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VEHICLE BRAKE SYSTEM

Abstract

One or more example vehicles, vehicle brake systems, and computer-implemented methods of operating a vehicle brake system. The vehicle brake system includes an electro-hydraulic control unit (EHCU) operable to control flow of a working fluid through the vehicle brake system contemporaneously with a linked braking operation.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION [0001] This Application claims benefit to U.S. Provisional Application No. 63/551,114, filed Feb. 8, 2024, which is incorporated by reference herein in its entirety for all purposes.

TECHNICAL FIELD

[0002] One or more embodiments relate generally to a vehicle, a vehicle brake system, a method of operating a vehicle brake system, and a computer program product. The vehicle brake system includes an electro-hydraulic control unit (EHCU) operable to control flow of a working fluid through the vehicle brake system contemporaneously with a linked braking operation.

BACKGROUND

[0003] Vehicles such as motorcycles having a design that incorporates an electronically-linked brake system (ELB) that links the front brake assembly and the rear brake assembly through the application of a linking pressure to the front wheel and the rear wheel in response to a single pressure or force input by a vehicle operator. General linked brake systems utilize an anti-lock brake (ABS) system having a pump and control valves as the structural architecture to accomplish linked braking. During activation of linked braking, however, the brake actuator (e.g., brake lever or brake pedal) may feel stiff to an operator. Such stiffness is caused by pressurization or pressure build-up in the ABS system during linked braking.

BRIEF SUMMARY

[0004] In accordance with one or more embodiments, an electronically-linked braking (ELB) system for a vehicle having an EHCU operable to control flow of a working fluid through the vehicle brake system contemporaneously with a linked braking operation.

[0005] In accordance with one or more example embodiments, a vehicle brake system comprises one or more of the following: an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator (arranged externally or internally relative to the EHCU); and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0006] In accordance with one or more example embodiments, a vehicle brake system comprises one or more of the following: a brake assembly including a front master cylinder assembly as a first hydraulic pressure source and a front brake caliper assembly as a second hydraulic pressure source; a front brake actuator; an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator (arranged at least partially external relative to the EHCU); and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0007] In accordance with one or more example embodiments, a vehicle brake system comprises one or more of the following: an EHCU operable to control flow of brake fluid through a hydraulic circuit (that establishes hydraulic coupling between a front master cylinder assembly and a front brake caliper assembly); a brake feel simulator (arranged at least partially externally relative to the EHCU) in hydraulic communication with the hydraulic circuit; one or more sensors operable to dynamically detect as sensor data, in response to initiation of a linked braking operation), a first hydraulic pressure (i.e., outgoing hydraulic pressure of the brake fluid from the front master cylinder assembly) and a second hydraulic pressure (i.e., incoming hydraulic pressure of the brake fluid from the front brake caliper assembly); and a vehicle controller, comprising one or more processors to execute a set of instructions to: execute braking analysis based on the detected sensor data, and regulate, in response to the braking analysis, the incoming hydraulic pressure to the second hydraulic pressure source by causing selective diversion of at least a portion of pressurized working fluid from the hydraulic circuit to the brake feel simulator.

[0008] In accordance with one or more example embodiments, a vehicle brake system comprises one or more of the following: an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a sensor module having one or more sensors operable to detect a load at the first hydraulic pressure source to initiate the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data; a brake feel simulator (arranged at least partially external relative to the EHCU); and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: causing detection of a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously cause detection, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0009] In accordance with the vehicle brake system, the braking analysis comprises executing a comparison between a first pressure value associated with the detected hydraulic pressure of the working fluid from the first hydraulic pressure source and a second pressure value associated with the detected hydraulic pressure of the working fluid to the second hydraulic pressure source.

[0010] In accordance with the vehicle brake system, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, the selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0011] In accordance with the vehicle brake system, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

[0012] In accordance with the vehicle brake system, the brake feel simulator comprises one or more accumulators having a stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0013] In accordance with the vehicle brake system, the brake feel simulator comprises one or more spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0014] In accordance with the vehicle brake system, the vehicle brake system comprises an electronically-linked vehicle brake system.

[0015] In accordance with one or more example embodiments, a vehicle comprises one or more of the following: a vehicle brake system that includes an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator (arranged at least partially external relative to the EHCU); and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0016] In accordance with one or more example embodiments, a vehicle comprises one or more of the following: a vehicle brake system that includes: a brake assembly including a front master cylinder assembly as a first hydraulic pressure source and a front brake caliper assembly as a second hydraulic pressure source; a front brake actuator; an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator (arranged at least partially external relative to the EHCU); and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0017] In accordance with one or more example embodiments, a vehicle comprises one or more of the following: a vehicle brake system that includes: an EHCU operable to control flow of brake fluid through a hydraulic circuit (that establishes hydraulic coupling between a front master cylinder assembly and a front brake caliper assembly); a brake feel simulator (arranged at least partially externally relative to the EHCU) in hydraulic communication with the hydraulic circuit; one or more sensors operable to dynamically detect as sensor data, in response to initiation of a linked braking operation, a first hydraulic pressure (i.e., outgoing hydraulic pressure of the brake fluid from the front master cylinder assembly) and a second hydraulic pressure (i.e., incoming hydraulic pressure of the brake fluid from the front brake caliper assembly); and a vehicle controller, comprising one or more processors to execute a set of instructions to: execute braking analysis based on the detected sensor data, and regulate, in response to the braking analysis, the incoming hydraulic pressure to the second hydraulic pressure source by causing selective diversion of at least a portion of pressurized working fluid from the hydraulic circuit to the brake feel simulator.

[0018] In accordance with one or more example embodiments, a vehicle comprises one or more of the following: a vehicle brake system that includes: an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a sensor module having one or more sensors operable to detect a load at the first hydraulic pressure source to initiate the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data; a brake feel simulator (arranged at least partially external relative to the EHCU); and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: causing detection of a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously cause detection, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0019] In accordance with the vehicle, the braking analysis comprises executing a comparison between a first pressure value associated with the detected hydraulic pressure of the working fluid from the first hydraulic pressure source and a second pressure value associated with the detected hydraulic pressure of the working fluid to the second hydraulic pressure source.

[0020] In accordance with the vehicle, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, the selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0021] In accordance with the vehicle, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

[0022] In accordance with the vehicle, the brake feel simulator comprises one or more accumulators having a stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0023] In accordance with the vehicle, the brake feel simulator comprises one or more spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0024] In accordance with the vehicle brake system, the vehicle brake system comprises an electronically-linked vehicle brake system.

[0025] In accordance with one or more example embodiments, a computer-implemented method of operating a vehicle brake system comprises one or more of the following: detecting a load at a first hydraulic pressure source to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of a working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to a brake feel simulator.

[0026] In accordance with one or more example embodiments, a computer-implemented method of operating a vehicle brake system comprises one or more of the following: detecting a load at a first hydraulic pressure source to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0027] In accordance with the computer-implemented method, the braking analysis comprises executing a comparison between a first pressure value associated with the detected hydraulic pressure of the working fluid from the first hydraulic pressure source and a second pressure value associated with the detected hydraulic pressure of the working fluid to the second hydraulic pressure source.

[0028] In accordance with the computer-implemented method, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, the selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0029] In accordance with the computer-implemented method, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

[0030] In accordance with the computer-implemented method, the brake feel simulator comprises one or more accumulators having a stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0031] In accordance with the computer-implemented method, the brake feel simulator comprises one or more spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0032] In accordance with the vehicle brake system, the vehicle brake system comprises an electronically-linked vehicle brake system.

[0033] In accordance with one or more example embodiments, a computer program product comprising at least one non-transitory computer readable medium having with a set of instructions of computer-executable program code, which when executed by one or more processors of a computing system, causes the one or more processors to perform operations that comprise one or more of the following: detecting a load at a first hydraulic pressure source of the vehicle brake system to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of a working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source of the vehicle brake system; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to a brake feel simulator of the vehicle brake system.

[0034] In accordance with one or more example embodiments, a computer program product comprising at least one non-transitory computer readable medium having with a set of instructions of computer-executable program code, which when executed by one or more processors of a computing system, causes the one or more processors to perform operations that comprise one or more of the following: detecting a load at a first hydraulic pressure source of the vehicle brake system to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source of the vehicle brake system; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to a brake feel simulator of the vehicle brake system.

[0035] In accordance with the computer program product, the braking analysis comprises executing a comparison between a first pressure value associated with the detected hydraulic pressure of the working fluid from the first hydraulic pressure source and a second pressure value associated with the detected hydraulic pressure of the working fluid to the second hydraulic pressure source.

[0036] In accordance with the computer program product, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, the selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

[0037] In accordance with the computer program product, regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

[0038] In accordance with the computer program product, the brake feel simulator comprises one or more accumulators having a stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0039] In accordance with the computer program product, the brake feel simulator comprises one or more spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0040] The various advantages of the embodiments of the present disclosure will become apparent to one skilled in the art by reading the following specification and appended claims, and by referencing the following drawings, in which:

[0041] FIG. **1** illustrates an example vehicle, in accordance with one or more embodiments set forth, illustrated, and described herein.

[0042] FIG. **2** illustrates a block diagram for the example vehicle of FIG. **1**.

[0043] FIG. **3** illustrates a block diagram of an example ELB system for the example vehicle of FIG. **1**, in accordance with one or more embodiments set forth, illustrated, and described herein.

[0044] FIG. **4** illustrates a block diagram of an example vehicle brake system for the example vehicle of FIG. **1**, in accordance with one or more embodiments set forth, illustrated, and described herein

[0045] FIG. **5** illustrates a diagram of one or more control blocks for operating the example vehicle brake system of FIG. **4**.

[0046] FIGS. **6**A through **6**C respectively illustrate a schematic hydraulic circuit diagram of an example ELB system for the example vehicle of FIG. **1**.

[0047] FIGS. **7** through **14** respectively illustrate a schematic diagram of example computer-implemented methods of operating a vehicle brake system, in accordance with one or more embodiments set forth, illustrated, and described herein.

DETAILED DESCRIPTION

[0048] Turning to the figures, in which FIGS. **1** and **2** illustrate an example vehicle **100** for operation by a vehicle operator, the vehicle **100** having a vehicle structure (e.g., chassis, frame, subframe, body, etc.), in accordance with one or more embodiments. In accordance with one or more embodiments, a "vehicle" may be in reference to any form of motorized transport. In the illustrated embodiment of FIG. **1**, the vehicle **100** comprises a two-wheeled vehicle such as a motorcycle. Embodiments, however, are not limited thereto, and thus, this disclosure contemplates the vehicle comprising a three-wheeled vehicle, a four-wheeled vehicle, or any suitable vehicle that falls within the spirit and scope of the principles of this disclosure.

[0049] In accordance with one or more embodiments, the vehicle **100** may comprise one or more operational elements. Some of the possible operational elements of the vehicle **100** are shown in FIG. **1** and will now be described. It will be understood that it is not necessary for the vehicle **100** to have all the elements forth, illustrated, and described in FIG. **1** and. The vehicle **100** may have any combination of the various elements illustrated in FIG. **1**. Moreover, the vehicle **100** may have additional elements to those illustrated in FIG. **1**, or may not include one or more of the elements shown in FIG. **1**. Moreover, while the various operational elements are illustrated as being located within the vehicle **100**, embodiments are not limited thereto, and thus, one or more of the operational elements may be located external to the vehicle **100**, and even physically separated by large spatial distances.

[0050] In the illustrated embodiment of FIGS. **1** through **6**, the vehicle **100** further includes a steering assembly **102** pivotably mounted to the vehicle structure **101**, a front wheel **103** rotatably mounted to the steering assembly **102**, a rear wheel **104** rotatably mounted to the vehicle structure **101**, and an engine **105** operatively connected to the vehicle structure **101**. The steering assembly **102** includes forks **106**, handlebars **107**, and controls coupled to the handlebars **107** to facilitate control of the vehicle **100** by the vehicle operator.

[0051] As illustrated in FIG. **2**, the vehicle **100** further includes an electronic brake system (EBS) such as an ELB system **110** (e.g., an anti-lock brake system (ABS)) that includes, but is not limited to, a front brake assembly **111** and a rear brake assembly **112**.

[0052] As illustrated in FIG. **3**, the front brake assembly **111** includes a front brake actuator **113** (e.g., hand lever) operatively coupled to a front master cylinder assembly **114**, and a front brake caliper assembly **115** that includes one or more front brake calipers operatively connected to the forks **106**. The front brake caliper assembly **115** is operable to selectively engage a front wheel rotor member (not illustrated) in response to actuation of the front brake actuator **113** by the vehicle operator and/or in response to actuation of the rear brake actuator **116** contemporaneously with an autonomous or linked braking operation.

[0053] The rear brake assembly **112** includes the rear brake actuator **116** (e.g., foot pedal) operatively coupled to a rear master cylinder assembly **117**, and a rear brake caliper assembly **118** that includes one or more rear brake calipers. The rear brake caliper assembly **118** is operable to selectively engage a rear wheel rotor member (not illustrated) in response to actuation of the rear brake actuator **116** by the vehicle operator and/or in response to actuation of the front brake actuator **113** contemporaneously with an autonomous or linked braking operation.

[0054] As illustrated in FIG. **6**, the EHCU **200** is operable to establish hydraulic communication between the front master cylinder assembly **114** and the front brake caliper assembly **115** to facilitate flow of a working fluid (e.g., brake fluid) through a hydraulic circuit of the EHCU **200** contemporaneously with a braking operation (e.g., a linked braking operation). A pump **250**, by operation of a motor **260**, is operable to drive the brake fluid through the hydraulic circuit.

[0055] The hydraulic circuit is operable to maintain hydraulic coupling between the front master cylinder assembly **114** and the front brake caliper assembly **115**. The hydraulic circuit includes one or more primary brake pathways that establishes the hydraulic coupling between the front master cylinder assembly **114** and the front brake caliper assembly **115**, a control valve module **220**, and one or more primary control valves **220-223** (e.g., linear control valves) which facilitate flow regulation of the brake fluid through the hydraulic circuit. The one or more primary control valves include a normally-open (NO) primary control valve **220**, a normally-open (NO) primary control valve **221**, a normally-closed (NC) primary control valve **222**, and a normally-closed (NC) primary control valve **223**. The hydraulic circuit also has one or more primary check valves that includes primary check valve **230** and primary check valve **231**. Although in the illustrated example, the primary control valves **220-223** comprise electro-magnetic valves, embodiments are not limited thereto. This disclosure contemplates the primary control valves **220-223** comprising any suitable valve architecture that falls within the spirit and scope of the principles of this disclosure. One or more primary brake fluid storage members **11** are operable to receive the brake fluid supplied to the ELB system **110**. The one or more primary brake fluid storage members **240** comprise spring-biased accumulators.

[0056] A brake feel simulator **242**, **242***b*, **242***c* is in selective hydraulic communication with the front master cylinder assembly **114** and the hydraulic circuit hydraulic circuit via brake pathway that branches from the hydraulic circuit in a manner that facilitates a selective directed or diversion of at least a portion of flow of the brake fluid from the hydraulic circuit.

[0057] In the illustrated example embodiment of FIG. **6**A, the brake feel simulator **242** is arranged externally relative to the EHCU **200** and the control valve **225** is located internally relative to the EHCU **200**.

[0058] In the illustrated example embodiment of FIG. **6**B, the brake feel simulator **242***b* and the control valve **225***b* are arranged internally relative to the EHCU **200**.

[0059] In the illustrated example embodiment of FIG. **6**C, the brake feel simulator **242***b* and the control valve **225***b* are arranged externally relative to the EHCU **200**, thereby facilitating adding such a module to a preexisting EHCU design.

[0060] One or more secondary control valves including normally-closed (NC) secondary control valve **225**, **225***b*, **225***c* and one or more secondary check valves including secondary check valve **232**, **232***b*, **232***c* are provided to facilitate regulation of the selectively directed or diverted flow of brake fluid to the brake feel simulator **242**, **242***b*, **242***c*.

[0061] In the illustrated example embodiments of FIGS. **6**A through **6**C, the brake feel simulator **242**, **242***b*, **242***c* comprises one or more secondary brake fluid storage members formed as spring-biased accumulators. The one or more secondary brake fluid storage members are operable to induce a resistance to the selectively directed or diverted flow of the brake fluid in a manner that reduces stiffness at the front brake actuator **113** when engaged by the vehicle operator. This may improve or otherwise enhance the operator's experience, for the brake actuator **113** may be easily engaged by the operator. Each spring-biased accumulator comprises one or more bias members having a spring stiffness value (i.e., spring constant) that substantially corresponds to the stiffness value of the front brake caliper assembly **115**. The brake pathways are operable to establish hydraulic coupling between the front master cylinder assembly **114** and the brake feel simulator **242**, **242***b*, **242***c* when the detected outgoing hydraulic pressure (P.sub.o) of the brake fluid flowing (from the front master cylinder assembly **114**) through the one or more brake pathways is less than the dynamically captured/detected incoming hydraulic pressure (P.sub.i) (i.e., the linking pressure) of the brake fluid flowing through the one or more brake pathways to the front brake caliper assembly **115**.

[0062] As illustrated in FIGS. **2** and **3**, the vehicle **100** comprises a control module that serves as a host, main, or primary control system of the vehicle **100** operable to control components, systems, sub-systems, assemblies, and sub-assemblies of the EHCU **200**, including, but not limited to, the motor **260**. In accordance with one or more example embodiments, the control module comprises a vehicle controller or electronic control unit (ECU) **300** to control, among other things, normally-open (NO) primary control valve **220**, normally-open (NO) primary control valve **221**, normally-closed (NC) primary control valve **222**, normally-closed (NC) primary control valve **223**, and normally-closed (NC) secondary control valve **224**, and the motor **260**. The ECU **300** may comprise one or more processors **330**. As set forth, described, and/or illustrated herein, “processor” means any component or group of components that are operable to execute any of the processes described herein or any form of instructions to carry out such processes or cause such processes to be performed. The processors **330** may be implemented with one or more general-purpose and/or one or more special-purpose processors. Examples include suitable processors graphics processors, microprocessors, microcontrollers, DSP processors, and other circuitry that may execute software (e.g., stored on a non-transitory computer-readable medium). Further examples of suitable processors include, but are not limited to, a central processing unit (CPU), an array processor, a vector processor, a digital signal processor (DSP), a field-programmable gate array (FPGA), a programmable logic array (PLA), an application specific integrated circuit (ASIC), programmable logic circuitry, and a controller. The processors **330** may comprise at least one hardware circuit (e.g., an integrated circuit) operable to carry out instructions contained in program code. In embodiments having a plurality of processors **330**, such processors **330** may work independently from each other, or one or more processors may work in combination with each other.

[0063] A I/O hub **310** is operatively connected to other systems and subsystems of the vehicle **100**. The I/O hub **310** may comprise an input interface and an output interface.

[0064] The input interface and the output interface may be integrated as a single, unitary interface, or alternatively, be separate as independent interfaces that are operatively connected. As used herein, the input interface is defined as any device, component, system, subsystem, element, or arrangement or groups thereof that enable information/data to be entered in a machine. The input interface may receive an input from a vehicle operator or a remote operator of the vehicle **100**. In one or more example embodiments, the input interface may comprise a user interface (UI), graphical user interface (GUI) such as, for example, a display, human-machine interface (HMI), or the like. Embodiments, however, are not limited thereto, and thus, this disclosure contemplates the input interface comprising any suitable configuration that falls within the spirit and scope of the principles of this disclosure. For example, the input interface may comprise a keypad, toggle switch, touch screen, multi-touch screen, button, joystick, mouse, trackball, microphone and/or combinations thereof.

[0065] As used herein, the output interface is defined as any device, component, system, subsystem, element, or arrangement or groups thereof that enable information/data to be presented to the vehicle operator and/or a remote operator of the vehicle **100**. The output interface may be operable to present information/data to the vehicle occupant and/or the remote operator. The output interface may comprise one or more of a visual display or an audio display such as a microphone, earphone, and/or speaker. One or more components of the vehicle **100** may serve as both a component of the input interface and a component of the output interface.

[0066] In accordance with one or more embodiments, the vehicle **100** comprises one or more data stores **320** for storing one or more types of data. The vehicle **100** may include one or more interfaces that enable one or more systems thereof to manage, retrieve, modify, add, or delete, the data stored in the data stores **320**. The data stores **320** may comprise volatile and/or non-volatile memory. Examples of suitable data stores **320** include RAM (Random Access Memory), flash memory, ROM (Read Only Memory), PROM (Programmable Read-Only Memory), EPROM (Erasable Programmable Read-Only Memory), EEPROM (Electrically Erasable Programmable Read-Only Memory), registers, magnetic disks, optical disks, hard drives, or any other suitable storage medium, or any combination thereof. The data stores **320** may be a component of the processors **330**, or alternatively, may be operatively connected to the processors **330** for use thereby. As set forth, described, and/or illustrated herein, “operatively connected” may include direct or indirect connections, including connections without direct physical contact.

[0067] The EHCU **200** further includes a sensor module **210** operable to, at least during operation of the vehicle **100**, dynamically detect, dynamically capture, determine, assess, monitor, measure, quantify, and/or sense one or more operational parameters, elements, or features of the vehicle **100** as sensor data. As set forth, described, and/or illustrated herein, “sensor” means any device, component, system, and/or subsystem that can perform one or more of detecting, determining, assessing, monitoring, measuring, quantifying, and sensing something. The one or more sensors may be operable to detect, determine, assess, monitor, measure, quantify and/or sense in real-time. As set forth, described, and/or illustrated herein, “real-time” means a level of processing responsiveness that a user, system, or subsystem senses as sufficiently immediate for a particular process or determination to be made, or that enables the processor to keep up with some external process.

[0068] The sensor module **210** comprises one or more pressure sensors, including a first pressure sensor **211** and a second pressure sensor **212**. The first pressure sensor **211** is spatially arranged or otherwise mounted at the one or more brake pathways of the hydraulic circuit downstream (e.g., in close spatial proximity to, or adjacent to) from the front master cylinder **114** to dynamically detect, determine, assess, monitor, measure, quantify, as sensor data, the hydraulic pressure of the brake fluid output from the front master cylinder **114**. The second pressure sensor **212** is spatially arranged or otherwise mounted downstream of the first pressure sensor **211** at the one or more brake pathways of the hydraulic circuit and upstream (e.g., in close spatial proximity to, or adjacent to) to the brake caliper assembly **115** to dynamically detect, determine, assess, monitor, measure, quantify, as sensor data, the hydraulic pressure of the brake fluid input to the brake caliper assembly **115**. The first pressure sensor **211** and the second pressure sensor **212** may work independently from each other, or alternatively, may work in combination with each other. The first pressure sensor **211** and the second pressure sensor **212** may be used in any combination and may be used redundantly to validate and improve the accuracy of the detection.

[0069] In accordance with one or more embodiments, operation of the ECU **300** may be implemented as computer readable program code that, when executed by a processor, implement one or more of the various processes set forth, described, and/or illustrated herein. The ECU **300** may be a component of the processors **330**, or alternatively, may be executed on and/or distributed among other processing systems to which the processors **330** are operatively connected. The ECU **300** may include a set of logic instructions executable by the processors **330**. Alternatively, or additionally, the data stores **320** may contain such logic instructions. The logic instructions may include assembler instructions, instruction set architecture (ISA) instructions, machine instructions, machine dependent instructions, microcode, state-setting data, configuration data for integrated circuitry, state information that personalizes electronic circuitry and/or other structural components that are native to hardware (e.g., host processor, central processing unit/CPU, microcontroller, etc.).

[0070] In the illustrated embodiment, the ECU **300**, **300***b*, **300***c* is operable to facilitate, via the sensor module **210**, dynamic detection as sensor data of one or more operational features of the vehicle **100**. For example, such operational features may include, but are not limited to, the hydraulic pressure at the front master cylinder **114** and the hydraulic pressure at the front brake caliper assembly **115** in response to engagement of the front brake actuator **113** by the vehicle operator. The dynamically captured/detected sensor data may be located in a vehicle database of the data stores **320** or an external source (e.g., cloud-based data store(s)).

[0071] In a standard braking application via the front brake assembly **111**, selective engagement of the front brake actuator **113** by the vehicle operator causes braking of the front wheel **103** independently of the rear wheel **104**. The selective engagement of the front brake actuator **113** generates a mechanical force or load that causes pressurization of brake fluid in the one or more brake pathways, which in turn causes hydraulic coupling between the front master cylinder assembly **114** and the front brake caliper assembly **115** when the normally-open (NO) primary control valve **221** and the normally-closed (NO) primary control valve **222** are in an open operating state.

[0072] In an example contemporary linked braking operation, selective engagement of the rear brake actuator **116**) by the vehicle operator (and/or activation of a brake switch via signal S**3**) causes linked braking between the front wheel **103** and the rear wheel **104** by dynamically distributing pressurized brake fluid to both the front brake assembly **111** and the rear brake assembly **112** in manner that induces braking at the front wheel **103** and the rear wheel **104**. As illustrated in FIGS. **5** and **6**A through **6**C, the selective engagement of the rear brake actuator **116** generates a data input signal S**1** that is transmitted to the ECU **300** which in turn, transmits one or more control signals C**1** that places the normally-open (NO) primary control valve **220** in a closed operating state and the normally-closed (NC) primary control valve **223** in an open operating state. One or more control signals C**3** are also transmitted to the motor **260** to cause activation of the motor **260**, which in turn causes the pump **250** to drive pressurized brake fluid from a front brake fluid reservoir to the front brake caliper assembly **115**. The pressurization or pressure build-up in the hydraulic circuit during linked braking, however, imparts stiffness at the front brake actuator **113** when engaged by the vehicle operator contemporaneously with linked braking.

[0073] In accordance with one or more embodiments, a technical solution to this problem is adding the brake feel simulator **242**, **242***b*, **242***c* to reduce stiffness contemporaneously with linked braking. Alternatively stated, the brake feel simulator **242**, **242***b*, **242***c* improves the feeling that an operator experiences in linked braking. For example, during pressurization or pressure build-up in the hydraulic circuit in a linked braking operation, the ECU **300** is operable to dynamically receive one or more data input signals S**1** from the first pressure sensor **211** (related to the outgoing hydraulic pressure P.sub.o) and one or more data input signals S**2** (related to the incoming hydraulic pressure P.sub.i) from the second pressure sensor **212**; converting the one or more data input signals S**1** and the one or more data input signals S**2** to hydraulic pressure values.

[0074] The ECU **300** then dynamically executes braking analysis of the dynamically captured/detected sensor data associated with the dynamically captured/detected outgoing hydraulic pressure P.sub.o of the brake fluid from the front master cylinder assembly **114** and the detected incoming hydraulic pressure P.sub.i (i.e., linking pressure) of the brake fluid to the front brake caliper assembly **115**. The braking analysis comprises executing, using comparator logic, a comparison between the hydraulic pressure value associated with the detected outgoing hydraulic pressure P.sub.o and the hydraulic pressure value associated with the detected incoming hydraulic pressure P.sub.i (i.e., linking pressure). Alternatively or additionally, the braking analysis comprises executing a comparison between the hydraulic pressure value associated with the detected outgoing hydraulic pressure P.sub.o with a predetermined threshold hydraulic pressure value stored in the one or more data stores **320**.

[0075] Responsive to executing the braking analysis, the ECU **300** is operable to regulate, when the hydraulic pressure value associated with the detected outgoing hydraulic pressure P.sub.o is less than the hydraulic pressure value associated with the detected incoming hydraulic pressure P.sub.i (i.e., linking pressure), the incoming hydraulic pressure P.sub.i of brake fluid to the front brake caliper assembly **115** in a manner that reduces stiffness at the front brake actuator **113** contemporaneously with linked braking.

[0076] Such regulation comprises reducing the incoming hydraulic pressure P.sub.i (i.e., linking pressure) by selectively diverting at least a portion of the pressurized brake fluid from the hydraulic circuit to the brake feel simulator **242**, **242***b*, **242***c*. In particular, when the detected outgoing hydraulic pressure P.sub.o is determined to be less than the incoming hydraulic pressure P.sub.i, the ECU **300** transmits one or more control signals C**2** to the normally-closed (NC) secondary control valve **225** to cause opening of the normally-closed (NC) secondary control valve **225**. Opening of the normally-closed (NC) secondary control valve **225**, in turn, causes selective diversion of at least a portion of the outgoing pressurized brake fluid from the front master cylinder assembly **114** to the brake feel simulator **242**, **242***b*, **242***c*. Particularly, a portion of flow of the outgoing pressurized brake fluid from the front master cylinder assembly **114** branches or diverts from the hydraulic circuit for flow into the brake feel simulator **242**, **242***b*, **242***c*. Due to the corresponding stiffness value of the secondary brake fluid storage member and stiffness value of the front brake caliper assembly **115**, the stiffness at the front brake actuator **113** when engaged by the vehicle operator is reduced.

[0077] Upon the detected outgoing hydraulic pressure P.sub.o exceeding the incoming hydraulic pressure P.sub.i (i.e., the linking pressure), brake linking is stopped by the ECU **300**. This is performed through the transmission of one or more control signals C**1** by the ECU **300** to the

normally-open (NO) primary control valve **220** to return the normally-open (NO) primary control valve **220** to an opened operating state, and one or more control signals C**1** by the ECU **300** to the normally-closed (NC) primary control valve **223** to return the normally-closed (NC) primary control valve **223** to a closed operating state. One or more control signals C**2** are also transmitted to the normally-closed (NC) secondary control valve **224** to return the normally-closed (NC) secondary control valve **224** to a closed operating state. In that way, the portion of pressurized brake fluid is recirculated from the brake feel simulator **242**, **242***b*, **242***c* to the hydraulic circuit.
[0078] In the illustrated examples of FIGS. **7** to **14**, a flowchart of computer-implemented methods **700** through **1400** for operating an electronically-linked vehicle brake system having a hydraulic circuit operable to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source. In one or more examples, the respective flowcharts of the methods **700** through **1400** may be implemented by the one or more processors **330**. For example, the one or more processors **330** are operable to implement the methods **700** through **1400** using logic instructions (e.g., software), configurable logic, fixed-functionality hardware logic, etc., or any combination thereof. In one or more examples, software executed by the ECU **300** provides functionality described or illustrated herein. In particular, software (e.g., stored on a non-transitory computer-readable medium)) executing by the one or more processors **330** is operable to perform one or more processing blocks of the computer-implemented methods **700** through **1800** set forth, described, and/or illustrated herein, or provides functionality set forth, described, and/or illustrated herein.
[0079] In the illustrated example computer-implemented method **700** of FIG. **7**, illustrated process block **702** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o of pressurized working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of pressurized working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).
[0080] The computer-implemented method **700** may then proceed to illustrated process block **704**, which includes executing braking analysis based on dynamically captured/detected sensor data associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.
[0081] In accordance with illustrated process block **704**, the braking analysis comprises executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.
[0082] The computer-implemented method **700** may then proceed to illustrated process block **706**, which includes regulating, in response to the braking analysis, the incoming hydraulic pressure P.sub.i (i.e., the linking pressure) by causing selective diversion of at least a portion of pressurized working fluid (e.g., brake fluid) from a hydraulic circuit to a brake feel simulator.
[0083] In accordance with illustrated process block **706**, regulating the incoming hydraulic pressure P.sub.i comprises causing, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, hydraulic coupling between the hydraulic circuit and the brake feel simulator.
[0084] In accordance with illustrated process block **706**, establishing the hydraulic coupling between the hydraulic circuit and the brake feel simulator causes selective diversion of at least a portion of the brake fluid from the hydraulic circuit to the brake feel simulator.
[0085] In accordance with computer-implemented method **700**, the brake feel simulator comprises: one or more secondary control valves to facilitate flow regulation of working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) comprising spring-biased accumulators having a spring

stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.
[0086] In accordance with illustrated process block **706**, establishing the hydraulic coupling between the hydraulic circuit and the brake feel simulator causes selective diversion of at least a portion of the working fluid (e.g., brake fluid) from the hydraulic circuit to the one or more secondary brake fluid storage members.
[0087] In accordance with illustrated process block **706**, regulating the incoming hydraulic pressure P.sub.i comprises selectively actuating, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the one or more secondary control valves (e.g., normally-closed (NC) secondary control valve **225**, **225***b*, **225***c*) to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.
[0088] In the illustrated example computer-implemented method **800** of FIG. **8**, illustrated process block **802** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o of working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).
[0089] The computer-implemented method **800** may then proceed to illustrated process block **804**, which includes executing braking analysis based on dynamically captured/detected sensor data associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.
[0090] In accordance with illustrated process block **804**, the braking analysis comprises executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.
[0091] The computer-implemented method **800** may then proceed to illustrated process block **806**, which includes reducing, in response to the braking analysis, the hydraulic pressure at the first hydraulic pressure source by causing selective diversion of at least a portion of a pressurized working fluid (e.g., brake fluid) from a hydraulic circuit to a brake feel simulator.
[0092] In accordance with illustrated process block **806**, reducing the incoming hydraulic pressure P.sub.i comprises causing, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, hydraulic coupling between the hydraulic circuit and the brake feel simulator.
[0093] In accordance with illustrated process block **806**, establishing the hydraulic coupling between the hydraulic circuit and the brake feel simulator causes selective diversion of at least a portion of the brake fluid from the hydraulic circuit to the brake feel simulator.
[0094] In accordance with computer-implemented method **800**, the brake feel simulator comprises: one or more secondary control valves to regulate flow of the working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.
[0095] In accordance with illustrated process block **806**, establishing the hydraulic coupling between the hydraulic circuit and the brake feel simulator causes selective diversion of at least a portion of the pressurized brake fluid from the hydraulic circuit to the one or more secondary brake fluid storage members.
[0096] In accordance with illustrated process block **806**, reducing the incoming hydraulic pressure P.sub.i comprises selectively actuating, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming

hydraulic pressure P.sub.i, the one or more secondary control valves to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.

[0097] In the illustrated example computer-implemented method **900** of FIG. **9**, illustrated process block **902** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o of working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).

[0098] The computer-implemented method **900** may then proceed to illustrated process block **904**, which includes executing braking analysis based on dynamically captured/detected sensor data associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0099] In accordance with illustrated process block **904**, the braking analysis comprises executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0100] The computer-implemented method **900** may then proceed to illustrated process block **906**, which includes causing, in response to the braking analysis, selective diversion of at least a portion of pressurized working fluid (e.g., brake fluid) from a hydraulic circuit to a brake feel simulator.

[0101] In accordance with illustrated process block **906**, causing selective diversion of at least a portion of the pressurized working fluid comprises causing, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

[0102] In accordance with computer-implemented method **900**, the brake feel simulator comprises: one or more secondary control valves to regulate flow of the working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) comprising spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0103] In accordance with illustrated process block **906**, causing selective diversion of at least a portion of the pressurized working fluid comprises selectively actuating, when the detected first hydraulic pressure is less than the detected second hydraulic pressure, the one or more secondary control valves to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.

[0104] In the illustrated example computer-implemented method **1000** of FIG. **10**, illustrated process block **1002** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o hydraulic pressure of working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).

[0105] The computer-implemented method **1000** may then proceed to illustrated process block **1004**, which includes executing braking analysis based on dynamically captured/detected sensor data associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0106] In accordance with illustrated process block **1004**, the braking analysis comprises executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically

captured/detected second or incoming hydraulic pressure P.sub.i.
[0107] The computer-implemented method **1000** may then proceed to illustrated process block **1006**, which includes causing, in response to the braking analysis, hydraulic coupling between a hydraulic circuit and a brake feel simulator.
[0108] In accordance with illustrated process block **1006**, the hydraulic coupling is executed when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.
[0109] In accordance with computer-implemented method **1000**, the brake feel simulator comprises: one or more secondary control valves to flow regulation of working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) comprising spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.
[0110] In accordance with illustrated process block **1006**, causing the hydraulic coupling comprises selectively actuating, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the one or more secondary control valves to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.
[0111] In the illustrated example computer-implemented method **1100** of FIG. **11**, illustrated process block **1102** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o hydraulic pressure of working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).
[0112] The computer-implemented method **1100** may then proceed to illustrated decision block **1104**, which includes executing braking analysis of the dynamically captured/detected sensor data that includes executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically captured/detected second or incoming hydraulic pressure P.sub.i to determine whether the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.
[0113] Should the braking analysis of decision block **1104** be answered in the affirmative or “Yes,” i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1100** proceeds to process block **1106**, which includes regulating, in response to the braking analysis, the incoming hydraulic pressure P.sub.i to the second hydraulic pressure source by causing selective diversion of at least a portion of the pressurized working fluid (e.g., brake fluid) from a hydraulic circuit to a brake feel simulator.
[0114] In accordance with illustrated process block **1106**, regulating the incoming hydraulic pressure P.sub.i comprises causing, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, hydraulic coupling between the hydraulic circuit and the brake feel simulator.
[0115] In accordance with illustrated process block **1106**, establishing the hydraulic coupling between the hydraulic circuit and the brake feel simulator causes selective diversion of at least a portion of the brake fluid from the hydraulic circuit to the brake feel simulator.
[0116] In accordance with computer-implemented method **1100**, the brake feel simulator

comprises: one or more secondary control valves to regulate flow of working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) comprising spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0117] In accordance with illustrated process block **1106**, establishing the hydraulic coupling between the hydraulic circuit and the brake feel simulator causes selective diversion of at least a portion of the working fluid (e.g., brake fluid) from the hydraulic circuit to the one or more secondary brake fluid storage members.

[0118] In accordance with illustrated process block **1106**, regulating the incoming hydraulic pressure P.sub.i comprises selectively actuating, when the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the one or more secondary control valves (e.g., normally-closed (NC) secondary control valve **224**) to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.

[0119] Should, on the other hand, the braking analysis of decision block **1104** be answered in the negative or “No,” i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1100** proceeds to illustrated decision block **1108**, which includes an evaluation to determine whether the first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i. Essentially, whether an equilibrium is reached between the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0120] Should the braking analysis of decision block **1108** be answered in the affirmative or “Yes,” i.e., should the comparison conclude the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1100** proceeds to process block **1110**, which includes terminating the linking application by transferring or otherwise recirculating flow of the pressurized fluid from the brake feel simulator to the hydraulic circuit.

[0121] Should, on the other hand, the braking analysis of decision block **1108** be answered in the negative or “No,” i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1100** returns to illustrated process block **1104**.

[0122] In the illustrated example computer-implemented method **1200** of FIG. **12**, illustrated process block **1202** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o hydraulic pressure of working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).

[0123] The computer-implemented method **1200** may then proceed to illustrated decision block **1204**, which includes executing braking analysis of the dynamically captured/detected sensor data that includes executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically captured/detected second or incoming hydraulic pressure P.sub.i to determine whether the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure

P.sub.i. Essentially, whether an equilibrium is reached between the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0124] Should the braking analysis of decision block **1204** be answered in the affirmative or "Yes," i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1200** proceeds to process block **1206**, which includes reducing, in response to the braking analysis, the incoming hydraulic pressure P.sub.i to the second hydraulic pressure source by causing selective diversion of at least a portion of pressurized working fluid (e.g., brake fluid) from a hydraulic circuit to a brake feel simulator.

[0125] In accordance with illustrated process block **1206**, reducing the incoming hydraulic pressure P.sub.i to the second hydraulic pressure source comprises causing, when the detected first hydraulic pressure is less than the detected second hydraulic pressure, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

[0126] In accordance with computer-implemented method **1200**, the brake feel simulator comprises: one or more secondary control valves to regulate flow of working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) comprising spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0127] In accordance with illustrated process block **1206**, establishing the hydraulic coupling between the hydraulic circuit and the brake feel simulator causes selective diversion of at least a portion of the brake fluid from the hydraulic circuit to the one or more secondary brake fluid storage members.

[0128] In accordance with illustrated process block **1206**, reducing the incoming hydraulic pressure P.sub.i to the second hydraulic pressure source comprises selectively actuating, when the dynamically captured/detected first hydraulic pressure is less than the dynamically captured/detected second hydraulic pressure, the one or more secondary control valves to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.

[0129] Should, on the other hand, the braking analysis of decision block **1204** be answered in the negative or "No," i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1200** proceeds to illustrated decision block **1208**, which includes an evaluation to determine whether the first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i. Essentially, whether an equilibrium is reached between the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0130] Should the braking analysis of decision block **1208** be answered in the affirmative or "Yes," i.e., should the comparison conclude the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1200** proceeds to process block **1210**, which includes terminating the linking application by transferring or otherwise recirculating flow of the pressurized fluid from the brake feel simulator to the hydraulic circuit.

[0131] Should, on the other hand, the braking analysis of decision block **1208** be answered in the negative or "No," i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1200** returns to illustrated process block **1204**.

[0132] In the illustrated example computer-implemented method **1300** of FIG. **13**, illustrated process block **1302** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o hydraulic pressure of working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).

[0133] The computer-implemented method **1300** may then proceed to illustrated decision block **1304**, which includes executing braking analysis of the dynamically captured/detected sensor data that includes executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically captured/detected second or incoming hydraulic pressure P.sub.i to determine whether the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i. Essentially, whether an equilibrium is reached between the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0134] Should the braking analysis of decision block **1304** be answered in the affirmative or “Yes,” i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1300** proceeds to process block **1306**, which includes causing, in response to the braking analysis, selective diversion of at least a portion of pressurized working fluid (e.g., brake fluid) from a hydraulic circuit to a brake feel simulator.

[0135] In accordance with illustrated process block **1306**, causing selective diversion of at least a portion of pressurized working fluid comprises causing, when the dynamically captured/detected first hydraulic pressure is less than the dynamically captured/detected second hydraulic pressure, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

[0136] In accordance with computer-implemented method **1300**, the brake feel simulator comprises: one or more secondary control valves to regulate flow of working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) comprising spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

[0137] In accordance with illustrated process block **1306**, causing selective diversion of at least a portion of pressurized working fluid comprises selectively actuating, when the dynamically captured/detected first hydraulic pressure is less than the dynamically captured/detected second hydraulic pressure, the one or more secondary control valves to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.

[0138] Should, on the other hand, the braking analysis of decision block **1304** be answered in the negative or “No,” i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1300** proceeds to illustrated decision block **1308**, which includes an evaluation to determine whether the first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i. Essentially, whether an equilibrium is reached between the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically

captured/detected second or incoming hydraulic pressure P.sub.i.
[0139] Should the braking analysis of decision block **1308** be answered in the affirmative or “Yes,” i.e., should the comparison conclude the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1300** proceeds to process block **1310**, which includes terminating the linking application by transferring or otherwise recirculating flow of the pressurized fluid from the brake feel simulator to the hydraulic circuit.
[0140] Should, on the other hand, the braking analysis of decision block **1308** be answered in the negative or “No,” i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1300** returns to illustrated process block **1304**.
[0141] In the illustrated example computer-implemented method **1400** of FIG. **14**, illustrated process block **1402** includes causing, in response to an application of hydraulic pressure at a first hydraulic pressure source (e.g., front master cylinder assembly **114**) contemporaneously with a linked braking operation, dynamic detection of a first or outgoing hydraulic pressure P.sub.o hydraulic pressure of working fluid (e.g., brake fluid) from the first hydraulic pressure source and a second or incoming hydraulic pressure P.sub.i of working fluid (e.g., brake fluid) to a second hydraulic pressure source (e.g., front brake caliper assembly **115**).
[0142] The computer-implemented method **1400** may then proceed to illustrated decision block **1404**, which includes executing braking analysis of the dynamically captured/detected sensor data that includes executing a comparison between a first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o and a second pressure value associated with the dynamically captured/detected second or incoming hydraulic pressure P.sub.i to determine whether the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i. Essentially, whether an equilibrium is reached between the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.
[0143] Should the braking analysis of decision block **1404** be answered in the affirmative or “Yes,” i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1400** proceeds to process block **1406**, which includes causing, in response to the braking analysis, hydraulic coupling between a hydraulic circuit and a brake feel simulator.
[0144] In accordance with illustrated process block **1406**, the hydraulic coupling is executed when the dynamically captured/detected first hydraulic pressure is less than the dynamically captured/detected second hydraulic pressure.
[0145] In accordance with computer-implemented method **1400**, the brake feel simulator comprises: one or more secondary control valves to regulate flow of working fluid to/from the brake feel simulator, and one or more secondary brake fluid storage members (e.g., spring-biased secondary brake fluid storage members) comprising spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.
[0146] In accordance with illustrated process block **1406**, causing the hydraulic coupling comprises selectively actuating, when the dynamically captured/detected first hydraulic pressure is less than the dynamically captured/detected second hydraulic pressure, the one or more secondary control valves to cause selective diversion of at least a portion of pressurized brake fluid from the hydraulic circuit to the spring-biased accumulators.
[0147] Should, on the other hand, the braking analysis of decision block **1404** be answered in the

negative or "No," i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not less than the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1400** proceeds to illustrated decision block **1408**, which includes an evaluation to determine whether the first pressure value associated with the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i. Essentially, whether an equilibrium is reached between the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i.

[0148] Should the braking analysis of decision block **1408** be answered in the affirmative or "Yes," i.e., should the comparison conclude the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1400** proceeds to process block **1410**, which includes terminating the linking application by transferring or otherwise recirculating flow of the pressurized fluid from the brake feel simulator to the hydraulic circuit.

[0149] Should, on the other hand, the braking analysis of decision block **1408** be answered in the negative or "No," i.e., should the comparison conclude that the dynamically captured/detected first or outgoing hydraulic pressure P.sub.o is not equal to the dynamically captured/detected second or incoming hydraulic pressure P.sub.i, the computer-implemented method **1400** returns to illustrated process block **1404**.

[0150] The terms "coupled," "attached," or "connected" may be used herein to refer to any type of relationship, direct or indirect, between the components in question, and may apply to electrical, mechanical, fluid, optical, electromagnetic, electro-mechanical or other connections. Additionally, the terms "first," "second," etc. are used herein only to facilitate discussion, and carry no particular temporal or chronological significance unless otherwise indicated. The terms "cause" or "causing" means to make, force, compel, direct, command, instruct, and/or enable an event or action to occur or at least be in a state where such event or action may occur, either in a direct or indirect manner.

[0151] Those skilled in the art will appreciate from the foregoing description that the broad techniques of the embodiments of the present disclosure may be implemented in a variety of forms. Therefore, while the embodiments have been described in connection with particular examples thereof, the true scope of the embodiments should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings, specification, and following claims.

EXAMPLES

[0152] The disclosure further includes additional notes and examples, as set forth in the following clauses.

Clause A

[0153] A vehicle brake system that includes: an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

Clause B

[0154] A vehicle brake system that includes: a brake assembly including a front master cylinder assembly as a first hydraulic pressure source and a front brake caliper assembly as a second hydraulic pressure source; a front brake actuator an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

Clause C

[0155] A vehicle brake system that includes: an EHCU operable to control flow of brake fluid through a hydraulic circuit; a brake feel simulator in hydraulic communication with the hydraulic circuit; one or more sensors operable to dynamically detect as sensor data, in response to initiation of a linked braking operation, a first hydraulic pressure and a second hydraulic pressure; and a vehicle controller, comprising one or more processors to execute a set of instructions to: execute braking analysis based on the detected sensor data, and regulate, in response to the braking analysis, the incoming hydraulic pressure to the second hydraulic pressure source by causing selective diversion of at least a portion of pressurized working fluid from the hydraulic circuit to the brake feel simulator.

Clause D

[0156] A vehicle brake system that includes: an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a sensor module having one or more sensors operable to detect a load at the first hydraulic pressure source to initiate the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: causing detection of a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously cause detection, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

Clause E

[0157] A vehicle that includes: a vehicle brake system having an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

Clause F

[0158] A vehicle that includes: a vehicle brake system having a brake assembly including a front master cylinder assembly as a first hydraulic pressure source and a front brake caliper assembly as a second hydraulic pressure source; a front brake actuator an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

Clause G

[0159] A vehicle that includes: a vehicle brake system having an EHCU operable to control flow of brake fluid through a hydraulic circuit; a brake feel simulator in hydraulic communication with the hydraulic circuit; one or more sensors operable to dynamically detect as sensor data, in response to initiation of a linked braking operation, a first hydraulic pressure and a second hydraulic pressure; and a vehicle controller, comprising one or more processors to execute a set of instructions to: execute braking analysis based on the detected sensor data, and regulate, in response to the braking analysis, the incoming hydraulic pressure to the second hydraulic pressure source by causing selective diversion of at least a portion of pressurized working fluid from the hydraulic circuit to the brake feel simulator.

Clause H

[0160] A vehicle that includes: a vehicle brake system having an EHCU operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source of the vehicle brake system contemporaneously with a linked braking operation; a sensor module having one or more sensors operable to detect a load at the first hydraulic pressure source to initiate the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: causing detection of a load at the first hydraulic pressure source of the vehicle brake system to initiate the linked braking operation, simultaneously cause detection, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

Clause I

[0161] A computer-implemented method of operating a vehicle brake system includes: detecting a load at a first hydraulic pressure source of the vehicle brake system to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of a working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source of the vehicle brake system; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to a brake feel simulator of the vehicle brake system.

Clause J

[0162] A computer-implemented method of operating a vehicle brake system includes: detecting a load at a first hydraulic pressure source of the vehicle brake system to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source of the vehicle brake system; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to a brake feel simulator of the vehicle brake system.

Clause K

[0163] A computer program product comprising at least one non-transitory computer readable medium having with a set of instructions of computer-executable program code, which when executed by one or more processors of a computing system, causes the one or more processors to perform operations that include: detecting a load at a first hydraulic pressure source of the vehicle brake system to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of a working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source of the vehicle brake system; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to a brake feel simulator of the vehicle brake system.

Clause L

[0164] A computer program product comprising at least one non-transitory computer readable medium having with a set of instructions of computer-executable program code, which when executed by one or more processors of a computing system, causes the one or more processors to perform operations that include: detecting a load at a first hydraulic pressure source of the vehicle brake system to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source of the vehicle brake system; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to a brake feel simulator of the vehicle brake system.

Claims

1. A vehicle brake system, comprising: an electro-hydraulic control unit (EHCU) operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.
2. The vehicle brake system of claim 1, wherein the braking analysis comprises executing a comparison between a first pressure value associated with the detected hydraulic pressure of the working fluid from the first hydraulic pressure source and a second pressure value associated with the detected hydraulic pressure of the working fluid to the second hydraulic pressure source.
3. The vehicle brake system of claim 2, wherein regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, the selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.
4. The vehicle brake system of claim 2, wherein regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, hydraulic coupling between the hydraulic circuit and the brake feel simulator.
5. The vehicle brake system of claim 2, wherein the brake feel simulator comprises one or more accumulators having a stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.
6. The vehicle brake system of claim 2, wherein the brake feel simulator comprises one or more spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.
7. The vehicle brake system of claim 1, wherein the vehicle brake system comprises an electronically-linked vehicle brake system.
8. A vehicle, comprising: a vehicle brake system that includes: an electro-hydraulic control unit (EHCU) operable to control flow of a working fluid through the vehicle brake system, the EHCU having a hydraulic circuit to establish hydraulic coupling between a first hydraulic pressure source and a second hydraulic pressure source contemporaneously with a linked braking operation; a brake feel simulator; and a vehicle controller, comprising one or more processors to execute a set of instructions to perform operations that include: detecting a load at the first hydraulic pressure source to initiate the linked braking operation, simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of the working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to the second hydraulic pressure source, executing braking analysis of the sensor data, and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.
9. The vehicle of claim 8, wherein the braking analysis comprises executing a comparison between

a first pressure value associated with the detected hydraulic pressure of the working fluid from the first hydraulic pressure source and a second pressure value associated with the detected hydraulic pressure of the working fluid to the second hydraulic pressure source.

10. The vehicle of claim 9, wherein regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, the selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

11. The vehicle of claim 9, wherein regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

12. The vehicle of claim 9, wherein the brake feel simulator comprises one or more accumulators having a stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

13. The vehicle of claim 9, wherein the brake feel simulator comprises one or more spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

14. The vehicle of claim 8, wherein the vehicle brake system comprises an electronically-linked vehicle brake system.

15. A computer program product comprising at least one non-transitory computer readable medium having with a set of instructions of computer-executable program code, which when executed by one or more processors of a control engine, cause the one or more processors to perform operations comprising: detecting a load at a first hydraulic pressure source to initiate a linked braking operation; simultaneously detecting, as sensor data contemporaneously with the linked braking operation, hydraulic pressure of a working fluid from the first hydraulic pressure source and hydraulic pressure of the working fluid to a second hydraulic pressure source; executing braking analysis of the sensor data; and regulating, in response to the braking analysis and contemporaneous with the linked braking operation, the hydraulic pressure of the working fluid to the second hydraulic pressure source by causing selective diversion of at least a portion of the working fluid from a hydraulic circuit to the brake feel simulator.

16. The computer program product of claim 15, wherein the braking analysis comprises executing a comparison between a first pressure value associated with the detected hydraulic pressure of the working fluid from the first hydraulic pressure source and a second pressure value associated with the detected hydraulic pressure of the working fluid to the second hydraulic pressure source.

17. The computer program product of claim 16, wherein regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, the selective diversion of at least a portion of the working fluid from the hydraulic circuit to the brake feel simulator.

18. The computer program product of claim 16, wherein regulating the hydraulic pressure of the working fluid to the second hydraulic pressure source comprises causing, when the first hydraulic pressure value is less than the second hydraulic pressure value, hydraulic coupling between the hydraulic circuit and the brake feel simulator.

19. The computer program product of claim 18, wherein the brake feel simulator comprises one or more accumulators having a stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.

20. The computer program product of claim 19, wherein the brake feel simulator comprises one or more spring-biased accumulators having a spring stiffness value that substantially corresponds to a stiffness value of the second hydraulic pressure source.