Sensor

FIG. 4

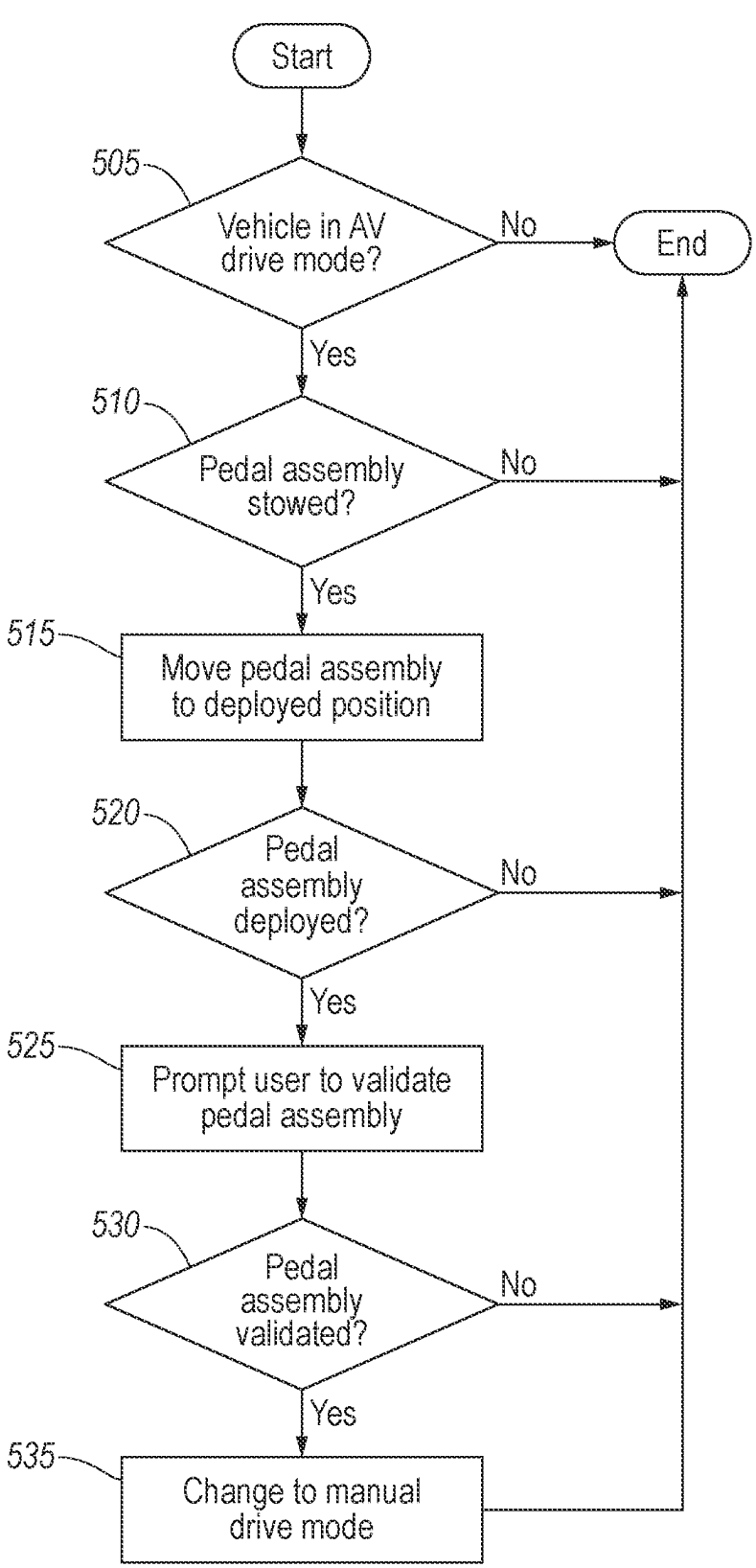

500
Start
505
Vehicle in AV drive mode?
No
End
Yes
510
Pedal assembly stowed?
No
Yes
515
Move pedal assembly to deployed position
520
Pedal assembly deployed?
No
Yes
525
Prompt user to validate pedal assembly
530
Pedal assembly validated?
No
Yes
535
Change to manual drive mode

FIG. 5

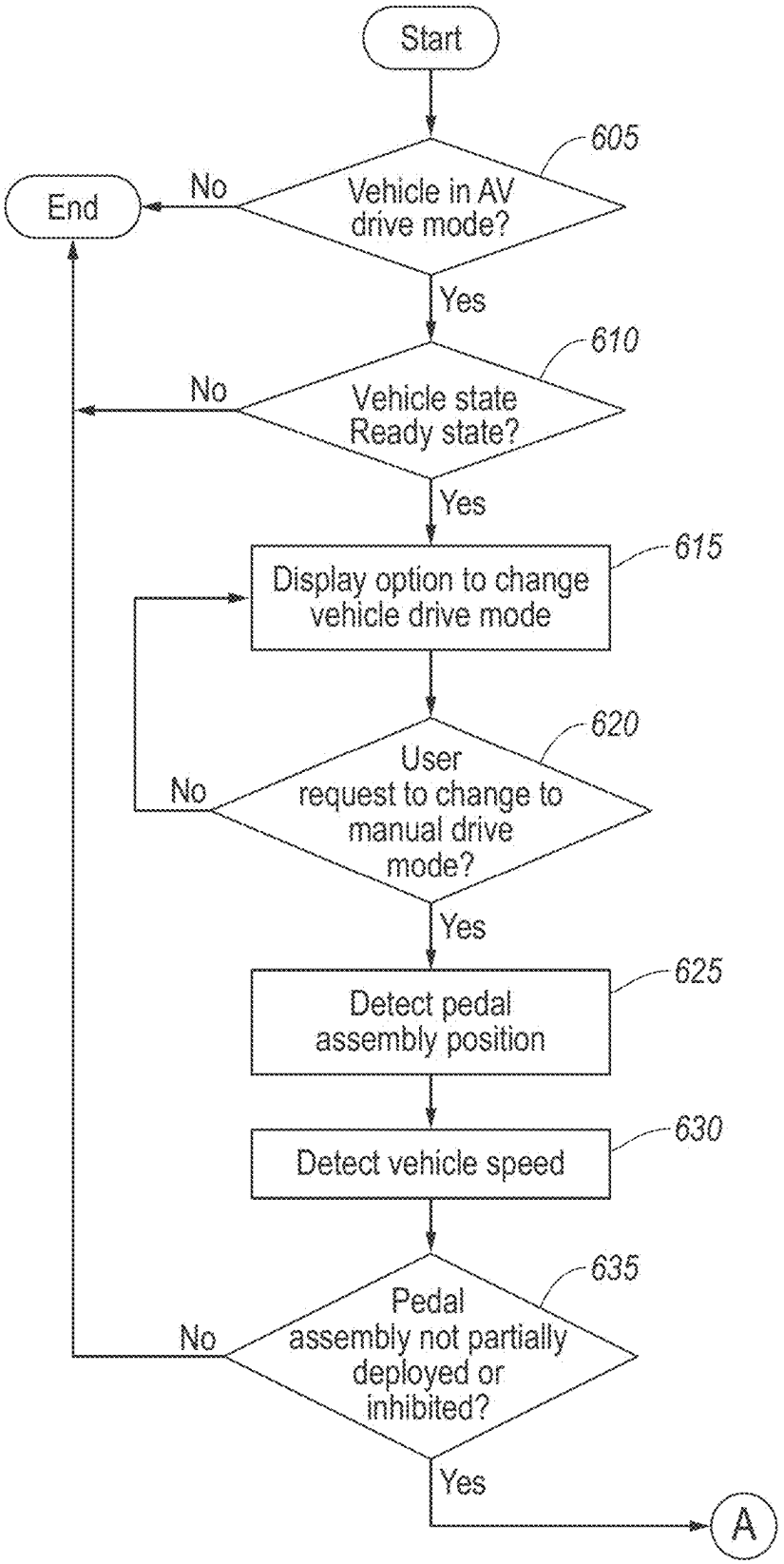

600
Start
605
Vehicle in AV drive mode?
No
End
Yes
610
Vehicle state Ready state?
No
Yes
615
Display option to change vehicle drive mode
620
User request to change to manual drive mode?
No
Yes
625
Detect pedal assembly position
630
Detect vehicle speed
635
Pedal assembly not partially deployed or inhibited?
No
Yes
A

FIG. 6A

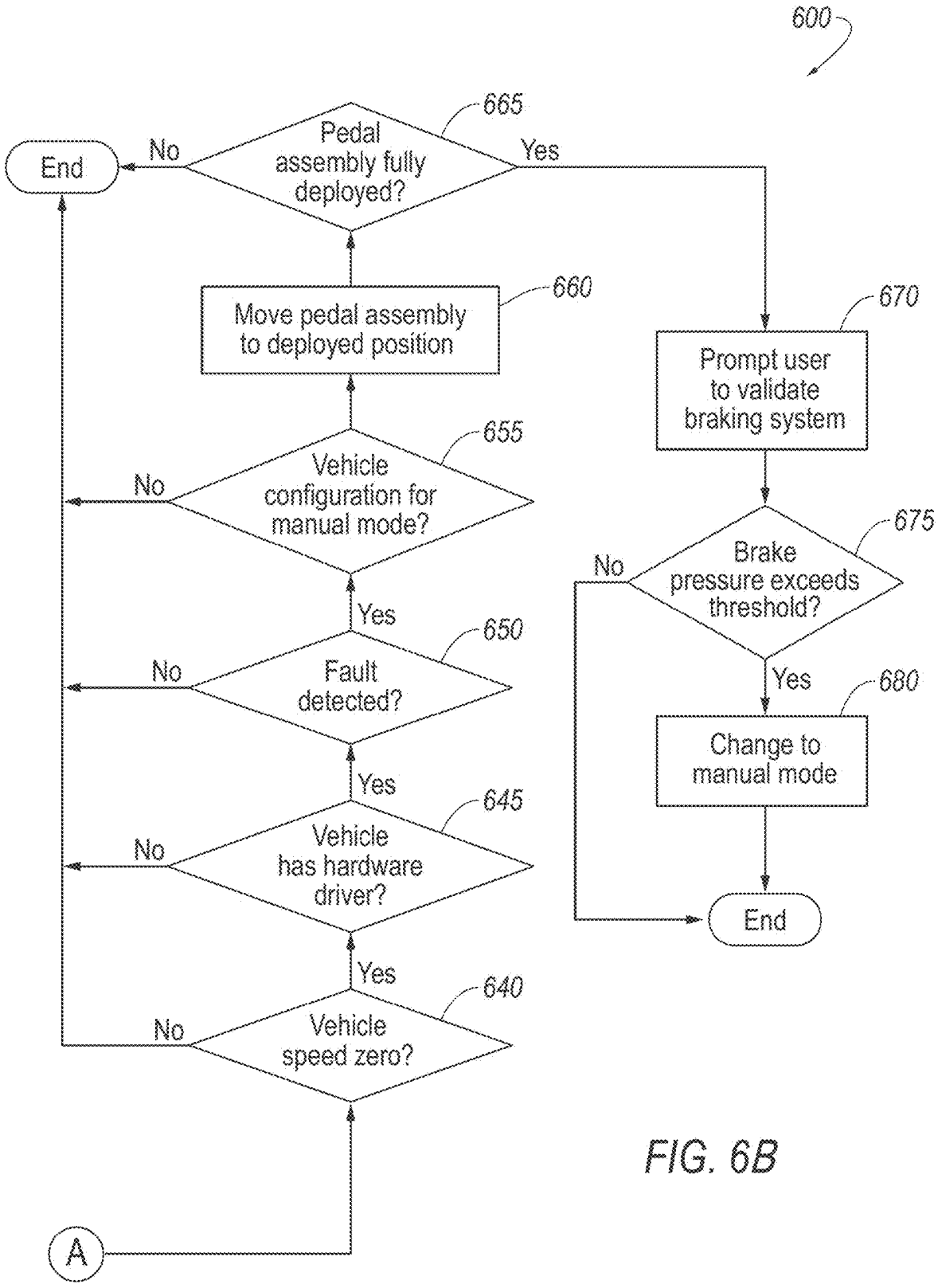

600
665
Pedal assembly fully deployed?
No
End
Yes
660
Move pedal assembly to deployed position
670
Prompt user to validate braking system
655
Vehicle configuration for manual mode?
No
675
Brake pressure exceeds threshold?
No
Yes
650
Fault detected?
No
Yes
680
Change to manual mode
645
Vehicle has hardware driver?
No
Yes
End
640
Vehicle speed zero?
No
A

FIG. 6B

STOWABLE PEDAL ASSEMBLY

BACKGROUND

A vehicle occupant may actuate one or more pedals that actuate components to operate a vehicle. The pedals may actuate a throttle, a brake, or a clutch. The pedals consume space in a vehicle cabin near the occupant's feet. The pedals are positioned for use by the vehicle occupant during operation of the vehicle to accept manual input from the vehicle occupant.

Vehicles can include at least two drive modes, namely an autonomous drive mode and a manual drive mode. In the manual drive mode, the human driver monitors or controls driving tasks including providing input to the pedals of the vehicle to control acceleration and braking. In the autonomous drive mode, a computer can be programmed to operate the vehicle without input from the human driver. As an example of human interaction in the autonomous drive mode, the human driver or occupant may input a destination, select a route, and/or instruct the vehicle to begin driving. In such examples, the pedals may be stowed while not in use and extended for use by the vehicle occupant when the vehicle is in manual drive mode.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a pedal assembly of a vehicle in a deployed position.

FIG. **2** is a perspective view of the pedal assembly in a stowed position.

FIG. **3** is a side view of the pedal assembly in the stowed and deployed positions.

FIG. **4** is a block diagram of the vehicle communication network.

FIG. **5** is a block diagram of a method to change from an autonomous drive mode to a manual drive mode.

FIGS. **6A-6B** is a block diagram of a method to change from the autonomous drive mode to the manual drive mode.

DETAILED DESCRIPTION

A vehicle includes a computer including a processor and a memory storing instructions executable by the processor to identify a vehicle being in an autonomous drive mode. The computer includes instructions to detect a user request to change the drive mode from the autonomous drive mode to a manual drive mode. The computer includes instructions to move the brake pedal from the stowed position to the deployed position in response to the response to the user request to change the drive mode. The computer includes instructions to prompt a user to validate the brake pedal being in the deployed position. The computer includes instructions to change from the autonomous drive mode to the manual drive mode in response to the user validating deployment of the brake pedal.

Detecting operability of the brake pedal includes detecting brake pressure exceeding a threshold brake pressure.

Detecting operability of the brake pedal includes detecting electronic input from the brake pedal based on movement of the brake pedal when the brake pedal is in the deployed position.

Validating deployment of the brake pedal includes at least detecting the brake pedal is unobstructed in the deployed position.

The computer includes instructions to determine whether a sensed vehicle condition satisfies a predetermined value for the vehicle condition; and in response at least to identifying that the sensed vehicle condition satisfies the predetermined value, change from the autonomous driving mode to the manual driving mode.

The sensed vehicle condition includes brake pedal position based at least one of (i) brake pedal motor current, (ii) brake pedal motor voltage, (iii) brake pedal motor rate, and (iv) brake pedal driver voltage, and (v) sensed brake pedal position.

The sensed vehicle condition may be brake pressure.

The sensed vehicle condition may be electronic input based on movement of the brake pedal.

The sensed vehicle condition may be a vehicle-interior configuration.

A method for changing vehicle drive modes includes identifying a vehicle being in an autonomous drive mode; detecting a user request to change the drive mode from the autonomous drive mode to a manual drive mode; identifying a vehicle component being in a stowed position; moving the vehicle component from the stowed position to the deployed position; prompting the user to validate the operability of the vehicle component; identifying a successful or failed validation of the operability of the vehicle component; maintaining the vehicle in the autonomous drive mode in response to a failed validation of the operability of the vehicle component; and changing the drive mode from the autonomous drive mode to the manual drive mode in response to a successful validation of the operability of the vehicle component.

The vehicle component may be a brake pedal.

The method may include determining whether a sensed vehicle condition satisfies a predetermined value for the vehicle condition; and in response at least to identifying that the sensed vehicle condition satisfies the predetermined value, changing from the autonomous drive mode to the manual drive mode.

When the vehicle component is a brake pedal, the sensed vehicle condition includes brake pedal position based on at least one of (i) brake pedal motor current, (ii) brake pedal motor voltage, (iii) brake pedal motor, and (iv) brake pedal driver voltage, and (v) sensed brake pedal position.

The sensed vehicle condition may be brake pressure.

The sensed vehicle condition may be electronic input based on movement of the brake pedal.

The sensed vehicle condition may be a vehicle-interior configuration.

A vehicle **10** includes a computer **12** including a processor and a memory storing instructions executable by the processor to identify a vehicle **10** being in an autonomous drive mode. The computer **12** includes instructions to detect a user request to change the drive mode from the autonomous drive mode to a manual drive mode. The computer **12** includes instructions to move the brake pedal **18** from the stowed position to the deployed position in response to the response to the user request to change the drive mode. The computer **12** includes instructions to prompt a user to validate the brake pedal **18** being operable. The computer **12** includes instructions to change from the autonomous drive mode to the manual drive mode in response to the user validating operability of the brake pedal **18**.

When the vehicle **10** is in the autonomous drive mode, the brake pedal **18** may be stowed for aesthetics, functionality, etc., since it is not in use. Specifically, the user may want the brake pedal **18** stowed when not in use, i.e., for the autonomous drive mode, but deployed when the user wishes to use the vehicle **10** in the manual drive mode. Since the brake pedal **18** is being moved between the stowed position and

the deployed position, the operability of the brake pedal **18** is validated each time the brake pedal **18** moves from the stowed position to the deployed position. Specifically, the validation of the brake pedal **18** operability occurs prior to changing from the autonomous drive mode to the manual drive mode. This confirms anticipated operation of the brake pedal **18** to receive inputs from the occupant to control a braking system **34** of the vehicle **10** before operation of the vehicle **10** is changed from autonomous drive mode to manual drive mode. As described below, the validating the operability of the brake pedal **18** may include confirming the position of the brake pedal **18** for input by a human driver, i.e., in a deployed position. As another example, validating the operability of the brake pedal **18** may include confirming the receipt of input from the human driver and/or confirming control of vehicle braking based on input by the human driver to the brake pedal **18**. For example, confirming control of vehicle braking includes confirming pressure in the braking system **34** of the vehicle and/or confirming electronic signals in the braking system **34**.

The vehicle **10** may be any suitable type of ground vehicle, e.g., a passenger or commercial automobile such as a sedan, a coupe, a truck, a sport utility, a crossover, a van, a minivan, a taxi, a bus, etc. Specifically, the vehicle **10** may be any suitable type of ground vehicle having an autonomous drive mode and a manual drive mode. The vehicle **10** includes a frame and a body (not numbered). The frame may be of unibody construction, in which the frame is unitary with the body including frame rails, rockers, pillars, roof rails, etc. As another example, the frame and the body may have any suitable construction. The frame and the body may be of any suitable material, for example, steel, aluminum, and/or fiber-reinforced plastic, etc.

The frame and/or the body defines a passenger compartment **20** to house occupants, if any, of the vehicle **10**. The passenger compartment **20** may extend across the vehicle **10**, i.e., from one side to the other side of the vehicle **10**. The passenger compartment **20** includes a front **20***a* and a rear. The passenger compartment **20** includes one or more seats. The seats may be arranged in any suitable manner in the passenger compartment **20**. The seat may include a seatback and a seat bottom (not numbered). The seatback may be supported on the seat bottom and be stationary or movable relative to the seat bottom. The seatback and the seat bottom may be adjustable in multiple degrees of freedom. The seats may be of any suitable type, e.g., a bucket seat, etc.

The vehicle **10** may include a bulkhead **22** disposed at the front **20***a* of the passenger compartment **20**. Specifically, the vehicle **10** may include a floor **24** and the bulkhead **22** extends upwardly from the floor **24**. As shown in the Figures, the bulkhead **22** separates a vehicle forward compartment **26** and the passenger compartment **20**. The vehicle forward compartment **26** may any suitable compartment, e.g., where the vehicle **10** has a combustion engine the engine may be disposed in the vehicle forward compartment **26**; and where the vehicle **10** is an electric vehicle the vehicle forward compartment **26** may be used for storage, e.g., luggage.

The vehicle **10** may include an instrument panel **28** disposed at the front **20***a* of the passenger compartment **20**. The instrument panel **28** is supported on the bulkhead **22**. The instrument panel **28** may support vehicle controls, including a steering wheel and a user interface **30**. The instrument panel **28** may extend across the front **20***a* end of the passenger compartment **20** from one side of the vehicle **10** to the other side of the vehicle **10**.

The vehicle **10** includes the user interface **30**. The user interface **30** outputs data and information to the user, e.g., a human driver, through visual display, audible feedback, haptic feedback, etc. The user interface **30** receives inputs from the user to control vehicle **10** operation. As one example, the user may change the vehicle drive mode between the autonomous drive mode and the manual drive mode using the user interface **30**. The user may control other vehicle operations via the user interface **30**, e.g., GPS navigation, temperature control, voice and texting, etc. In other examples, the user interface **30** may be disposed forward of the steering wheel and display vehicle **10** information, e.g., speed, fuel economy, etc. The user interface **30** may include any suitable input device, e.g., a touch-sensitive display screen, knobs, buttons, voice input hardware, combinations thereof, etc.

The vehicle **10** may include a footwell **32** in front of the seats. The footwell **32** is at the front **20***a* of the passenger compartment **20**. The footwell **32** receives feet of the human driver seated in one of the seats. The footwell **32** may be defined by, for example, one of the sides of the vehicle **10**, the floor **24**, the bulkhead **22**, and a bottom of the instrument panel **28**.

The vehicle **10** includes at least one vehicle system. As shown in the Figures, the vehicle **10** includes a braking system **34**. The braking system **34** resists the motion of the vehicle **10** to thereby slow and/or stop the vehicle **10**. The braking system **34** may include friction brakes such as disc brakes, drum brakes, band brakes, and so on; regenerative brakes; any other suitable type of brakes; or a combination. The braking system **34** is in communication with and receives input from the computer **12** and/or a human driver. The human driver may control the braking system **34** via, e.g., the brake pedal **18**.

The vehicle **10** includes the pedal assembly **36**. The pedal assembly **36** includes a housing **40** and a motor **42** that moves the brake pedal **18** relative to the housing **40** between the stowed position and the deployed position. The motor **42** may move the brake pedal **18** between the stowed position and the deployed position by rotating the brake pedal **18** relative to the housing **40**, linearly moving the brake pedal **18** relative to the housing **40**, etc.

In one example, the pedal assembly **36** may include the pedals **44** (including the brake pedal **18**), a master cylinder **38**, and a brake pressure sensor **48***f*. In another example, the pedal assembly **36** may include pedals **44** (including the brake pedal **18**) and a pedal depression sensor (not shown). In the example shown in FIG. **4**, the vehicle **10** includes the brake pressure sensor **48***f* and in other examples the vehicle **10** includes the pedal depression sensor in addition to or in the alternative to the brake pressure sensor **48***f*. As shown in the Figures, the pedal assembly **36** is disposed in the footwell **32**. When the pedal assembly **36** is in the deployed position, the human driver can control the braking system **34** by depressing the brake pedal **18**. Specifically, in an example including the master cylinder **38**, depression of the brake pedal **18** by the human driver pressurizes the master cylinder **38** to actuate the braking system **34**. As another example including the pedal depression sensor, depression of the brake pedal **18** by the human driver is sensed by the pedal depression sensor. In such an example, the braking of the vehicle is based on the sensed position of the brake pedal **18** as sensed by the pedal depression sensor. Specifically, the pedal depression sensor provides an electronic signal to the computer **12** indicating the position of the brake pedal **18** relative to the housing **40** and the computer **12** controls braking of the vehicle **10** based on the electronic signal. In

other words, in such an example the braking system **34** is an electronic braking system. In such an example, the pedal depression sensor may be of any suitable type such as one or more rotary position sensors, proximity sensors, hall effect sensors, contact sensors, etc. In an example in which the pedal depression sensor is a rotary position sensor, the rotary position sensor is designed to vary a voltage signal, i.e., brake pedal driver voltage, to the computer **12** based on the position of the brake pedal **18** relative to the housing **40**.

The pedal assembly **36** may be of any suitable type, e.g., a swing assembly, a floor-mounted assembly, etc. As shown in the Figures, the pedal assembly **36** is a swing assembly. In this example, the pedals **44** are supported adjacent the instrument panel **28** and extends downwardly from the instrument panel **28** toward the floor **24**. In examples where the pedal assembly **36** is a floor-mounted assembly, the pedals **44** are supported by the floor **24** and extend upwardly toward the instrument panel **28**.

As set forth above, the pedal assembly **36** includes pedals **44** including the brake pedal **18**. In addition to the brake pedal **18**, the pedal assembly **36** may include an accelerator pedal, a clutch petal, etc. The pedals **44** are disposed above the floor **24**. The human driver provides manual input to the brake pedal **18**, e.g., by depressing the brake pedal **18**, to actuate one or more components of the braking system **34**.

The master cylinder **38** actuates the brake for the wheel. The master cylinder **38** actuates the brakes for all the wheels of the vehicle **10**. The master cylinder **38** actuates the brake or a brake cylinder of the brake directly or indirectly. For example, the master cylinder **38** may build a pressure of a brake fluid, the brake actuating in response to the increased pressure of the brake fluid. In other examples, the vehicle **10** may send an electrical signal to the brake, the electrical signal causing the brake to actuate. In such an example, the vehicle **10** does not include a master cylinder **38**.

The pedal assembly **36** may include a pedal housing **40**. The pedal housing **40** receives the pedals **44**. The pedal housing **40** may define a cavity. The pedals **44**, including the brake pedal **18**, may be disposed in the cavity. That is, the brake pedal **18** may be movable relative to the pedal housing **40** between a stowed position (FIG. **1**) and a deployed position (FIG. **2**). In the stowed position, the brake pedal **18** is disposed in the cavity. In the deployed position, the brake pedal **18** is positioned away from the pedal housing **40** and out of the cavity. In the stowed position, the brake pedal **18** may be positioned such that the human driver may not reach the brake pedal **18** to manually actuate one or more components. In the deployed position, the human driver may provide manual input to the brake pedal **18**, as described above. When the vehicle **10** operates in the autonomous drive mode, the brake pedal **18** may be in the stowed position, and the human driver does not provide manual input to the pedal **18**, **44**. In the stowed position, manual input to the pedal **18**, **44** from the human driver may not be transmitted to a corresponding component, i.e. braking.

The vehicle **10** may include a motor **42** for moving the pedal assembly **36** between the stowed and deployed positions. As shown in the Figures, the pedal assembly **36** includes the motor **42**. The motor **42** may be connected to the brake pedal **18**. The motor **42** may move the pedals **44**, including the brake pedal **18**, between the stowed position and the deployed position. Specifically, the motor **42** may be connected to an actuator **46** and the actuator **46** moves the pedals **44** between the stowed position and the deployed position. The actuator **46** may be of any suitable type, e.g., mechanical, hydraulic, pneumatic, or any other suitable type. As an example shown in the Figures, motor **42** may be arranged such that a shaft of the motor **42** is fixed to the pedal **18**, **44**, and when the shaft rotates, the pedal **18**, **44** rotates with the shaft from the stowed position to the deployed position. When the vehicle **10** transitions from the autonomous drive mode to the manual drive mode, the motor **42** may rotate the pedal **18**, **44** to the deployed position. The motor **42** may be any suitable type, e.g., a DC brushless motor **42**, an AC brushless motor **42**, a DC brushed motor **42**, etc.

As discussed above, the vehicle **10** includes at least two drive modes, the autonomous drive mode and the manual drive mode. The vehicle **10** may include additional drive modes, e.g., semi-autonomous drive modes. In the manual drive mode, the human driver monitors or controls the majority of the driving tasks, often with no help from the vehicle **10**. As an example, the human driver may be responsible for all vehicle **10** operations. As another example, the vehicle **10** may assist with steering, acceleration, or braking, with interaction from the human driver. In the autonomous drive mode, a computer **12** can be programmed to operate the vehicle **10** independently of the intervention of the human driver, completely or to a lesser degree. The computer **12** may be programmed to operate the propulsion, braking system **34**, steering, and/or other vehicle systems based on sensor input, as described below. In other words, the vehicle controls the majority of the driving tasks, often with no help from the human driver or occupant. As an example of human interaction in the autonomous drive mode, the human driver or occupant may input a destination, select a route, and/or instruct the vehicle **10** to begin driving.

For the purposes of this disclosure, autonomous operation means the computer **12** controls the propulsion device, braking system **34**, and steering system without input from a human driver; semi-autonomous operation means the computer **12** controls one or two of the propulsion system, braking system **34**, and steering system and a human driver controls the remainder; and nonautonomous operation means a human driver controls the propulsion system, braking system **34**, and steering system.

The vehicle **10** may include sensors, shown in FIG. **4**. The sensors may be located at numerous points in or on the vehicle **10** and may be of any suitable type for providing information for autonomous operation of the vehicle **10**. The sensors can obtain one or more measurements of one or more physical phenomena. The sensors may include a variety of devices, and can be disposed to sense the environment, provide data about a machine, etc., in a variety of ways. For example, the sensor may be mounted to a stationary infrastructure element on, over, or near a road. Various controllers of the vehicle **10** may operate as sensors to provide data via the vehicle network **50** or bus, e.g., data relating to vehicle **10** speed, acceleration, location, subsystem and/or component status, etc. The sensors, in or on a vehicle **10**, stationary infrastructure element, etc., could include cameras, short range radar, long range radar, LIDAR, and/or ultrasonic transducers, weight sensors, accelerometers, motion detectors, etc., i.e., sensors to provide a variety of data.

The sensors may detect internal states of the vehicle **10**, for example, wheel speed, wheel orientation, and engine and transmission variables, a rotational position of the pedal **18**, **44** relative to the footwell **32**, etc., e.g., with proximity sensors, hall effect sensors, etc.

The sensors may detect the position or orientation of the vehicle **10**, for example, global positioning system GPS sensors; accelerometers such as piezo-electric or microelec-

tromechanical systems MEMS; gyroscopes such as rate, ring laser, or fiber-optic gyroscopes; inertial measurements units IMU; and magnetometers.

The sensors may detect the external world, for example, radar sensors, scanning laser range finders, light detection and ranging LIDAR devices, and image processing sensors such as cameras.

The vehicle **10** may include a pedal position sensor **48***c*. The pedal position sensor **48***c* detects the position of the pedal **18**, **44** in the stowed position and the deployed position. The pedal position sensor **48***c* may detect the position of the pedal **18**, **44** in the stowed position and/or the deployed position in any suitable manner. For example, the sensors may detect position of the motor **42** that moves the pedal assembly **36** between the stowed and deployed positions, distance between the pedal **18**, **44** and the bulkhead **22**, etc., e.g., with proximity sensors, hall effect sensors, contact sensors, etc.

The vehicle **10** may include an obstacle sensor **48***d*. The obstacle sensor **48***d* may detect an obstacle in a path of the brake pedal **18** between the stowed position and the deployed position. The path of the brake pedal **18** is the trajectory of the brake pedal **18** the footwell **32** along which the brake pedal **18** moves between the stowed position and the deployed position, i.e., from the stowed position to the deployed position and from the deployed position to the stowed position. The obstacle sensor **48***d* detects obstacles in the path of the brake pedal **18** in any suitable manner. For example, the obstacle sensor **48***d* may detect the brake pedal **18** contacting an obstacle in the footwell **32**, e.g., a foot, a purse, etc., with, e.g., proximity sensors, contact sensors, etc.

The vehicle **10** may include a motor sensor **48***e*. The motor sensor **48***e* detects various conditions of the motor **42** that moves the pedal assembly **36** between the stowed and deployed positions such as position of the motor **42**, operation of the motor **42**, etc., using any suitable sensor, e.g., voltage sensors, current sensors, etc. The motor sensor **48***e* may, for example, sense electrical current in brake pedal motor **42**, voltage in the brake pedal motor voltage, rate of the brake pedal **42**, etc.

The vehicle **10** may include a brake pressure sensor **48***f*. The brake pressure sensor **48***f* detects the pressure of the brake fluid in the braking system **34**, i.e., pressure generated by the master cylinder **38**. The brake pressure sensor **48***f* may be any suitable sensor, e.g., pressure sensors, etc.

The vehicle **10** may include a vehicle interior configuration sensor **48***g*. The vehicle interior configuration sensor **48***g* detects the configuration of the interior of the vehicle **10**, e.g., seat configuration, whether the human driver is in the driver's seat, whether the human driver in the driver's seat is restrained by a seatbelt, etc. Specifically, proper operation of the vehicle **10** in the autonomous drive mode and the manual drive mode may be dependent upon the configuration of the interior of the vehicle **10**. For example, a driver's seat may be rearward facing in autonomous driving mode and must be forward-facing in manual drive mode. As another example, a human driver must be seated in the driver's seat in manual drive mode. As another example, at least the driver's seat must be in an upright position in manual drive mode. The vehicle configuration sensor **48***g* may be, for example, vision systems, radar, LIDAR, infrared cameras, sensors for detecting whether a seatbelt for one of the seats is buckled (i.e. seatbelt sensors in the seatbelt), sensors in the seat that detect seat position (i.e., seat position sensors), etc.

The computer **12** includes a processor and a memory. The memory includes one or more forms of computer readable media and stores instructions executable by the computer **12** for performing various operations, including the methods **500**, **600** described herein. In other words, the computer **12** is programmed to perform various operations including methods **500**, **600**. For example, a computer **12** can be a generic computer **12** with a processor and memory as described above and/or may include an electronic control unit ECU or controller for a specific function or set of functions, and/or a dedicated electronic circuit including an ASIC (application specific integrated circuit) that is manufactured for a particular operation, e.g., an ASIC for processing sensor data and/or communicating the sensor data. In another example, a computer **12** may include an FPGA (Field-Programmable Gate Array) which is an integrated circuit manufactured to be configurable by a user. Typically, a hardware description language such as VHDL (Very High Speed Integrated Circuit Hardware Description Language) is used in electronic design automation to describe digital and mixed-signal systems such as FPGA and ASIC. For example, an ASIC is manufactured based on VHDL programming provided pre-manufacturing, whereas logical components inside an FPGA may be configured based on VHDL programming, e.g. stored in a memory electrically connected to the FPGA circuit. In some examples, a combination of processor(s), ASIC(s), and/or FPGA circuits may be included in a computer **12**. The memory can be of any type, e.g., hard disk drives, solid state drives, servers, or any volatile or non-volatile media. The memory can store the collected data sent from the sensors. The memory can be a separate device from the computer **12**, and the computer **12** can retrieve information stored by the memory via a network in the vehicle **10**, e.g., over a CAN bus, a wireless network, etc. Alternatively or additionally, the memory can be part of the computer **12**, e.g., as a memory of the computer **12**.

The computer **12** may include or be communicatively coupled to, e.g., via a vehicle network **50** such as a communications bus as described further below, more than one processor, e.g., included in components such as sensors, electronic control units (ECUs) or the like included in the vehicle **10** for monitoring and/or controlling various vehicle components, e.g., a powertrain controller, a brake controller, a steering controller, etc. The computer **12** is generally arranged for communications on a vehicle communication network **50** that can include a bus in the vehicle **10** such as a controller area network CAN or the like, and/or other wired and/or wireless mechanisms. Alternatively or additionally, in cases where the computer **12** actually comprises a plurality of devices, the vehicle communication network **50** may be used for communications between devices represented as the computer **12** in this disclosure. Further, as mentioned below, various controllers and/or sensors may provide data to the computer **12** via the vehicle communication network **50**.

The vehicle network **50** is a network via which messages can be exchanged between various devices in vehicle **10**. The computer **12** can be generally programmed to send and/or receive, via vehicle network **50**, messages to and/or from other devices in vehicle **10** e.g., any or all of ECUs, sensors, actuators, components, communications module, a human machine interface HMI, etc. Additionally or alternatively, messages can be exchanged among various such other devices in vehicle **10** via vehicle network **50**. In cases in which computer **12** actually comprises a plurality of devices, vehicle network **50** may be used for communications between devices represented as computer **12** in this disclo-

sure. Further, as mentioned below, various controllers and/or vehicle sensors **48** may provide data to the computer **12**. In some implementations, vehicle network **50** can be a network in which messages are conveyed via a vehicle communications bus. For example, vehicle network **50** can include a controller area network CAN in which messages are conveyed via a CAN bus, or a local interconnect network LIN in which messages are conveyed via a LIN bus. In some implementations, vehicle network **50** can include a network in which messages are conveyed using other wired communication technologies and/or wireless communication technologies e.g., Ethernet, WiFi, Bluetooth, etc. Additional examples of protocols that may be used for communications over vehicle network **50** in some implementations include, without limitation, Media Oriented System Transport MOST, Time-Triggered Protocol TTP, and FlexRay. In some implementations, vehicle network **50** can represent a combination of multiple networks, possibly of different types, that support communications among devices in vehicle **10**. For example, vehicle network **50** can include a CAN in which some devices in vehicle **10** communicate via a CAN bus, and a wired or wireless local area network in which some device in vehicle **10** communicate according to Ethernet or Wi-Fi communication protocols.

The computer **12** may be programmed to operate one or more of vehicle brakes, propulsion e.g., control of acceleration in the vehicle **10** by controlling one or more of an internal combustion engine, electric motor, hybrid engine, etc., steering, climate control, interior and/or exterior lights, etc., as well as to determine whether and when the computer **12**, as opposed to a human operator, is to control such operations. Additionally, the computer **12** may be programmed to determine whether and when the human driver is to control such operations.

The computer **12** may be programmed to operate the vehicle **10** in the autonomous drive mode. In the autonomous drive mode, the computer **12** operates the vehicle **10** by transmitting commands to the propulsion system, the braking system **34**, a steering system of the vehicle **10**, etc., without the human driver input, e.g., the brake pedal **18**, the accelerator pedal, steering wheel, etc. The computer **12** may operate the vehicle **10** in the autonomous drive mode based on information from the sensors, e.g., received via the communication network.

The computer **12** may be programmed to permit human driver control of the vehicle **10** in the manual drive mode. In the manual mode the human driver provides input to control the propulsion system, the braking system **34**, steering system, etc. In the manual drive mode the computer **12** may operate as a relay to transmit input provided from the human driver as commands to the propulsion system, the braking system **34**, steering system, etc., based on the inputs. In the manual drive mode, the computer **12** may provide supplemental control to the propulsion system, the braking system **34**, steering system, etc., in addition to the input provided by the human driver, e.g., to control transmission shift points, actuate anti-lock braking, etc.

The computer **12** may be programmed to switch operation of the vehicle **10** between the autonomous drive mode and the manual drive mode based on input from the human driver of the vehicle **10** through the user interface **30**. For example, the human driver may provide input to the user interface **30** selecting the manual drive mode or the autonomous drive mode. The user interface **30** may transmit information to the computer **12**, e.g., via the communication network, indicating such change. As an example, the human driver may change from manual drive mode to autonomous drive mode while the vehicle **10** is moving, i.e., in Drive, and may change from autonomous drive mode to manual drive mode while the vehicle **10** is moving.

The computer **12** is programmed to move the pedal **18**, **44** from the stowed position to the deployed position in response to the human driver switching from the autonomous drive mode to the manual drive mode. Specifically, the human driver may provide input to the computer **12** to switch from autonomous drive mode to manual drive mode by providing input to the computer **12** through the user interface **30**. In response to input to switch from autonomous drive mode to manual drive mode, the computer **12** may send an instruction, e.g., via the vehicle network **50**, to the motor **42** instructing the motor **42** to move the pedal **18**, **44** from the stowed position to the deployed position.

As set forth above, the computer **12** validates the operability of the brake pedal **18**. As examples, this may include confirming the position of the brake pedal **18** for input by a human driver, i.e., in the deployed position; confirming the receipt of input to the brake pedal **18** and/or the braking system **34** from the human driver; and/or detecting the brake pedal **18** is unobstructed in the deployed position.

Specifically, the computer **12** may be programmed to determine whether a sensed vehicle condition satisfies a predetermined value for the vehicle condition. The computer **12** is programmed to, in response at least to identifying that the sensed vehicle condition satisfies the predetermined value, change from the autonomous driving mode to the manual driving mode. In other words, the computer **12** may store a predetermined value and may compare the sensed vehicle condition to the predetermined value to validate the operability of the brake pedal **18**. For example, the sensed vehicle condition may be brake pressure, in which case the predetermined value is a predetermined brake pressure and the computer **12** compares the sensed brake pressure with the predetermined value. In such an example, the brake pressure may be sensed by the brake pressure sensor **48***f*, as described above. As another example, the sensed vehicle condition may be electronic input based on movement of the brake pedal when the brake pedal is in the deployed position. In such an example, the electronic input may be the signal from the pedal depression sensor to the computer **12**, as described above. As another example, the sensed vehicle condition may be sensed travel of the brake pedal **18** when depressed by the vehicle driver. In such an example, the travel of the brake pedal **18** may be detected by the pedal position sensor **48***c* and/or the pedal depression sensor, as described above. As another example, the sensed vehicle condition may be detection that the brake pedal is unobstructed in the deployed position. In such an example, the unobstructed travel of the brake pedal **18** may be detected by the pedal position sensor **48***c* and/or the pedal depression sensor, as described above. As another example, the sensed vehicle condition may be detection an interior configuration of the vehicle. In such an example, the interior configuration may be detected by interior configuration sensor **48***g*, as described above. It should be appreciated that the computer **12** may be programed to determine whether one or more of these examples of sensed vehicle conditions satisfies the respective predetermined value.

In response to input from the human driver to switch from autonomous drive mode to manual drive mode, the computer **12** initially operates the brake pedal **18** and/or the braking system **34** in validation mode. In the event that the operation of the brake pedal **18** and/or the braking system **34** is validated, as described further below, the computer **12** switches operation of the vehicle **10** from autonomous drive

mode to manual drive mode in response to the validation. In the event that the operation of the brake pedal **18** and/or the braking system **34** is not validated, as described further below, the computer **12** maintains operation of the vehicle **10** in autonomous drive mode. In such an event, the computer **12** may instruct the user interface to indicate to the human driver that the operation of the vehicle **10** will remain in the autonomous drive mode. Also, in such an event, the computer **12** may move the brake pedal **18** to the stowed position. As another example in an event where the brake pedal **18** and/or braking system **34** is not validated, the computer **12** may instruct the user interface to prompt the user to make another attempt to validate the brake pedal **18** and/or braking system **34**.

As set forth above, the computer **12** may be programmed operate the brake pedal **18** and/or the braking system **34** in a validation mode to validate the operability of the brake pedal **18**. Specifically, the computer **12** may be programmed operate the brake pedal **18** and/or the braking system **34** in the validation mode while the vehicle **10** is in autonomous driving mode to validate operation of the brake pedal **18** and/or the braking system **34** before switching from autonomous driving mode to manual driving mode. In the validation mode, the computer **12** does not use input from the brake pedal **18** to slow or stop the vehicle **10**. Instead, in the validation mode, the computer **12** uses information from the brake pedal **18** to validate the operation of the brake pedal **18** and/or the braking system **34** without slowing or stopping the vehicle **10** before switching the operation of the vehicle **10** from the autonomous driving mode to the manual driving mode and, after being switched to the manual driving mode, input from the human driver to the brake pedal **18** operates the braking system **34** to slow or stop the vehicle **10**. The computer **12** may operate the brake pedal **18** and/or the braking system **34** in the validation mode when the vehicle **10** is in, for example, Park, Drive, Neutral, and/or Reverse.

As used in this disclosure, Park means the vehicle **10** is stationary and input to the accelerator pedal, brake pedal **18**, etc., do not move the vehicle **10**, e.g., power is not supplied to the wheels of the vehicle by a transmission, electronic signal, etc. Drive means the vehicle **10** is capable of powered movement in a vehicle-forward direction when the brakes are released. Neutral means the wheels of the vehicle **10** are disengaged with the powertrain (e.g., an internal combustion engine, an electric powertrain motor, etc.) such that wheels are free to rotate when the brakes are released but are not driven by the powertrain. Reverse means the vehicle **10** is capable of powered movement in a vehicle-rearward direction when the brakes are released. In vehicles **10** with a transmission, the driver may physically change between Park, Drive, Neutral, and Reverse by shifting the transmission. In other vehicles **10**, e.g., electric vehicles, the vehicle **10** may be change between Park, Drive, Neutral, and Reverse electronically.

The computer **12** may be programmed to prompt the human driver to validate the operation of vehicle systems by testing the operability of the brake pedal **18**. The computer **12** may be programmed to prompt the human driver using the user interface **30**. The computer **12** may generate a message to be displayed on the user interface **30**. For example, in response to the motor **42** moving the pedal **18**, **44** from the stowed position to the deployed position, the computer **12** may prompt the human driver to test the braking system **34** by depressing the brake pedal **18**.

Specifically, the computer **12** may prompt the human driver to depress the brake pedal **18** to a validation point. As an example, the computer **12** may prompt the human driver to fully depress the brake pedal **18**, i.e., move the brake pedal **18** through the entire range of motion of the brake pedal **18**. During this movement of the brake pedal **18**, brake pressure (e.g., as detected by the brake pressure sensor **48***f*), generation of an electronic signal (e.g., as detected by the pedal position sensor **48***c* and/or the pedal depression sensor), and or length of travel of the brake pedal **18** (e.g., as detected by the pedal position sensor **48***c*, the pedal depression sensor, and/or the obstacle sensor **48***d*) may be used to validate operability of the brake pedal **18** and/or the braking system **34**. For example, the computer **12** may determine whether a sensed vehicle condition satisfies a predetermined value for the vehicle condition, as described above.

For example, the computer **12** is programmed to receive a measurement from the brake pressure sensor **48***f* indicating brake pressure applied by the human driver. The computer **12** is programmed to compare the measurement of the brake pressure sensor **48***f* with a threshold value for the brake pressure. The threshold value may be, for example, a stored value in the computer **12**, a plurality of stored values dependent on other factors and stored in a lookup table in the computer **12**, determined by an algorithm performed by the computer **12**, etc. The threshold value may be based on empirical data.

The computer **12** may be programmed to prompt the human driver of the vehicle state. As an example, when the vehicle **10** is in the validation state, the computer **12** may alert the human driver that the vehicle **10** is in the validation state and will reject input by the human driver. In other words, the computer **12** may alert the human driver that, for example, depressing the brake pedal **18** will not slow or stop the vehicle **10** until after validation. As another example, when the human driver changes from the manual drive mode to the autonomous drive mode, the computer **12** may alert the human driver that the human driver is still in control of the vehicle **10**. In other words, the computer **12** may alert the human driver that the vehicle **10** has not changed from the manual drive mode to the autonomous drive mode. The computer **12** may be programmed to prompt the human driver in any suitable manner, e.g., visual prompts, audible prompts, haptic prompts, etc.

The computer **12** is programmed to change from the autonomous drive mode to the manual drive mode in response to validation of the operability of the brake pedal **18** and/or the braking system **34**. For example, the computer **12** may be programmed to change from the autonomous drive mode to the manual drive mode in response to the brake pressure in the master cylinder **38** exceeding the threshold value for the brake pressure. Specifically, prior to changing from the autonomous drive mode to the manual drive mode, the computer **12** compares the brake pressure applied by the human driver, e.g., as detected by the brake pressure sensor **48***f* with the threshold value for the brake pressure, as described above. As an example, the human driver may depress the brake pedal when prompted by the user interface and the brake pressure sensor **48***f* sends a measurement of the brake pressure in the master cylinder **38** to the computer **12**. In such an example, if the computer **12** determines the brake pressure exceeds the threshold value for the brake pressure, the computer **12** may permit the vehicle **10** to switch from the autonomous drive mode to the manual drive mode. As another example, the computer **12** may be programmed to change from the autonomous drive mode to the manual drive mode in response to the computer **12** receiving a signal from the brake pedal **18** that the brake pedal **18** has been depressed. Specifically, prior to changing from the autonomous drive mode to the manual drive mode,

the user interface prompts the human driver to depress the brake pedal **18**. The braking system **34** may be an electronic braking system. When the human driver depresses the brake pedal **18**, the brake pedal **18** sends a signal to the computer **12** and the computer **12** instructs the braking system **34** to actuate the brakes. In such an example, where the braking system **34** is an electronic braking system, the brakes may be any suitable type, e.g., brake pads, magnetic, etc. As another example, the computer **12** may be programmed to change from the autonomous drive mode to the manual drive mode in response to validation that the brake pedal **18** is unobstructed in the deployed position. Specifically, the obstacle sensor **48***d* detects whether the brake pedal **18** can be depressed without encountering an obstacle and sends a signal to the computer **12** that the brake pedal **18** can be depressed without encountering an obstacle. In other words, the obstacle sensor **48***d* sends a signal to the computer **12** that there is no obstacle in the path of the brake pedal **18**.

The computer **12** may be programmed to identify an obstacle in the path of the pedal **18**, **44**. Specifically, the computer **12** is programmed to send instructions to the motor **42** to stop the movement of the pedal **18**, **44** in response to the obstacle sensor **48***d* detecting an obstacle in the path of the pedal **18**, **44**. As an example, the computer **12** instructs the motor **42** to move the pedal **18**, **44** between the stowed position and the deployed position, and an obstacle is in the path of the pedal **18**, **44**, e.g., a purse, a box, etc. The obstacle sensor **48***d* detects the obstacle in the path of the pedal **18**, **44**, and the computer **12** instructs the motor **42** to stop. As another example, the obstacle sensor **48***d* may detect no obstacle in the path of the pedal **18**, **44**, and the motor **42** moves the pedal **18**, **44** from the stowed position to the deployed position.

FIG. **5** is a flow diagram illustrating an example method **500** for changing from the autonomous drive mode and the manual drive mode. The method **500** begins in block **505**. The computer **12** receives information from the sensors that the human driver has selected the manual drive mode. In response to the user selection, the computer **12** determines whether the vehicle **10** is in the autonomous drive mode. If the vehicle **10** is in the manual drive mode, the process ends. If the vehicle **10** is in the autonomous drive mode, the process moves to block **510**.

In block **510**, the computer **12** determines whether the pedal **18**, **44** is in the stowed position. Specifically, the computer **12** determines whether the pedal **18**, **44** is in the stowed position based on, for example, information from the pedal position sensors **48***c* received via the vehicle network **50**. If the pedal **18**, **44** is not in the stowed position, the process ends. If the pedal **18**, **44** is in the stowed position, the process moves to block **515**.

In block **515**, the computer **12** instructs the motor **42** to move the pedal **18**, **44** from the stowed position to the deployed position. Specifically, the computer **12** sends instructions, e.g., via the vehicle network **50**, to the motor **42** move the pedal **18**, **44** from the stowed position to the deployed position.

In block **520**, the computer **12** determines whether the pedal **18**, **44** has been moved to the deployed position. Specifically, the computer **12** determines whether the pedal **18**, **44** is in the deployed position based on, for example, information from the pedal position sensors **48***c* received via the vehicle network **50**. If the pedal **18**, **44** has not been moved to the deployed position, the process ends. If the pedal **18**, **44** has been moved to the deployed position, the process moves to block **525**.

In block **525**, the computer **12** prompts the user to validate deployment of the pedal **18**, **44**. As an example, the computer **12** may instruct the user interface **30** to display a visual prompt asking the human driver to depress the brake pedal **18**.

In block **530**, the computer **12** determines whether the user has depressed the brake pedal **18**. Specifically, the computer **12** determines whether the user has depressed the brake pedal **18** based on, for example, information from the brake pressure sensor **48***f* received via the vehicle network **50**. The computer **12** determines whether the brake pressure generated by the master cylinder **38** exceeds the threshold brake pressure based on the information from the brake pressure sensor **48***f*. If the brake pressure generated by the master cylinder **38** does not exceed the threshold brake pressure, the process ends. If the brake pressure generated by the master cylinder **38** exceeds the threshold brake pressure, deployment of the pedal **18**, **44** is validated the process moves to **535**.

In block **535**, the computer **12** changes the vehicle drive mode from the autonomous drive mode to the manual mode and the process ends.

FIGS. **6**A-**6**B is a flow diagram illustrating a second example method **600** for changing from the autonomous drive mode and the manual drive mode. The method **600** begins in block **605**.

In block **605**, the computer **12** determines if the vehicle **10** is in the autonomous drive mode or the manual drive mode. If the vehicle **10** is in the manual drive mode, the process ends. If the vehicle **10** is in the autonomous drive mode, method moves to block **610**.

In block **610**, the computer **12** determines the vehicle state of the vehicle **10**. Specifically, the computer **12** determines if the vehicle **10** is in the validation state based on, for example, information received from the vehicle state sensor **48***b*. If the vehicle state is not validation state, the process ends. If the vehicle is in the validation state the method moves to block **615**.

In block **615** the computer **12** sends instructions to the user interface **30** to display an option to the user to change vehicle drive mode to the manual drive mode. The process then moves to block **620**. In block **620**, the computer **12** determines whether the user has made a request to change the vehicle drive mode to the manual drive mode. Specifically, the computer **12** determines whether the user has made a request to change the vehicle drive mode to the manual drive mode based on, for example, information received from the user interface **30**. If the computer **12** does not detect a user request to change the vehicle drive mode to the manual drive mode, the process repeats block **615**. If the computer **12** detects a user request to change the vehicle drive mode to the manual drive mode, the method moves to block **625**.

In block **625** the computer **12** determines the position of the pedal **18**, **44**. Specifically, the computer **12** determines the position of the pedal **18**, **44** based on, for example, information received by the computer **12** from the pedal position sensor **48***c*. The method moves to block **630**.

In block **630** the computer **12** determines the speed of the vehicle **10**. The method moves to block **635**.

In block **635** the computer **12** determines whether the pedal **18**, **44** is partially deployed or inhibited. Specifically, the computer **12** determines whether the pedal **18**, **44** is partially deployed based on block **625**. The computer **12** determines whether the pedal **18**, **44** is inhibited based on, for example, information received by the computer **12** from the obstacle sensor **48***d*. If the pedal **18**, **44** is either partially

deployed or inhibited, the method ends. If the pedal **18**, **44** is fully deployed and uninhibited, the method moves to block **640**.

In block **640** the computer **12** determines whether the vehicle **10** speed is zero. Specifically, the computer **12** determines whether the vehicle **10** speed is zero based on block **630**. If the vehicle **10** speed is not zero, the method ends. If the vehicle **10** speed is zero, the method moves to block **645**.

In block **645**, the computer **12** detects whether the vehicle **10** includes a hardware driver for the pedal **18**, **44** and motor **42**. If the hardware driver is not detected, the method ends. If the hardware driver is detected, the method moves to block **650**.

In block **650**, the computer **12** detects whether a fault is present in the circuit. If a fault is detected, the method ends. If a fault is not detected, the method moves to block **655**.

In block **655**, the computer **12** detects whether the vehicle **10** is configured for the manual drive mode. Specifically, the computer **12** detects the vehicle configuration based on, for example, the vehicle configuration sensor **48***g*. The computer **12** compares the information from the vehicle configuration sensor **48***g* against the predetermined value for the vehicle configuration in the manual drive mode, e.g., the driver's seat facing forward, etc. If the detected vehicle configuration does not meet the predetermined value for the vehicle configuration in the manual drive mode, the method ends. If the detected vehicle configuration meets the predetermined value for the vehicle configuration in the manual drive mode, the method moves to block **660**.

In block **660**, the computer **12** sends instructions to the motor **42** to move the pedal **18**, **44** to the deployed position. Specifically, the computer **12** sends instructions to the motor **42** to move the pedal **18**, **44** from the stowed position to the deployed position. The method moves to block **665**.

In block **665**, the computer **12** detects the position of the pedal **18**, **44**. Specifically, the computer **12** detects the position of the pedal **18**, **44** based on, for example, information received by the computer **12** from the pedal position sensor **48***c*. As described above, the pedal position sensor **48***c* may determine the pedal **18**, **44** position in any suitable manner, e.g., by using sensed motor **42** voltage, sensed motor **42** current, sensed actuator **46** position, hardware driver state, etc. If the position of the pedal **18**, **44** is not fully deployed, the method ends. If the position of the pedal **18**, **44** is fully deployed, the method moves to block **670**

In block **670**, the computer **12** sends instructions to the user interface **30** to prompt the user to validate the braking system **34**. For example, the computer **12** may instruct the user interface **30** to display a message for the human driver to depress the brake pedal **18**. The method moves to block **675**.

In block **675**, the computer **12** detects the brake pressure applied by the human driver. Specifically, the computer **12** detects the brake pressure applied by the human driver based on, for example, the brake pressure sensor **48***f*. If the computer **12** does not detect brake pressure applied to the master cylinder **38** by the user, the method repeats block **670**. If the brake pressure does not exceed the threshold brake pressure, the method ends. If the brake pressure exceeds the threshold brake pressure, the method moves to **680**.

In block **680**, the computer **12** changes the vehicle drive mode to the manual drive mode.

With regard to the media, processes, systems, methods, etc. described herein, it should be understood that, although the steps of such processes, etc. have been described as occurring according to a certain ordered sequence, unless indicated otherwise or clear from context, such processes could be practiced with the described steps performed in an order other than the order described herein. Likewise, it further should be understood that certain steps could be performed simultaneously, that other steps could be added, or that certain steps described herein could be omitted. In other words, the descriptions of processes herein are provided for the purpose of illustrating certain embodiments.

The disclosure has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. Use of "based on" and "in response to" herein indicate a causal relationship, not merely a temporal relationship. Many modifications and variations of the present disclosure are possible in light of the above teachings, and the disclosure may be practiced otherwise than as specifically described.

The invention claimed is:

1. A computer including a processor and a memory storing instructions executable by the processor to:

detect a request by a human driver in a vehicle to change the vehicle from an autonomous drive mode to a manual drive mode;

operate a braking system of the vehicle in a validation mode while the vehicle remains in the autonomous drive mode in response to a request by the human driver to change the vehicle from autonomous drive mode to manual drive mode;

while the braking system is in the validation mode and the vehicle is in autonomous drive mode, move a brake pedal of the braking system from a stowed position to a deployed position in response to the request by the human driver to change the vehicle from autonomous drive mode to the manual drive mode;

with the brake pedal in the deployed position and while the vehicle remains in the autonomous drive mode and the braking system remains in the validation mode, prompt the human driver to depress the brake pedal;

while the vehicle remains in the autonomous drive mode and the braking system remains in the validation mode, validate the braking system as being operable to control vehicle braking based on the depression of the brake pedal by the human driver without using input from the brake pedal to slow the vehicle; and

change from the autonomous drive mode to the manual drive mode in response to validation that the braking system is operable to control vehicle braking based on depression of the brake pedal by the human driver in the validation mode.

2. The computer of claim **1**, wherein validating the braking system as being operable to control vehicle braking includes detecting brake pressure in the braking system exceeding a threshold brake pressure.

3. The computer of claim **1**, wherein validating the braking system as being operable to control vehicle braking includes detecting electronic input from the brake pedal indicating a position of the brake pedal when depressed by the human driver when the brake pedal is in the deployed position.

4. The computer of claim **1**, wherein validating the braking system as being operable to control vehicle braking includes at least detecting the brake pedal is unobstructed in the deployed position.

5. The computer of claim **1**, validating the braking system as being operable to control vehicle braking includes:

determine whether a sensed vehicle condition satisfies a predetermined value for the vehicle condition; and

in response at least to identifying that the sensed vehicle condition satisfies the predetermined value, change from the autonomous drive mode to the manual drive mode.

6. The computer of claim **5**, wherein the sensed vehicle condition includes brake pedal position based on at least one of (i) brake pedal motor current, (ii) brake pedal motor voltage, (iii) brake pedal motor rate, (iv) brake pedal driver voltage, and (v) sensed brake pedal position.

7. The computer of claim **6**, wherein the sensed vehicle condition is brake pressure.

8. The computer of claim **6**, wherein the sensed vehicle condition is electronic input indicating a position of the brake pedal when depressed by the human driver when the brake pedal is in the deployed position.

9. The computer of claim **6**, wherein the sensed vehicle condition is a vehicle-interior configuration.

10. The computer of claim **1**, further including instructions to:

identify a successful validation or a failed validation that the braking system is operable to control vehicle braking based on depression of the brake pedal by the human driver;

change the vehicle from the autonomous drive mode to the manual drive mode in response to successful validation; and

maintain the vehicle in the autonomous drive mode in response to failed validation.

11. The computer of claim **1**, wherein the request by the human driver to change the vehicle from autonomous drive mode to manual drive mode is received from the human driver through a user interface.

12. The computer of claim **1**, further including instructions to control the braking system while the braking system is in validation mode.

13. A method for changing vehicle drive modes including:

detecting a request by a human driver in a vehicle to change the vehicle from an autonomous drive mode to a manual drive mode;

operating a braking system of the vehicle in a validation mode while the vehicle remains in the autonomous drive mode in response to a request by the human driver to change the vehicle from autonomous drive mode to manual drive mode;

while the braking system is in the validation mode and the vehicle is in autonomous drive mode, moving a brake pedal of the braking system from a stowed position to a deployed position in response to the request by the human driver to change the vehicle from the autonomous drive mode to the manual drive mode;

with the brake pedal in the deployed position and while the vehicle remains in the autonomous drive mode and the braking system remains in the validation mode, prompting the human driver to depress the brake pedal;

while the vehicle remains in the autonomous drive mode and the braking system remains in the validation mode, validating the braking system as being operable to control vehicle braking based on the input by the depression of the brake pedal by the human driver without using input from the brake pedal to slow the vehicle; and

changing the vehicle from the autonomous drive mode to the manual drive mode in response to validation that the braking system is operable to control vehicle braking based on the depression of the brake pedal by the human driver in the validation mode.

14. The method of claim **13**, where in validating that the braking system is operable to control vehicle braking includes:

determining whether a sensed vehicle condition satisfies a predetermined value for the vehicle condition; and

in response at least to identifying that the sensed vehicle condition satisfies the predetermined value, changing from the autonomous drive mode to the manual drive mode.

15. The method of claim **14**, wherein the sensed vehicle condition includes brake pedal position based on at least one of (i) brake pedal motor current, (ii) brake pedal motor voltage, (iii) brake pedal motor, and (iv) brake pedal driver voltage, (v) sensed brake pedal position.

16. The method of claim **15**, wherein the sensed vehicle condition is brake pressure.

17. The method of claim **15**, wherein the sensed vehicle condition is electronic input indicating a position of the brake pedal when depressed by the human driver when the brake pedal is in the deployed position.

18. The method of claim **15**, wherein the sensed vehicle condition is a vehicle-interior configuration.

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