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(54) Title: A HYDRAULIC CIRCUIT FOR A SEATING ARRANGEMENT

(57) Abstract: This disclosure relates to a hydraulic circuit 100 for dampening vibrations in a hydraulically adjustable vehicle seat 102. The hydraulic circuit 100 may include an actuator 104 coupled to the vehicle seat 102. The hydraulic circuit 100 may further include a secondary reservoir 124 configured to exchange a hydraulic fluid with the actuator 104 in response to a fluctuation in a pressure in the actuator 104, resulting from a fluctuation in a load on the vehicle seat 102 due to vibrations in the vehicle seat 102. A decoupling device 132 hydraulically coupled to the secondary reservoir 124 may hydraulically decouple the secondary reservoir 124 from the actuator 104, thereby limiting an unintended vertical movement of the vehicle seat 102.

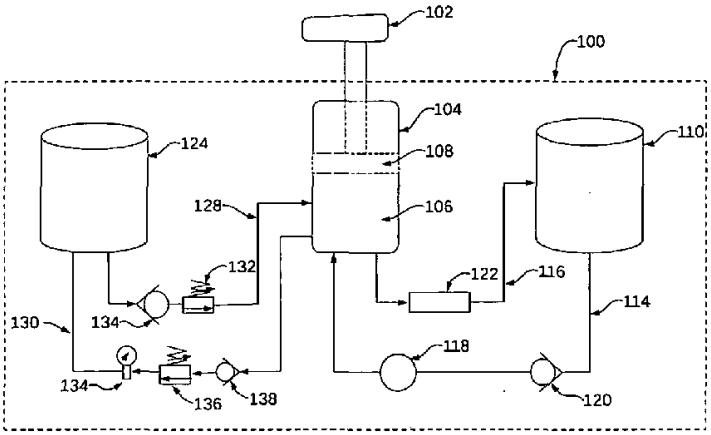

Figure 1

ABSTRACT

A HYDRAULIC CIRCUIT FOR A SEATING ARRANGEMENT

This disclosure relates to a hydraulic circuit 100 for dampening vibrations in a hydraulically adjustable vehicle seat 102. The hydraulic circuit 100 may include an actuator 104 coupled to the vehicle seat 102. The hydraulic circuit 100 may further include a secondary reservoir 124 configured to exchange a hydraulic fluid with the actuator 104 in response to a fluctuation in a pressure in the actuator 104, resulting from a fluctuation in a load on the vehicle seat 102 due to vibrations in the vehicle seat 102. A decoupling device 132 hydraulically coupled to the secondary reservoir 124 may hydraulically decouple the secondary reservoir 124 from the actuator 104, thereby limiting an unintended vertical movement of the vehicle seat 102.

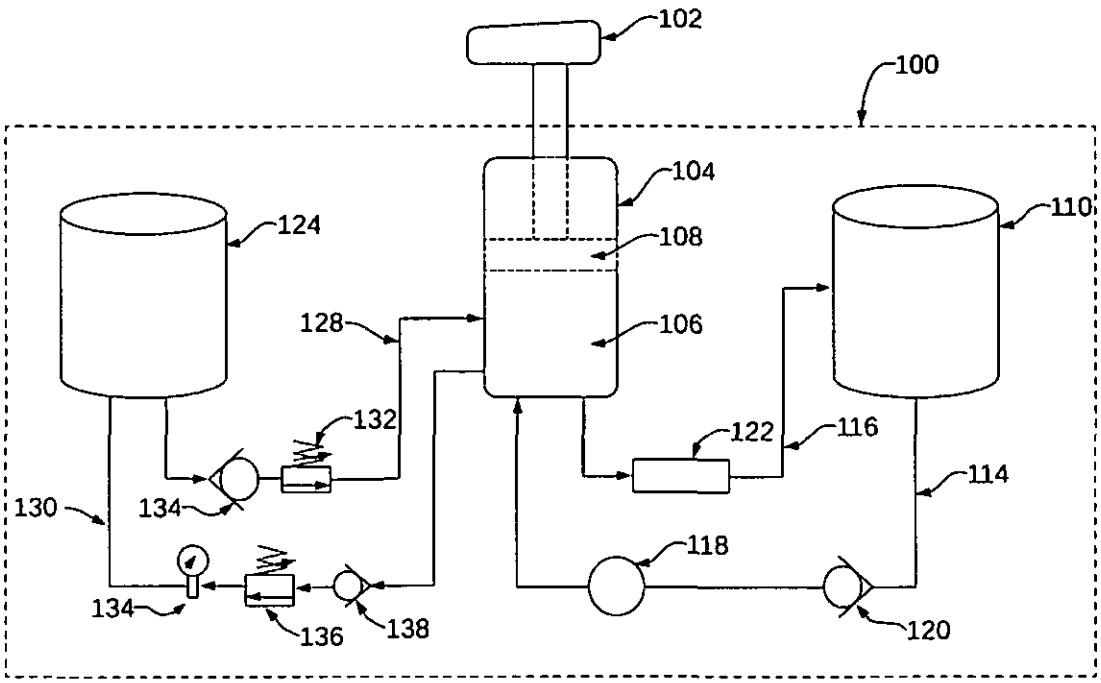

FIG. 1

We Claim:

1. A hydraulic circuit (100) for dampening vibrations in a hydraulically adjustable vehicle seat (102), the hydraulic circuit (100) comprising:

an actuator (104) coupled to the hydraulically adjustable vehicle seat (102), wherein the actuator (104) is further hydraulically coupled to a primary reservoir (110) and is configured to cause an intended vertical movement of the hydraulically adjustable vehicle seat (102) by exchanging a hydraulic fluid with the primary reservoir (110) on receiving a height adjustment trigger;

a secondary reservoir (124) hydraulically coupled to the actuator (104), wherein the secondary reservoir (124) is configured to exchange the hydraulic fluid with the actuator (104) in response to a fluctuation in a pressure in the actuator (104) resulting from a fluctuation in a load on the hydraulically adjustable vehicle seat (102) due to vibrations in the hydraulically adjustable vehicle seat (102), thereby dampening the vibrations; and

a decoupling device (132) coupled to the secondary reservoir (124), wherein the decoupling device (132) is configured to hydraulically decouple the secondary reservoir (124) from the actuator (104), thereby limiting an unintended vertical movement of the hydraulically adjustable vehicle seat (102).

2. The hydraulic circuit (100) as claimed in claim 1, wherein the primary reservoir (110) is a hydraulic fluid tank, and wherein the secondary reservoir (124) is a pressurized hydraulic accumulator having a pressurized gas.

3. The hydraulic circuit (100) as claimed in claim 1, wherein the hydraulic fluid is exchanged between the primary reservoir (110) and the actuator (104) via a primary inlet passage (114) and a primary outlet passage (116), wherein the hydraulic fluid is supplied from the primary reservoir (110) to the actuator (104) via the primary inlet passage (114) and the hydraulic fluid is released from the actuator (104) to the primary reservoir (110) via the primary outlet passage (116).

4. The hydraulic circuit (100) as claimed in claim 3, wherein the hydraulic fluid is supplied from the primary reservoir (110) to the actuator (104) to vertically raise the position of the hydraulically adjustable vehicle seat (102) by operating a pump (118), wherein the pump (118) is one of a manually powered pump and an electrically powered pump.

5. The hydraulic circuit (100) as claimed in claim 3, further comprising a primary check valve (120) on the primary inlet passage (114) to prevent back flow of the hydraulic fluid from the actuator (104) to the primary reservoir (110).

6. The hydraulic circuit (100) as claimed in claim 3, further comprising a primary relief valve (122) on the primary outlet passage (116) to release the hydraulic fluid from the actuator (104) to the secondary reservoir (124) to vertically lower the position of the hydraulically adjustable vehicle seat (102).

7. The hydraulic circuit (100) as claimed in claim 1, wherein the hydraulic fluid is exchanged between the secondary reservoir (124) and the actuator (104) via a secondary inlet passage (128) and a secondary outlet passage (130), wherein the hydraulic fluid is supplied from the secondary reservoir (124) to the actuator (104) via the secondary inlet passage (128) and the hydraulic fluid is released from the actuator (104) to the secondary reservoir (124) via the secondary outlet passage (130).

8. The hydraulic circuit (100) as claimed in claim 7, wherein the decoupling device (132) comprises one of a secondary spool valve or a secondary low pressure relief valve on the secondary inlet passage (128), and wherein the decoupling device (132) hydraulically decouples the secondary reservoir (124) from the actuator (104) in response to the pressure in the actuator (104) falling below a pre-defined pressure resulting from the load on the hydraulically adjustable vehicle seat (102) falling below a pre-defined load.

9. The hydraulic circuit (100) as claimed in claim 7, further comprising a secondary check valve (138) on the secondary outlet passage (130) to prevent back flow of the hydraulic fluid from the secondary reservoir (124) to the actuator (104).

10. The hydraulic circuit (100) as claimed in claim 7, further comprising a secondary pressure regulator relief valve (136) on the secondary outlet passage (130), wherein the secondary pressure regulator relief valve (136) is set at a pre-set pressure, and wherein the secondary pressure regulator relief valve (136) permits flow of the hydraulic fluid from the actuator (104) to the secondary reservoir (124) when pressure in the actuator is greater than the pre-set pressure.

Dated this 13th day of February 2018

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Technical Field

[001] This disclosure relates generally to a hydraulically adjustable vehicle seat, and more particularly to a hydraulic circuit for dampening vibrations in a hydraulically adjustable vehicle seat.

Background

[002] Conventionally, vehicles seats may be provided with various adjustment mechanisms for adjusting the positioning of the seat in order to accommodate the physique of a seat occupant and provide the occupant with comfortable seating experience. These mechanisms may allow the occupant to move or adjust the seat in forward-rearward directions, as well as in upward-downward directions, to achieve a desired position (i.e., adjusted position) of the vehicle seat.

[003] Additionally or alternatively; the vehicle seats may be provided with mechanisms for absorbing shock and vibrations in the vehicle seat when the vehicle encounters an uneven terrain. Such mechanisms may be used especially in off-highway vehicles, such as trucks, buses, construction equipment, and rail vehicle. However, such position controlling and shock absorbing mechanisms are bulky, complex, and costly.

[004] Some of the existing mechanisms providing position controlling and vibration dampening capabilities employ one or more sensors. As will be appreciated, inclusion of these sensors makes the overall construction of the vehicle seat complex, and further adds to the manufacturing and maintenance cost. Moreover, in many of the mechanisms, it is observed that, once the occupant vacates the vehicle seat, the vehicle seat regains its original position (i.e., unadjusted position). Therefore, every time the occupant re-occupies the vehicle seat, the positioning of the vehicle seat must be re-adjusted so as to achieve the desired position. The conventional vehicle seats do not have any mechanism to enable the vehicle seat to retain its adjusted position.

SUMMARY

[005] In one embodiment, a hydraulic circuit for dampening vibrations in a hydraulically adjustable vehicle seat is disclosed. The hydraulic circuit may include an actuator

coupled to the hydraulically adjustable vehicle seat. The actuator may be further hydraulically coupled to a primary reservoir and may be configured to cause an intended vertical movement of the hydraulically adjustable vehicle seat by exchanging a hydraulic fluid with the primary reservoir on receiving a height adjustment trigger. The hydraulic circuit may further include a secondary reservoir hydraulically coupled to the actuator. The secondary reservoir may be configured to exchange the hydraulic fluid with the actuator in response to a fluctuation in a pressure in the actuator resulting from a fluctuation in a load on the hydraulically adjustable vehicle seat due to vibrations in the hydraulically adjustable vehicle seat, thereby dampening the vibrations. The hydraulic circuit may further include a decoupling device coupled to the secondary reservoir. The decoupling device is configured to hydraulically decouple the secondary reservoir from the actuator, thereby limiting an unintended vertical movement of the hydraulically adjustable vehicle seat.

[006] In another embodiment, a hydraulically adjustable vehicle seat is disclosed. The hydraulically adjustable vehicle seat may include a vehicle seat. The hydraulically adjustable vehicle seat may further include a hydraulic circuit for controlling vertical positioning of the vehicle seat and dampening vibrations in the vehicle seat. The hydraulic circuit may further include an actuator coupled to the vehicle seat. The actuator may be further hydraulically coupled to a primary reservoir and may be configured to cause an intended vertical movement of the hydraulically adjustable vehicle seat by exchanging a hydraulic fluid with the primary reservoir on receiving a height adjustment trigger. The hydraulic circuit may further include a secondary reservoir hydraulically coupled to the actuator, wherein the secondary reservoir may be configured to exchange the hydraulic fluid with the actuator in response to a fluctuation in a pressure in the actuator. The fluctuation in the pressure in the actuator may result from a fluctuation in a load on the hydraulically adjustable vehicle seat due to vibrations in the hydraulically adjustable vehicle seat, thereby dampening the vibrations. The hydraulic circuit may further include a decoupling device coupled to the secondary reservoir. The decoupling device may be configured to hydraulically decouple the secondary reservoir from the actuator, thereby limiting an unintended vertical movement of the hydraulically adjustable vehicle seat.

[007] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[008] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

[009] **FIG. 1** illustrates a schematic diagram of an exemplary hydraulic circuit for controlling vertical movement of a hydraulically adjustable vehicle seat and dampening vibrations in the hydraulically adjustable vehicle seat, in accordance with some embodiments;

[010] **FIG. 2** illustrates a schematic diagram of an exemplary primary hydraulic circuit for controlling vertical movement of a hydraulically adjustable vehicle seat, in accordance with some embodiments;

[011] **FIG. 3** illustrates a schematic diagram of an exemplary secondary hydraulic circuit for dampening vibrations in a hydraulically adjustable vehicle seat, in accordance with some embodiments; and

[012] **FIG. 4** illustrates a schematic diagram of an another exemplary hydraulic circuit for controlling vertical movement of a hydraulically adjustable vehicle seat and dampening vibrations in the hydraulically adjustable vehicle seat, in accordance with some embodiments.

DETAILED DESCRIPTION

[013] Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are

described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being indicated by the following claims.

[014] Referring now to FIG. 1, a schematic of an exemplary hydraulic circuit 100 for controlling vertical positioning of a hydraulically adjustable vehicle seat 102 (hereinafter, referred to as vehicle seat 102), and dampening vibrations in the vehicle seat 102, is illustrated, in accordance with some embodiments. The hydraulic circuit 100 may be employed in association with the vehicle seat 102 of a vehicle (not shown in the FIG. 1), such as a car, a truck, a bus, a railroad vehicle, etc. It may be understood that the vibrations may be transmitted to the vehicle seat 102 due to an uneven terrain the vehicle may encounter, or due to absence of or improper working of the shock absorbing system of the vehicle. It may be noted that the vehicle seat 102 may be coupled to the vehicle body (not shown in the FIG. 1) via the hydraulic circuit 100, so that the vibrations experienced by the vehicle body may be dampened by the hydraulic circuit 100 before the vibrations can be transmitted to the vehicle seat 102. As such, the hydraulic circuit 100 may be coupled to the vehicle body at one end, and to the vehicle seat 102 at the other end.

[015] The hydraulic circuit 100 may include a primary hydraulic circuit for controlling vertical positioning of the vehicle seat 102. The primary hydraulic circuit may include an actuator 104 and a primary reservoir 110. The actuator 104 may be coupled to the vehicle seat 102, and may cause the vehicle seat 102 to move upward or downward. For example, the actuator 104 may be arranged in a vertical position under the vehicle seat 102. The actuator 104 may include a vertically movable piston 108 disposed within a hydraulic cylinder 106. In some embodiments, the cylinder 106 and the piston 108 may be arranged in such a way that one end of a piston 108 may be enclosed within the cylinder 106, and the other end of the piston 108 may be coupled to the vehicle seat 102. It may be understood that an upward and a downward movement of the piston 108 within the cylinder 106 may cause the upward and the downward movement of the vehicle seat 102, respectively.

[016] The piston 108 may be movable by a hydraulic fluid in the hydraulic cylinder 106. The hydraulic fluid may be supplied from the primary reservoir 110 to the actuator 104 to vertically raise the position of the vehicle seat 102. The hydraulic fluid may include any suitable fluid, such as mineral oil, ester, glycol, silicone, ether, etc. The hydraulic fluid may be stored in the primary reservoir 110. The primary reservoir, for example, may be a reservoir, such as a fluid tank, or a container, or a sump etc. In some embodiments, the primary reservoir 110 may be a concentric cylindrical tank encasing the cylinder 106.

[017] The primary reservoir 110 may be hydraulically coupled to the actuator 104 via a primary fluid flow passage, thereby forming a closed loop with the actuator 104. The flow passage may include a primary inlet passage 114 and a primary outlet passage 116, such that the hydraulic fluid may be exchanged between the primary reservoir 110 and the actuator 104 via the primary inlet passage 114 and the primary outlet passage 116. The hydraulic fluid may be supplied from the primary reservoir 110 to the actuator 104 via the primary inlet passage 114. The hydraulic fluid may be released from the actuator 104 to the primary reservoir 110 via the primary outlet passage 116. In some embodiments, the primary inlet passage 114 and the primary outlet passage 116 may include one or more openings. In alternate embodiments, the primary inlet passage 114 and the primary outlet passage 116 may include one or more pipes or tubes. The pipes or tubes may be built of any suitable material, such as plastic, metal, alloy, etc.

[018] The first circuit of the hydraulic circuit 100 may further include a pump 118, a primary check valve 120, and a primary relief valve 122. The first circuit of the hydraulic circuit 100 is further explained in detail, in conjunction with FIG. 2.

[019] Referring now to FIG. 2, a primary hydraulic circuit 200 corresponding to the hydraulic circuit 100 of FIG. 1, for controlling vertical positioning of the vehicle seat 102 is illustrated, in accordance with some embodiments. The primary hydraulic circuit 200 may include the actuator 104 and the primary reservoir 110, as already explained in conjunction with FIG. 1. As mentioned earlier, the first circuit of the hydraulic circuit 100 may further include a pump 118, a primary check valve 120, and a primary relief valve 122.

[020] In some embodiments, the actuator 104 may cause an intended vertical movement of the vehicle seat 102 by exchanging a hydraulic fluid with the primary reservoir 110 on receiving a height adjustment trigger. In some embodiments, the trigger may be provided using the pump 118. For example, the hydraulic fluid may be supplied from the primary reservoir 110 to the actuator 104 by operating the pump 118. In some embodiments, the pump 118 may be a manually powered pump. The manually powered pump 118 may further include a handle 202. The user may use the handle 202 to pump the hydraulic fluid from the primary reservoir 110 to the actuator 104, to thereby cause the intended vertical movement of the vehicle seat 102, and achieve an intended vertical height of the vehicle seat 102. In alternate embodiments, the pump 118 may be an electrically powered pump. The electrically powered pump may be powered by an electric motor (for example, 12V DC motor) operable via a switch.

[021] The hydraulic circuit 200 may further include the primary check valve 120 on the primary inlet passage 114, and the primary relief valve 122 on the primary outlet passage 116. As will be appreciated by those skilled in the art, a check valve on a fluid passage may allow fluid flow in one direction, and may block the fluid flow in opposite thereto direction in the fluid passage. The primary check valve 120 on the primary inlet passage 114 may prevent back flow of the hydraulic fluid from the actuator 104 to the primary reservoir 110.

[022] The primary relief valve 122 provided on the primary outlet passage 116 may allow releasing of the hydraulic fluid from the actuator 104 to the primary reservoir 110. It may be understood that releasing of the hydraulic fluid from the actuator 104 to the primary reservoir 110 may affect vertically lowering of the position of the vehicle seat 102. Therefore, for lowering the vertical position of the vehicle 102, the hydraulic fluid may be released from the actuator to the primary reservoir by operating the primary relief valve 122. It may be noted that the primary relief valve 122 may be either a manually operated relief valve or an electrically operated relief valve, such as a solenoid operated relief valve. For example, the solenoid may be a 12V DC solenoid operable via a switch.

[023] As will be appreciated, the vehicle seat 102 may be caused to move in the vertically upward direction by a pre-determined length, upon supplying of a pre-determined

quantity of the hydraulic fluid from the primary reservoir 110 to the actuator 104. Similarly, the vehicle seat 102 may be caused to move in the vertically downward direction by a pre-determined length upon releasing of a pre-determined quantity of the hydraulic fluid from the actuator 104 to the primary reservoir 110. Therefore, a length by which the vehicle seat 102 moves in the vertically upward or downward direction may be proportional to a quantity of the hydraulic fluid that is exchanged between the actuator 104 and the primary reservoir 110. In some embodiments, the pre-determined quantity of hydraulic fluid required for causing a pre-determined length of vertical movement of the vehicle seat 102 may be set by a user, depending on a required height of the vehicle seat 102. The pre-determined quantity of the hydraulic fluid may be further set based on factors of weight of the user, height of the user, etc.

[024] Referring back to FIG. 1, the hydraulic circuit 100 may further include a secondary hydraulic circuit for dampening the vibrations in the vehicle seat 102. The secondary hydraulic circuit may include a secondary reservoir 124 hydraulically coupled to the actuator 104. The secondary reservoir 124 may be hydraulically coupled to the actuator 104 via a secondary fluid flow passage forming a closed loop with the actuator 104. The secondary flow passage may include a secondary inlet passage 128 and a secondary outlet passage 130. The secondary inlet passage 128 may provide for supplying the hydraulic fluid from the secondary reservoir 124 to the actuator 104, and secondary outlet passage 130 may provide for releasing the hydraulic fluid from the actuator 104 to the secondary reservoir 124. The secondary inlet passage 128 and the secondary outlet passage 130 may include one or more openings, or one or more pipes or tubes.

[025] The secondary reservoir 124 may exchange a hydraulic fluid with the actuator 104. The secondary reservoir 124 may exchange the hydraulic fluid with the actuator 104 in response to a fluctuation in a pressure in the actuator 104 resulting from a fluctuation in a load on the vehicle seat 102. It may be understood that the fluctuation in the load on the vehicle seat 102 may be due to vibrations in the vehicle seat 102. It may be further understood that the vibrations in the vehicle seat 102 may be due uneven terrain encountered by the vehicle or a faulty shock absorbing (suspension) system of the vehicle. By way of exchanging of the hydraulic fluid

between the actuator 104 and the secondary reservoir 124, the dampening of vibrations in the vehicle seat may be achieved.

[026] The secondary hydraulic circuit may further include a decoupling device 132, a secondary check valve 134, a secondary pressure regulator relief valve 136, a secondary check valve 138, and a pressure gauge 140. The secondary hydraulic circuit is further explained in detail in conjunction with FIG. 3.

[027] Referring now to FIG. 3, a secondary hydraulic circuit 300 corresponding to the hydraulic circuit 100 of FIG. 1, for dampening vibrations in the vehicle seat 102, is illustrated, in accordance with some embodiments. As mentioned earlier, the secondary hydraulic circuit may include the actuator 104, the secondary reservoir 124, hydraulically coupled to the actuator 104 via the secondary inlet passage 128 and the secondary outlet passage 130. The secondary hydraulic circuit may further include the decoupling device 132, the secondary check valve 134, the secondary pressure regulator relief valve 136, the secondary check valve 138, and the pressure gauge 140.

[028] The secondary reservoir 124 may include pressurized gas. By way of an example, the secondary reservoir 124 may be a two part assembly including a hydraulic fluid chamber (not shown in FIG. 1) and a gas chamber (not shown in FIG. 1) fluidically coupled to each other and separated by a diaphragm. The gas chamber may include a pressurized gas at a predetermined pressure. It may be noted that the gas may an inert gas, such as nitrogen.

[029] Due to the pressurized gas, the secondary reservoir 124 may permit release of the hydraulic fluid from the actuator 104 to the secondary reservoir 124 above a pre-determined pressure of the pressurized gas in the secondary reservoir 124. In other words, the hydraulic fluid may flow from the actuator 104 to the secondary reservoir 124, only when the pressure in the actuator 104 is above the pre-determined pressure of the pressurized gas in the secondary reservoir 124. As will be appreciated, in some embodiments, the pre-determined pressure of the pressurized gas in the secondary reservoir 124 may be a design choice, and to change the pre-determined pressure, the secondary reservoir 124 may have to be re-calibrated. As already

mentioned, the pressure in the actuator 104 may be due to the load on the vehicle seat 102. It may be understood that the load on the vehicle seat 102 may be due to weight of an occupant occupying the vehicle seat and due to the vibrations in the vehicle seat 102. It may be further understood that the vibrations in the vehicle seat 102 may be due to, for example, the vehicle encountering an uneven terrain or due to faulty suspension of the vehicle. Therefore, the secondary reservoir 124 may selectively accumulate the hydraulic fluid under pressure built up in actuator 104 due to vibrations in the vehicle seat 102. This selective accumulation of the hydraulic fluid by the secondary reservoir 124 may provide a dampening effect on the vibrations in the vehicle seat 102.

[030] It should be noted that the pressurized gas may cause the secondary reservoir 124 to supply the hydraulic fluid into the actuator 104, when the pressure in the actuator falls below at pre-defined pressure. The pressure in the actuator may fall below the pre-defined pressure, for example, when the occupant occupying the vehicle seat 102 vacates the vehicle seat, thereby substantially reducing the load on the vehicle seat. In such a scenario, the pressurized gas may cause the entire hydraulic fluid in the secondary reservoir 124 to flow uncontrollably to the actuator 104. The hydraulic fluid flowing uncontrollably from the secondary reservoir 124 to the actuator 104 may cause an unintended vertically upwards movement of the vehicle seat 102. This unintended vertically upwards movement of the vehicle seat 102 may continue until the pressure in the secondary reservoir 124 becomes equal to the pressure in the actuator 104. Therefore, every time the occupant vacates the vehicle seat 102, the vehicle seat 102 may end up unintendedly moving vertically and regaining its original position.

[031] In order to prevent this unintended vertical movement of the vehicle seat 102, the hydraulic circuit 10 may further include a decoupling device 132 coupled to the secondary reservoir 124. The decoupling device 132 may hydraulically decouple the secondary reservoir 124 from the actuator 104. Therefore, by way of hydraulically decoupling the secondary reservoir 124 from the actuator 104, the decoupling device 132 may restrict or stop the flow of the hydraulic fluid from the secondary reservoir 124 to the actuator 104, thereby limiting the unintended vertical movement of the vehicle seat 102.

[032] In some embodiments, the decoupling device 132 may include one of a secondary spool valve and a secondary low pressure relief valve. In such embodiments, the decoupling device 132 (i.e. the secondary low pressure relief valve) may hydraulically decouple the secondary reservoir 124 from the actuator 104 in response to the pressure in the actuator 104 falling below a pre-defined pressure resulting from the load on the hydraulically adjustable vehicle seat 102 falling below a pre-defined load. In other words, the decoupling device 132 may be calibrated in such a way that it may allow the flow of hydraulic fluid from the secondary reservoir 124 to the actuator 104 as long as the pressure in the actuator 104 is above, or equal to, the pre-defined pressure. As soon as the pressure in the actuator 104 falls below the pre-defined pressure, the decoupling device 132 may restrict or completely stop the flow of the hydraulic fluid from the secondary reservoir 124 to the actuator 104. As will be appreciated, in some embodiments, the pre-defined pressure of decoupling device 132 may be a design choice, and to change the pre-defined pressure, the decoupling device 132 may have to be re-calibrated. As will be further appreciated, in some embodiments, the decoupling device 132 may include an interface for setting the pre-defined pressure. As such, a user may interact with the interface of the decoupling device 132 to calibrate the decoupling device 132 and set the pre-defined pressure, at the time of installing the decoupling device 132 on the secondary inlet passage 128. Alternately, the decoupling device 132 may be calibrated by default.

[033] In alternate embodiments, the decoupling device 132 may be operated by a switch. The switch may be an electrically powered switch that may be operated manually or based on signals from a sensor. For example, the user many manually operate the switch to engage the decoupling device 132 and decouple the secondary reservoir 124 from the actuator 104. Similarly, the sensor may detect the pressure in the actuator 104 falling below a pre-defined pressure, or the load on the hydraulically adjustable vehicle seat 102 falling below a pre-defined load. In response to detecting one or both of these occurrences, the sensor may trigger the switch to engage the decoupling device and cause the decoupling device 132 to restrict or completely stop the flow of the hydraulic fluid from the secondary reservoir 124 to the actuator 104. It may be understood that, in such embodiments, the decoupling device 132 may include any suitable

mechanism (e.g., switch operated check valve) to restrict or completely stop the flow of the hydraulic fluid from the secondary reservoir 124 to the actuator 104.

[034] The secondary check valve 134 on the secondary inlet passage 128 may prevent back flow of the hydraulic fluid from the actuator 104 to the secondary reservoir 124. Similarly, a secondary check valve 138 on the secondary outlet passage 130 may prevent back flow of the hydraulic fluid from the secondary reservoir 124 to the actuator 104. In other words, the secondary check valves 13, and 138 may allow only unidirectional flow of the hydraulic fluid from the secondary reservoir 124 to the actuator 104 on the secondary inlet passage 128 and from the actuator 104 to the secondary reservoir 124 on the secondary outlet passage 130 respectively.

[035] The secondary pressure regulator relief valve 136 may be provided on the secondary outlet passage 130. In some embodiments, the secondary pressure regulator relief valve 136 may be set at a pre-set pressure. It may be understood that the secondary pressure regulator relief valve 136 may permit flow of the hydraulic fluid from the actuator 104 to the secondary reservoir 124 when pressure in the actuator 104 is greater than the pre-set pressure. As mentioned earlier, the actuator 104 may be subject to fluctuation in the pressure in the actuator 104, resulting from a fluctuation in a load on the vehicle seat 102, due to vibrations in the vehicle seat 102. Therefore, when the pressure in the actuator 104 rises greater than the pre-set pressure, the hydraulic fluid may start flowing from the actuator 104 to the secondary reservoir 124. The pre-set pressure of the secondary pressure regulator relief valve 136 may be set manually or automatically depending on the anticipated frequency and/or amplitude of the vibrations the vehicle may encounter (which, in turn, may be depend on driving terrain) and/or the weight of the occupant (on the vehicle seat). It may be understood that when the pre-set pressure is higher, the secondary pressure regulator relief valve 136 may permit the flow of the hydraulic fluid from the actuator 104 to the secondary reservoir 124 only when the amplitude of the vibrations is high (for example, during off-roading when the driving terrain is rough). In other words, when the pre-set pressure is high, the dampening of vibrations may be achieved only for strong vibrations, and no dampening may be achieved for minor vibrations. The secondary hydraulic circuit 300 may further include the pressure gauge 140 on the secondary outlet passage 130. The pressure

gauge 140 may be used to monitor the pressure in the actuator 104. Accordingly, the pressure gauge 140 may include an interface device, such as a dial, to allow a user to monitor the pressure in the actuator 104. Additionally, the pressure gauge 140 may be used to set the pre-set pressure. Further, in some embodiments, the pressure gauge 140 may include two or more buttons for setting the pre-set pressure for hard cushioning or soft cushioning. For example, the user may use the button to select hard cushioning when off-roading, and to select soft cushioning during city or highway travel (when the driving terrain is relatively smooth). It may be understood that for hard cushioning, the secondary pressure regulator relief valve 136 may be set at a higher pre-set pressure, and for soft cushioning, the secondary pressure regulator relief valve 136 may be set at a lower pre-set pressure.

[036] During operation, in response to a fluctuation in a pressure in the actuator 104 (resulting from a fluctuation in a load on the vehicle seat 102 due to vibrations in the vehicle seat 102), the hydraulic fluid may be released from the actuator 104 to the secondary reservoir 124 via the secondary outlet passage 130. As it may be apparent from the above disclosure, the release of the hydraulic fluid from the actuator 104 to the secondary reservoir 124 may be subject to the pre-set pressure set at the secondary pressure regulator relief valve 136. As such, the hydraulic fluid may be released from the actuator 104 to the secondary reservoir 124 only when the pressure in the actuator 104 is above than the pre-set pressure set at the secondary pressure regulator relief valve 136. It may be further apparent from the above disclose that the release of the hydraulic fluid from the actuator 104 to the secondary reservoir 124 may be further subject to the pre-determined pressure of the pressurized gas in the secondary reservoir 124. Accordingly, the hydraulic fluid may flow from the actuator 104 to the secondary reservoir 124, only when the pressure in the actuator 104 is above the pre-determined pressure of the pressurized gas in the secondary reservoir 124. When the pressure in the actuator 104 is above the pre-set pressure set at the secondary pressure regulator relief valve 136 and the pre-determined pressure of the pressurized gas in the secondary reservoir 124, the hydraulic fluid may be released into the secondary reservoir 124. Therefore, the secondary reservoir 124 may selectively accumulate the hydraulic fluid actuator 104. This selective accumulation of the hydraulic fluid by the secondary reservoir 124 may provide a dampening effect on the vibrations in the vehicle seat 102.

[037] As will be appreciated, in a scenario, when the occupant occupying the vehicle seat 102 vacates the vehicle seat 102, the pressure in the actuator 104 may fall down considerably. In such a scenario, when the pressure in the actuator 104 falls below the pre-determined pressure of the pressurized gas in the secondary reservoir 124, the secondary reservoir 124 may start supplying the hydraulic fluid from the secondary reservoir 124 to the actuator 104. The secondary reservoir 124 may keep supplying the hydraulic fluid from the secondary reservoir 124 to the actuator 104, until the pressure in the secondary reservoir 124 becomes equal to the pressure in the actuator 104. This may lead to an unintended vertical movement of the vehicle seat 102.

[038] In the above scenario, the decoupling device 132 may hydraulically decouple the secondary reservoir 124 from the actuator 104. As a result, the unintended vertical movement of the vehicle seat 102 may be limited.

[039] Referring now to FIG. 4, a schematic diagram of an exemplary hydraulic circuit 400 (analogous to the hydraulic circuit 100) for dampening vibrations in a hydraulically adjustable vehicle seat 402, is illustrated, in accordance with some embodiments. The hydraulic circuit 400 may be employed in association with the vehicle seat 402 for controlling vertical positioning of the vehicle seat 402 as well as dampening vibrations in the vehicle seat 402.

[040] The hydraulic circuit 400 may include an actuator 404, and a primary reservoir 406. The actuator 404 may be a linear hydraulic actuator. The actuator 404 may be coupled to the vehicle seat 402, such that a reciprocating movement of the actuator 404 may cause to vertically move the position of the vehicle seat 402. In some embodiments, the actuator 404 may be directly attached to the vehicle seat 402. In alternate embodiments, the actuator 404 may be attached to the vehicle seat 402 via a link (not shown in FIG. 4). The actuator 404 may include a vertically movable piston disposed within a hydraulic cylinder (not shown in FIG. 4). In some embodiments, the cylinder and the piston may be arranged in such a way that one end of a piston may be enclosed within the cylinder, and the other end of the piston may be coupled to the vehicle seat 402. An upward and downward movement of the piston within the cylinder may affect movement of the vehicle seat 402 in the upward and downward direction, respectively.

[041] The actuator 404 may be hydraulically coupled to a primary reservoir 406 containing a hydraulic fluid. An exchange of the hydraulic fluid between the actuator 404 and the primary reservoir 406 may cause the actuator 404 to perform the upward and downward movement of the vehicle seat 402. In some embodiments, the primary reservoir 406 may encase the actuator 404. In such embodiments, the primary reservoir 406 may have a cylindrical shape, such that the primary reservoir 406 is substantially concentric to the actuator 404. In alternate embodiments, the primary reservoir 406 encasing the hydraulic actuator 404 may have any other shape, such as cubical or cuboidal shape. In some embodiments, the actuator 404 and the primary reservoir 406 may be enclosed within a body 408. The body 408 may be made of a metallic or a non-metallic material. The body 408 may provide shield the hydraulic actuator 404 and the primary reservoir 406 against external damage.

[042] The actuator 404 and the primary reservoir 406 may be coupled to each other via a primary inlet passage 410 and a primary outlet passage 412. The primary inlet passage 410 and the primary outlet passage 412 may be arranged in a region below the primary reservoir 406, and enclosed within the body 408. The primary inlet passage 410 may provide for supplying the hydraulic fluid from the primary reservoir 406 to the actuator 404, and the primary outlet passage 412 may provide for releasing the hydraulic fluid from the actuator 404 to the primary reservoir 406. The hydraulic fluid may be pumped from the primary reservoir 406 to the actuator 404. In some embodiments, the hydraulic fluid may be pumped using a manually operated plunger 414. In alternate embodiments, the hydraulic fluid may be pumped using an electrically powered pump (for example, 12V DC motor powered pump). The hydraulic circuit 400 may further include a primary relief valve 416 on the primary outlet passage 412 for releasing the hydraulic fluid from the actuator 404 to the secondary reservoir 418 to vertically lower the position of the hydraulically adjustable vehicle seat 402. The primary relief valve 416 may be a manually operated relief valve or an electrically operated relief valve (for example, 12V solenoid operated relief valve).The actuator 404 may cause an intended vertical movement of the vehicle seat 402 by exchanging the hydraulic fluid with the primary reservoir 406, as already explained in conjunction with FIG. 1 and 2.

[043] The hydraulic circuit 400 may further include a secondary reservoir 218 containing a hydraulic fluid. It may be understood that the hydraulic fluid in the secondary reservoir 418 may be the same hydraulic fluid as in contained in the primary reservoir 406. The secondary reservoir 418 may be hydraulically coupled to the actuator 404. The secondary reservoir 418 may be hydraulically coupled to the actuator 404 via a secondary inlet passage 410 and a secondary outlet passage 422. The secondary inlet passage 420 may provide for supplying the hydraulic fluid from the secondary reservoir 418 to the actuator 404, and a secondary outlet passage 422 may provide for releasing the hydraulic fluid from the actuator 404 to the secondary reservoir 418. In some embodiments, the secondary inlet passage 420 and the secondary outlet passage 422 may be arranged behind the vehicle seat 402. The secondary reservoir 218 may exchange the hydraulic fluid with the actuator 404 in response to a fluctuation in a pressure in the actuator 404, due to a fluctuation in a load on the vehicle seat 402, which may be further due to vibrations in the vehicle seat 402. By exchanging the hydraulic fluid between the actuator 404, the secondary reservoir 418 may be able to dampen the vibrations in the vehicle seat 402, as already explained in conjunction with FIG. 1 and 3.

[044] The hydraulic circuit 400 may further include a decoupling device 424 and a secondary check valve 426 on the secondary inlet passage 420. The decoupling device 424 may hydraulically decouple the secondary reservoir 418 from the actuator 404. For example, in some embodiments, the decoupling device 424 may hydraulically decouple the secondary reservoir 418 from the actuator 404 in response to the pressure in the actuator 404 falling below a pre-defined pressure resulting from the load on the vehicle seat 402 falling below a pre-defined load, thereby limiting an unintended vertical movement of the vehicle seat 402. The secondary check valve 426 may prevent back flow of the hydraulic fluid from the actuator 404 to the secondary reservoir 418. The hydraulic circuit 400 may further include a secondary check valve, a secondary pressure regulator relief valve, and a pressure gauge, collectively shown as 428, on the secondary outlet passage 422. The pressure regulator relief valve may permit flow of the hydraulic fluid from the actuator 404 to the secondary reservoir 418 when pressure in the actuator 404 is greater than a pre-set pressure. The secondary check valve may prevent back flow of the hydraulic fluid from the secondary reservoir 218 to the actuator 404. The pressure gauge

may be used to monitor the pressure in the actuator 404. The operation of the above elements is already explained in conjunction with FIG. 1 and 3.

[045] Referring once again to FIG. 1, a hydraulically adjustable vehicle seat assembly (hereinafter referred to as seat assembly) is disclosed. The seat assembly may include a vehicle seat 102, and a hydraulic circuit 100 for controlling vertical positioning of the vehicle seat 102 and dampening vibrations in the vehicle seat 102. The hydraulic circuit 100 may include an actuator 104 coupled to the vehicle seat 102. The actuator 104 may be further hydraulically coupled to a primary reservoir 110, to cause an intended vertical movement of the hydraulically adjustable vehicle seat 102 by exchanging a hydraulic fluid with the primary reservoir 110 on receiving a height adjustment trigger. The hydraulic circuit 100 may further include a secondary reservoir 124 hydraulically coupled to the actuator 104. The secondary reservoir 124 may be charged with a pressurized gas. The secondary reservoir 124 may exchange the hydraulic fluid with the actuator 104, in response to a fluctuation in a pressure in the actuator 104 resulting from a fluctuation in a load on the vehicle seat 102 due to vibrations in the vehicle seat 102. By way of exchanging the hydraulic fluid, the vibrations in the vehicle seat 102 may be dampened.

[046] The hydraulic circuit 100 may further include a decoupling device 132 coupled to the secondary reservoir 124. The decoupling device 132 may be configured to hydraulically decouple the secondary reservoir 124 from the actuator 104. As a result, an unintended vertical movement of the vehicle seat 102 may be limited. In some embodiments, the decoupling device 132 may include one of a secondary spool valve or a secondary low pressure relief valve on the secondary inlet passage 128. In such embodiments, the decoupling device 132 may hydraulically decouple the secondary reservoir 124 from the actuator 104 in response to the pressure in the actuator 104 falling below a pre-defined pressure resulting from the load on the hydraulically adjustable vehicle seat 102 falling below a pre-defined load. In alternative embodiments, the decoupling device 132 may be a switch operated check valve. The switch may be operated manually or based on signal from a sensor.

[047] In some embodiments, the hydraulically adjustable vehicle seat assembly may further include an extendable link for additionally controlling the vertical height of the vehicle

seat 102. The link may be provided between the actuator 104 and the vehicle seat 102, such that the link is coupled to the actuator 104 at one end and to the vehicle seat 102 at the other end. The vertical height of the vehicle seat 102 may be controlled by extending the length of the link. In some embodiments, the link may be a threaded rod. By way of an example, the vertical height of the vehicle seat 102 may be controlled by loosening the threaded rod (while being coupled to the vehicle seat) from the actuator, moving the threaded rod vertically upward or downward with respect to the actuator, and then tightening the threaded rod at a desired position. In some embodiments, the link may be a telescopic rod. The length of the link may be adjusted manually, or by using an electrical device, such as a motor.

[048] The hydraulic circuit and the hydraulically adjustable vehicle seat, described in various embodiments discussed above, may use a secondary reservoir for dampening vibrations in the vehicle seat, thus providing an alternate or an additional vibration absorbing mechanism in a vehicle. Further, the hydraulic circuit and the hydraulically adjustable vehicle seat, as described in the various embodiments above, include a decoupling device for decoupling the secondary reservoir from the actuator, (for example, when the pressure in the actuator falls below a pre-defined pressure, resulting from the load on the vehicle seat falling below a pre-defined load upon an occupant occupying the vehicle seat vacating the vehicle seat). By way of decoupling, the decoupling device limits an unintended vertical movement of the hydraulically adjustable vehicle seat. The decoupling mechanism therefore, saves the hassle of every time re-adjusting the vertical position of the vehicle seat to a desired vertical position, after the occupant vacates the vehicle seat. Further, the hydraulic circuit and the hydraulically adjustable vehicle seat, as described in the various embodiments above, provide for a cost effective and efficient mechanism for controlling the vertical height of the vehicle seat, dampening the vibration in the vehicle seat, and decoupling the secondary reservoir from the actuator. Moreover, the hydraulic circuit and the hydraulically adjustable vehicle seat may provide for reduced installation and maintenance time and cost.

[049] It is intended that the disclosure and examples be considered as exemplary only, with a true scope and spirit of disclosed embodiments being indicated by the following claims.

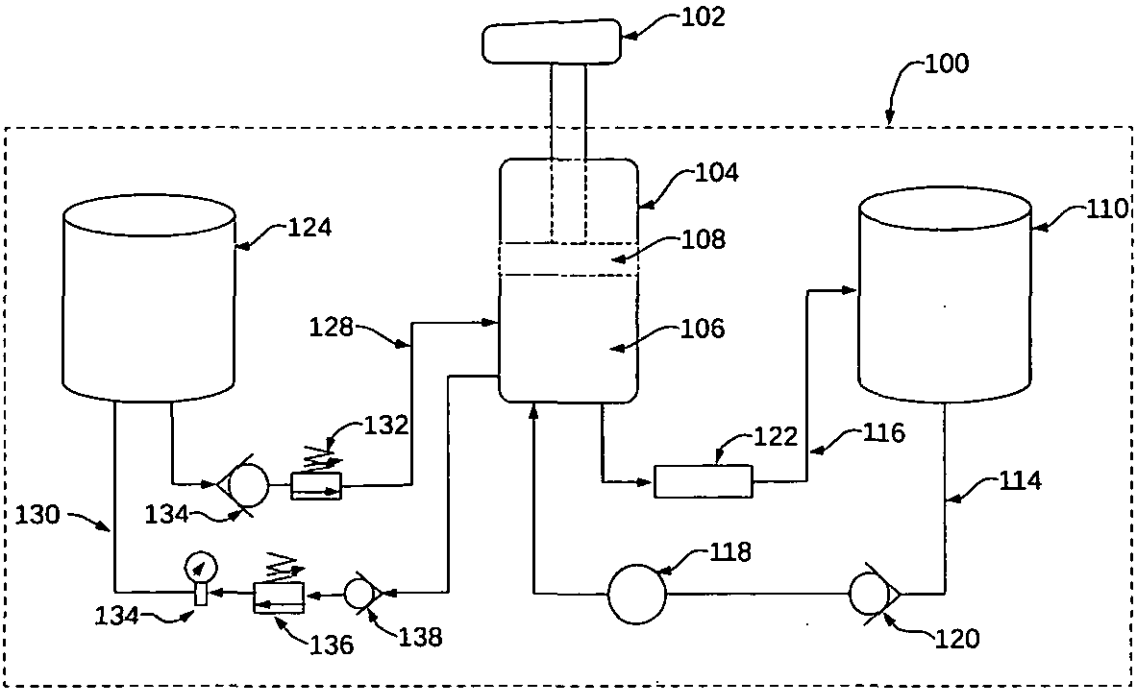

Figure 1

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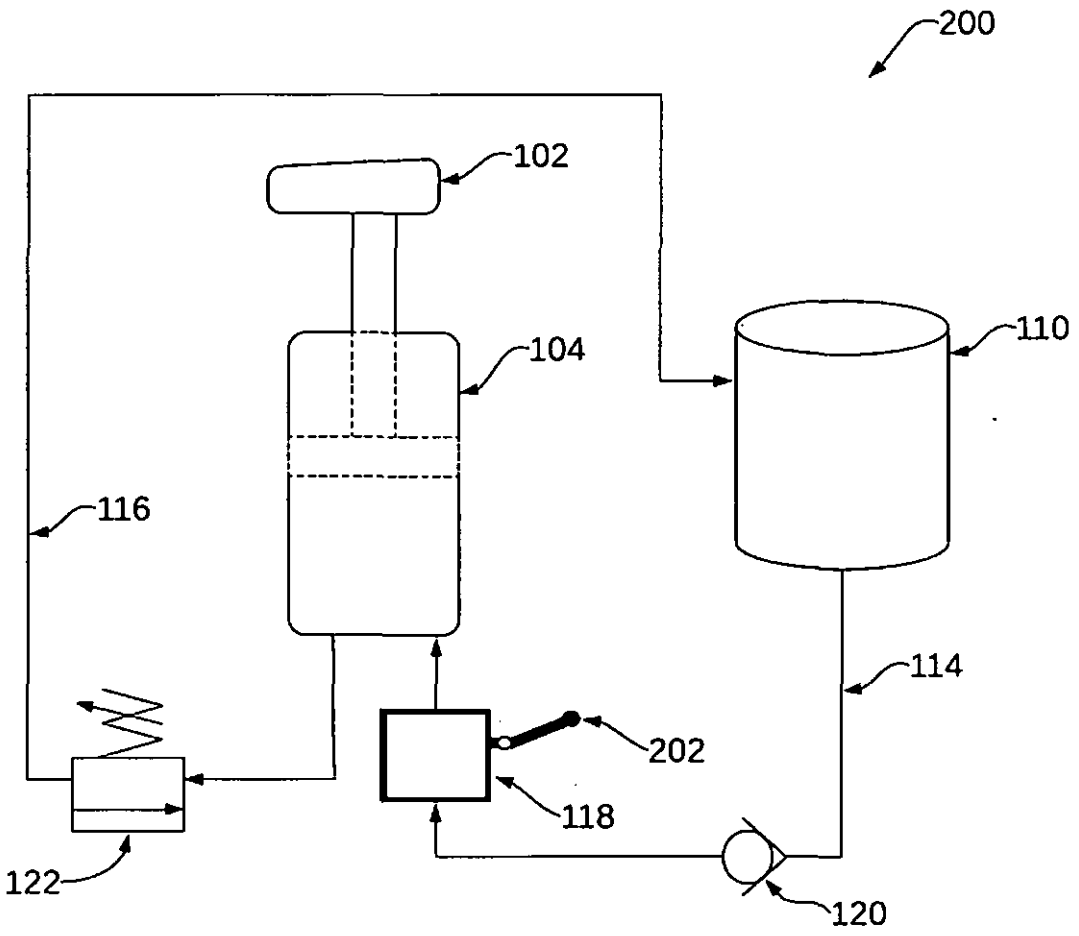

Figure 2

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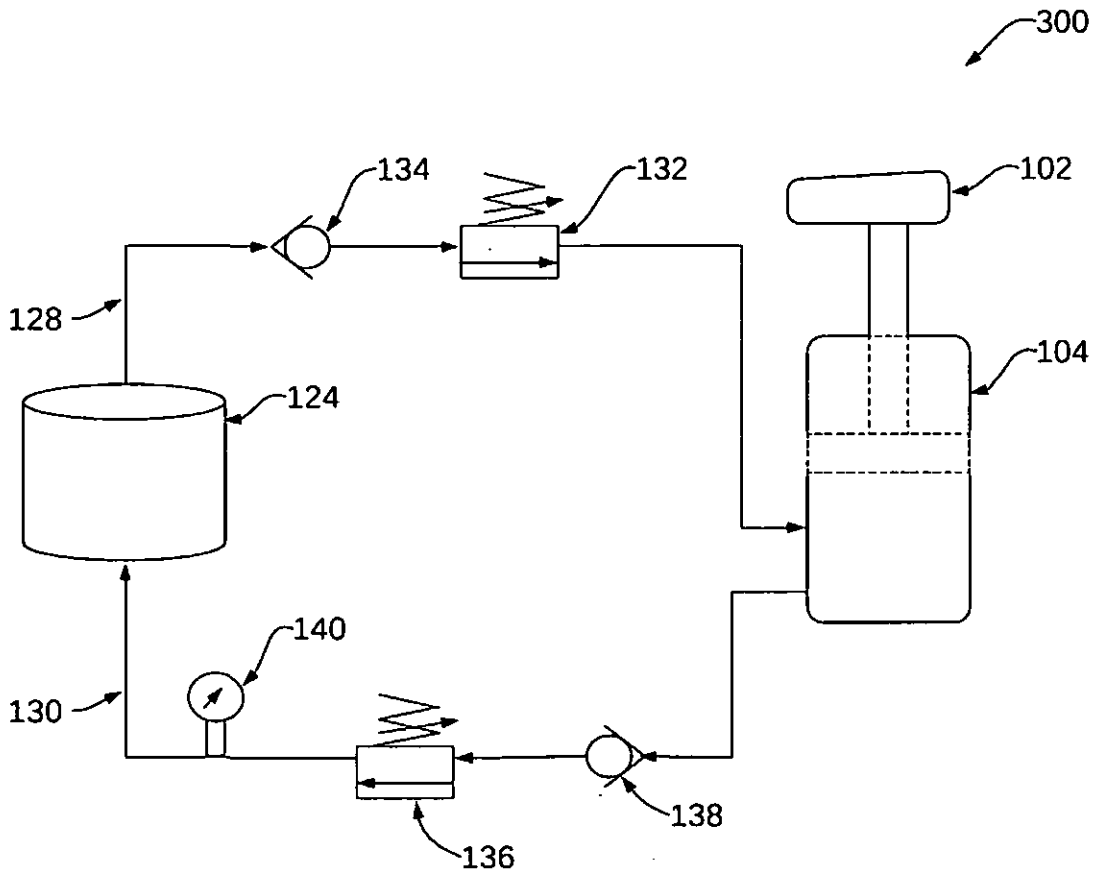

Figure 3

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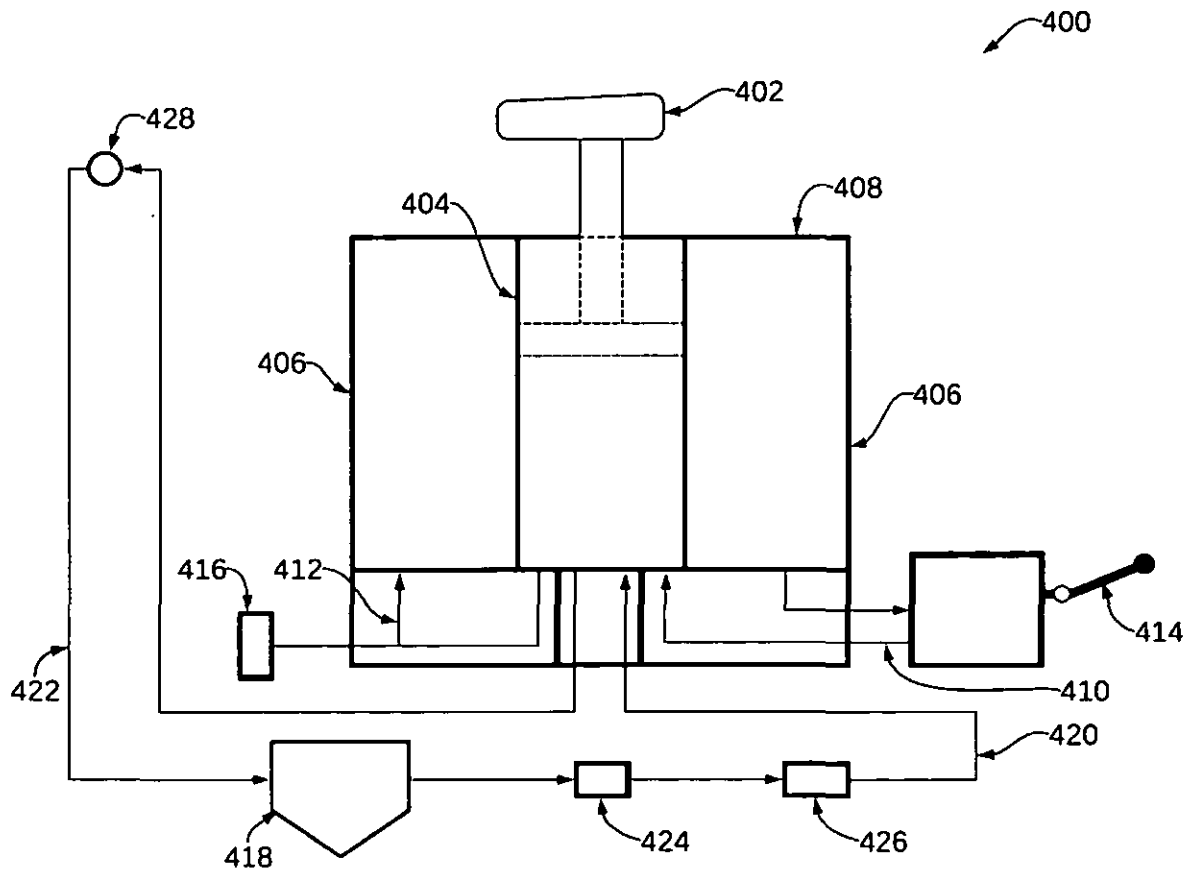

Figure 4

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