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ELECTRONICALLY CONTROLLED FULL POWER BRAKE VALVE
ELEKTRONISCH GESTEUERTES VERSTÄRKERBREMSVENTIL
SOUPAPE DE FREINAGE DE PUISSANCE MAXIMALE A COMMANDE ELECTRONIQUE

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Hydraulic braking systems for automobiles and/or other mobile vehicles are well known. Traditionally, hydraulic braking systems include a method of brake actuation to engage the vehicle brakes. For example, traditional braking systems use a variety of devices to convert mechanical power into fluid power, in the form of fluid displacement and pressure, to actuate the vehicle brakes. In these braking systems, however, the amount of fluid displacement and pressure supplied to the vehicle brakes is limited. Full power hydraulic brake systems, on the other hand, are capable of supplying larger amounts of fluid displacement and hydraulic pressure directly to the vehicle brakes. As a result, full power hydraulic braking systems are capable of supplying significantly higher braking torques with actuation that is faster than traditional hydraulic braking systems.

Variable ratios of braking output or pressure have been achieved when electrically controlled devices are utilized in conjunction with traditional hydraulic braking systems. For example, braking systems exist that utilize the electronically controlled device to vary the braking output based on input received from vehicle control systems, such as, the anti-lock braking system, vehicle wheel sensors, or vehicle speed sensors. However, these systems have several shortcomings.

For example, many existing brake systems that use electronically controlled devices to vary the braking output only are capable of providing a preset output in response to certain vehicle conditions. Furthermore, many existing hydraulic braking systems that utilize electronically controlled devices to vary the braking output rely on a separate boosting mechanism to increase the pressure directly to the brakes (see US-A-5 613 740). Hence these braking systems are limited in their ability to affect the braking output characteristics of the mechanically produced braking output. As a result, many existing braking systems lack the necessary versatility to accommodate the various situations that are encountered by the driver and that require different braking outputs.

Improvements in the mode of operation of hydraulic braking systems is, therefore, desired.

Summary of the Disclosure

The present disclosure relates to hydraulic braking systems according to claim 1. More particularly, the present disclosure is directed towards a hydraulic braking system having an electronically controlled full power brake valve. The hydraulic braking system of the present disclosure includes a primary brake valve assembly, a secondary valve assembly and an electronic controller. The system is designed such that the pressure output of the primary brake valve assembly can be varied based on inputs received from vehicle sensors, thereby, giving a wide range of control options.

The hydraulic braking system supplies a braking output for a vehicle having at least one wheel. The hydraulic braking system includes a primary valve assembly that is configured to receive a manually controlled input that varies the braking output of the braking system. The primary valve assembly includes a first spool valve configured to vary the braking output according to the manually controlled input. The hydraulic braking system also includes a secondary valve assembly integral with the primary valve assembly. The secondary valve assembly is configured to receive input signals from a programmable electronic controller and includes a second spool valve configured to operate with the primary valve assembly. The secondary valve assembly also includes an actuator for engaging and actuating the second spool valve according to the input signals received from the programmable electronic controller such that the second spool valve modulates the braking output produced by the primary valve assembly.

The first spool valve is positionable between a first position, a second position, and an intermediate position between the first and second positions. In the first position, the first spool valve provides fluid communication between at least one of the wheels and a first pressure source. In the second position, the first spool valve provides fluid communication between at least one of the wheels and a second pressure source. In the intermediate position, the first spool valve restricts fluid communication between the vehicle wheels and the first and second pressure sources. Similarly, the second spool valve is positionable between a first position, a second position, and an intermediate position between the first and second positions. In the second spool valve first position, the second spool valve provides fluid communication between the primary valve assembly and the first pressure source. In the second spool valve second position, the second spool valve provides fluid communication between the primary valve assembly and the second pressure source.
sition, the second spool valve restricts fluid communication between the vehicle wheels and the first and second pressure sources. In so doing, the second spool valve is able to modulate between the secondary valve assembly first and intermediate positions such that the secondary valve assembly pilot assists the primary valve assembly to intensify the braking output provided by the primary valve assembly when the actuator urges the second spool valve to the first position.

[0010] The second spool valve is constructed and arranged to modulate between the secondary valve assembly second and intermediate positions such that the secondary valve assembly decreases the braking output produced by the primary valve assembly.

[0011] The actuator is a solenoid actuator having a coil and an armature for engaging and actuating the second spool valve according to the input signals received from the programmable electronic controller. In so doing, the second spool valve modulates the braking output produced by the primary valve assembly.

[0012] Furthermore, the programmable electronic controller is configurable to receive input from one or more vehicle control systems such that the secondary valve assembly modulates the braking output produced by the primary valve assembly according to preset values. Alternatively, the programmable electronic controller is configurable to receive input from a serial control device such that the secondary valve assembly modulates the braking output produced by the primary valve assembly in real-time.

[0013] The above summary of the present invention is not intended to describe each illustrated embodiment or every implementation of the present invention. Other objects, features and advantages of the present invention will become more apparent in light of the following detailed description of exemplary embodiments thereof, as illustrated in the accompanying drawings.

**Brief Description of the Drawings**

[0014] The invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

FIG. 1 is a view showing the mechanically produced output of a hydraulic braking system in accordance with the prior art represented as pressure output percentage versus pedal rotation percentage;

FIG. 2 is a cross-sectional view of a hydraulic brake system according to the principals of the present disclosure shown in a non-actuated state;

FIG. 3 is a cross-sectional view of a hydraulic brake system according to the principals of the present disclosure shown in an actuated state;

FIG. 4 is an enlarged, cross-sectional view of a primary valve assembly as illustrated in the hydraulic brake system of FIGS. 2 and 3;

FIG. 5 is an enlarged, cross-sectional view of a secondary valve assembly as illustrated in the hydraulic brake system of FIGS. 2 and 3;

FIG. 6 is a hydraulic schematic diagram of the hydraulic brake system illustrated in FIGS. 1 and 2 shown in a first (non-actuated) position;

FIG. 7 is a hydraulic schematic diagram of the hydraulic brake system illustrated in FIGS. 1 and 2 shown in a second (actuated) position;

FIG. 8 is a hydraulic schematic diagram of the hydraulic brake system illustrated in FIGS. 1 and 2 shown in an intermediate position between the first and second positions of FIGS. 6 and 7;

FIG. 9 is a view showing various braking outputs produced using an electronic controller according to the present disclosure varied relative to pedal position;

FIG. 10 is a view showing a standard linear programmed slope represented as pressure output percentage versus pedal rotation percentage;

FIG. 11 is a view showing a slope adjusted for lower speeds represented as pressure output percentage versus pedal rotation percentage;

FIG. 12 is a view showing a slope adjusted for higher speeds represented as pressure output percentage versus pedal rotation percentage;

FIG. 13 is a view showing exemplary programmed slopes according to an embodiment of the present disclosure; and

FIG. 14 is a view showing another exemplary programmed braking slope according to an embodiment of the present disclosure.

[0015] While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail.

**Detailed Description**

[0016] The present disclosure generally relates to hydraulic braking systems. More particularly, the present disclosure is directed towards a hydraulic braking system having an electronically controlled full power brake valve. While the present invention is not so limited, a more detailed understanding of the present invention will be gained through a discussion of the drawings in connection with the examples provided below.

[0017] Referring now to FIG. 2, a cross-sectional view of a hydraulic brake valve 100 according to the principals of the present disclosure is shown in a non-actuated state. By "non-actuated," it is generally meant that the vehicle brakes are not engaged and, thus, do not restrict the motion of the vehicle. Conversely, the hydraulic braking system as shown in FIG. 3 depicts the hydraulic brake valve 100 in an actuated state. By "actuated," it is generally meant that the vehicle brakes are at least partially engaged and, thus, restrict the motion of the vehicle.
As shown in FIG. 2 the hydraulic brake valve 100 includes a primary brake valve assembly 102 and a secondary brake valve assembly 104. The primary brake valve assembly 102 is configured to receive a manually controlled input through an actuating mechanism 106, such as a brake pedal, brake lever, or other suitable mechanism for providing manually controlled input into the hydraulic braking system. The actuating mechanism 106 transmits an input force from the operator to the brake assembly through an input cylinder 108. As shown in FIG. 2, the actuating mechanism 106 acts on a spring 109 (represented as arrows) and moves a spring retainer 110 disposed within the input cylinder 108 downwardly through the housing of the primary valve 102. By "downwardly," it is generally meant that in the orientation of the braking system shown in FIG. 2, the spring retainer 110 moves from the top of the input cylinder 108 in the direction of the primary valve assembly 102.

The spring retainer 110 urges an intermediate piston 112 into engagement with a first spool valve 114 disposed within the primary valve assembly 102. The first spool valve 114 is configured to selectively provide fluid communication between the vehicle brakes 105a, 105b and a first pressure source 150 (e.g., the reservoir pressure) or the second pressure source 152 (e.g., the system pressure). In an actuated state, the secondary valve assembly 104 provides fluid communication between the primary valve assembly 102 and the system pressure 152. Conversely, in a non-actuated state, the secondary valve assembly 104 provides fluid communication between the primary valve assembly 102 and the reservoir pressure 150.

The second valve assembly 104 also includes an actuator 138 for engaging and actuating the second spool valve 126 between a non-actuated state to an actuated state. In one embodiment, the actuator 138 is an electromagnetic solenoid. However, the actuator 138 can be any mechanism that is capable of actuating the second spool valve 126 between a non-actuated state and an actuated state. In the illustrated embodiment, the actuator 138 preferably has a coil 140 and a plunger or armature 142 disposed within the coil 140. As is generally understood, the coil 140 can be constructed and arranged to generate a magnetic field that is capable of driving the armature 142 downwardly in the axial direction of the coil 140. Again, by "downwardly," it is generally meant that in the orientation of the braking system shown in FIG. 2, the armature 142 moves from the top and along the axial direction of the coil 140 towards the second spool valve 126. The magnetic field created within the coil 140 urges the armature 142 into engagement with the second spool valve 126.

The actuator 138 receives input signals 145 from an electronic controller 144. The electronic controller is configured to vary the input signals 145 supplied to the actuator 138 according to input received from an interface circuit 148. In one embodiment, the interface circuit 148 can be any sensor capable of varying an electronic signal to the electronic controller 144 based upon the relative position of the actuating mechanism 106, such as a potentiometer or hall effect sensor. Accordingly, the electronic controller 144 is capable of varying the
input signals 145 (e.g., electrical current) to the actuator 138 based upon the relative position of the actuating mechanism 106. In so doing, the electronic controller 144 can actuate the secondary valve assembly 104 such that the secondary valve assembly 104 pilot assists the primary valve assembly 102 during brake actuation. By "pilot assist," it is generally meant that the secondary valve assembly 104 increases the pressure applied to the primary valve assembly 102, thereby increasing the overall braking output for the braking system 100. Moreover, because the electronic controller 144 varies the input signals 145 based upon the relative position of the actuation mechanism 106, the secondary valve assembly 104 and the intermediate piston 112 (FIG. 2) are able to intensify the ratio of output pressure to input position of the pedal. A more detailed discussion of the electronic controller 144 is presented below.

[0025] Conversely, when the actuator 138 is not actuating the secondary valve assembly 104, the second spool valve 126 is in a non-actuated state. Thus, the second spool valve 126 is positioned such that secondary valve assembly 104 does not exert any fluid pressure on the primary valve assembly 102. To accomplish this, fluid communication is provided between the primary valve assembly 102 and the reservoir 150. The various positions of the hydraulic braking system will be described in greater detail below in conjunction with FIGS. 6-8.

[0026] Referring now to FIG. 5, an enlarged view of the secondary valve assembly 104 is shown. The second spool valve 126 has a first end 128 and a second end 130 opposite the first end 128. The secondary valve assembly 104 can also include a spring 137 that biases the second spool valve 126 towards the non-actuated state. The second spool valve 126 as shown in FIG. 5 is shown in a partially actuated state. When the actuator coil 140 is energized, the armature 142 is biased or forced downwards and into engagement with the first end 128 of the second spool valve 126. Conversely, when the actuator coil is de-energized, the armature 142 returns to its natural, unbiased position within the coil 140, therefore, allowing the spring 137 to return the second spool valve 126 to the non-actuated state.

[0027] As discussed above, the second spool valve 126 is configured to selectively provide fluid communication between the primary valve assembly 102 and a first pressure source 150 (e.g., the reservoir pressure) or a second pressure source 152 (e.g., the system pressure). For example, when the second spool valve 126 is in its non-actuated state, the second spool valve 126 is positioned such that fluid communication is provided between the primary valve assembly 102 and the reservoir 150. More particularly, when the second spool valve 126 is in its actuated state, the second spool valve 126 is positioned such that fluid communication is provided between the first end 116 of the primary valve assembly 102 and the reservoir 150. Alternatively, when the second spool valve 126 is in its actuated state, the second spool valve 126 is positioned such that fluid communication is provided between the primary valve assembly 102 and the system pressure 152 via cavity 135. More particularly, when the second spool valve 126 is in its actuated state, the second spool valve 126 is positioned such that fluid communication is provided between the first end 116 of the primary valve assembly 102 and the system pressure 152. In the actuated state, the secondary valve assembly 104 pilot assists the primary valve assembly 102. Thus, the secondary valve assembly 104 increases the pressure applied to the first end 116 of the first spool valve 114 and, therefore, further biases the first spool valve 114 into its actuated state as described above.

[0028] FIGS. 6-8 are hydraulic schematic diagrams that illustrate the various positions of the first spool valve and second spool valves of the hydraulic braking system described above. The first spool valve 202 (e.g., first spool valve 102 described above) is positionable between a first position, a second position, and an intermediate position between the first and second position. Similarly, the second spool valve 204 (e.g., second spool valve 104 described above) is positionable between a corresponding first position, second position, and intermediate position between the first and second position.

[0029] As shown in FIG. 6, the first spool valve 202 and the second spool valve 204 are each shown in the first position. In the first position, the first spool valve 202 is non-actuated and as such provides fluid communication between the reservoir pressure 208 to at least one of the vehicle brakes 205 via passageways 212, 214. Likewise, the second spool valve 204 is non-actuated in the first position and provides fluid communication between the reservoir pressure 208 and the primary valve assembly 202 via cavities 212a, 220 and 224.

[0030] FIG. 7 shows both the first spool valve 202 and the second spool valve 204 in the second position. As described above, the actuating mechanism 203 forces the primary valve assembly from the first position to the second position. In the second position, the primary valve assembly 202 provides fluid communication between the vehicle brakes 205 and the system pressure 206 through the system pressure passageways 210, 214.

[0031] While the first spool valve 202 is in the second position, the second spool valve 204 can be in any of its three positions depending upon the input signals 232 provided to the actuator 234 from the electronic controller 230. For example, the second spool valve 204 can remain in the first position such that fluid communication is provided between the reservoir pressure 208 and the first spool valve 202. This typically occurs when the hydraulic brake system of the present disclosure suffers a power failure. In such a scenario, the secondary valve assembly is unable to assist the primary valve assembly during braking. Instead, the primary valve assembly operates as it normally does. Accordingly, the hydraulic brake valve of the present disclosure simplifies the operational mechanics used to apply the brakes when the system suffers a power failure.
Alternatively, while the first spool valve 202 is in the second position, the second spool valve 204 can be urged towards its second position by the actuator 234 as depicted in FIG. 7. In its second position, the second spool valve 204 provides fluid communication between the first spool valve 202 and the system pressure 206 through the passageways 210a, 220 and 224.

FIG. 8 shows both the first spool valve 202 and the second spool valve 204 in the intermediate position. In the intermediate position, the first spool valve 202 restricts substantially all fluid communication between the vehicle brakes 205 and the reservoir pressure 208 and the system pressure 206. Similarly, the secondary spool valve assembly 204 restricts substantially all fluid communication between the primary valve assembly 202 and the reservoir pressure 208 and the system pressure 206. The intermediate positions of the first and second spool valves 202, 204 are typically achieved as the first and second spool valves 202, 204 modulate between their respective first and second positions. Modulation of the first and second spool valves 202, 204 will be discussed in greater detail below.

The operational mechanics of the hydraulic brake system of the present disclosure will now be described in connection with FIGS. 2-5. As is commonly understood by those skilled in the art, the first spool valve 114 is a conventional spool valve and is constructed and arranged to modulate between first and second positions. By "modulate," it is generally meant that the first spool valve 114 moves within the primary valve assembly 102 between the first position, intermediate, and second positions according to the pressures or forces being exerted on its first end 116 and its second end 118. Furthermore, the modulation in the first spool valve 114 allows the reactive force on the actuating mechanism 106 (FIG. 2) felt by the operator to be proportional to the brake line pressure being generated in passageway 154.

For example, when a user depresses the actuating mechanism 106, the spring retainer 110 within the input cylinder 108 (FIG. 2) urges the intermediate piston 112 into engagement with the first end 116 of the first spool valve 114. As discussed above, the intermediate piston 112 urges the spool valve downwprops to provide fluid communication between the system pressure 152 and the vehicle brakes 105a, 105b via passageway 154. In this position, high pressure fluid is also provided to a second chamber 122 via feedback circuit 124. Accordingly, the high pressure fluid in the second chamber 122 urges the first spool valve 114 upwards and acts against the downwardly acting force provided by the intermediate piston 112 on the first end 116 of the first spool valve 114. In situations where the force provided by the intermediate piston 112 is less than the force provided by the high pressure fluid in the second chamber 122, the high pressure fluid in the second chamber 122 biases the first spool valve 114 upwards towards its first position. Conversely, in situations where the force provided by the intermediate piston 112 is greater than the force provided by the high pressure fluid in the second chamber 122, the intermediate piston 112 is able to bias the first spool valve 114 downwards towards its second position.

As discussed above, the electronic controller 144 sends input signals 145 to the actuator 138. The electronic controller 140 is capable of varying the input signals 145 (e.g., the electrical current) supplied to the actuator 138 based upon the relative position of the actuating mechanism 106. Therefore, the electronic controller 140 is capable of actuating the secondary valve assembly 104 such that the secondary valve assembly 104 pilot assists the primary valve assembly 102 during brake actuation. In other words, when the electronic controller 140 actuates the secondary valve assembly 104, the secondary valve assembly 104 increases the pressure applied to the primary valve assembly 102 by applying hydraulic pressure directly to the first spool valve 114, for example, the first end 116 of the first spool valve.

The second spool valve 126 operates in a similar fashion to the first spool valve 114 as discussed above. For example, as can be seen in FIG. 3, when the actuator 138 is energized, the armature 142 urges the second spool valve 126 downward into an actuated state. In the actuated state, the second spool valve 126 provides fluid communication between the system pressure 152 via passageway 153a and the primary valve assembly 102 via passageway 135. More specifically, the second spool valve 126 provides fluid communication between the first end 116 of the first spool valve 114 and the system pressure 152.

The high pressure fluid acting on the first end 116 of the first spool valve 114 via the passageway 135 increases the downwardly acting forces on the first spool valve 114 and further biases the first spool valve 114 towards an actuated state. Thus, the secondary valve assembly 104 pilot assists the primary valve assembly 102 to intensify the braking output. Moreover, this causes the first spool valve 114 to continue to modulate between the actuated state and the intermediate position until the operator no longer desires braking and releases the pressure exerted on the actuating mechanism 106. As discussed above, because the braking output of the hydraulic braking system 100 (FIG. 2) is varied based upon the relative position of the actuation mechanism 106, the secondary valve assembly 104 serves to intensify the ratio of output braking pressure to input position of the actuating member 106.

Furthermore, the high pressure fluid in the fluid chamber 120 adjacent to the first end 116 of the first spool valve 114 exerts an upward pressure on the intermediate piston 112. This pressure exerted on the intermediate piston 112 is in turn felt by the operator via the actuating mechanism 106. As a result, the reactive force in the actuating mechanism 106 will be proportional to the brake line pressure being generated.

Referring again to the secondary valve assembly as shown in FIGS. 3 and 5, the second spool valve 216 has a feedback circuit 136 that allows high pressure...
fluid to enter a fluid chamber 134 adjacent to the second end 130 of the second spool valve 126. The pressure in the fluid chamber 134 acts on the second end 130 of the second spool valve 126. In so doing, the high pressure fluid opposes the force exerted on the first end 128 of the second spool valve 126 by the armature 142 such that the second spool valve 126 is biased upwards towards the intermediate position. Once in the intermediate position, if the force acting on the first end 128 of the second spool valve 126 by the armature 142 is sufficient to overcome the fluid pressure in the fluid chamber 134 and the force from return spring 137, the second spool valve 126 is again biased to an actuated state. Accordingly, the second spool valve 126 modulates between the actuated state and the intermediate position. As a result, the actuation of the secondary valve assembly 104 will increase the overall braking output of the braking system if the pressure being modulated from the secondary spool valve 104 creates a force on the first end 116 of the first spool valve 114 greater than the force being exerted on intermediate piston 112 from the actuating mechanism 106 through spring 109 and spring retainer 110. Furthermore, because the electronic controller 144 varies the input signals 145 based upon the relative position of the actuation mechanism 106, the secondary valve assembly 104 is able to intensify the ratio of output pressure to input force on the actuating mechanism 106 (e.g., the pedal).

[0041] Alternatively, the secondary valve assembly 104 can reduce the pressure being exerted on the first surface 116 of the first spool valve 114, thereby reducing the overall braking output of the braking system. For example, when the actuator 138 is de-energized, the pressure in the second chamber 134 and the return spring 137 is sufficient to overcome the force exerted on the first surface 128 of the second spool valve 126 such that the second spool valve 126 returns to the non-actuated position. As discussed above, the second spool valve 126 in its non-actuated state allows fluid communication between the first surface 116 of the first spool valve 114 and the reservoir 150. Accordingly, the fluid pressure in the first chamber 120 is decreased, thereby allowing the first spool valve 114 to be urged towards its non-actuated state. As a result, the overall braking output of the braking system is reduced.

[0042] The electronic controller 144 is programmable. By "programmable," it is generally meant that the electronic controller 144 is capable of receiving input from one or more sensors or vehicle control systems to vary the braking output from the hydraulic braking system 100. In one embodiment, the electronic controller 144 can be actively programmed in real-time using, for example, a serial controller or other similar controller. Alternatively, the electronic controller 144 can be automatically set to permanent or temporary preset values according to digital inputs from one or more vehicle control systems 147. For example, the vehicle control systems 147 can be the anti-lock brake system, the collision avoidance system, or other vehicle control systems. In either case, the electronic controller 144 is capable of supplying an appropriate braking output based upon both the road conditions and/or the operator’s driving or braking requirements.

[0043] FIG. 9 illustrates various braking output slopes produced as a result of the electronic controller 144. Line 250 shows the mechanically produced braking output of a standard brake valve without electronic control according to the principles of the present disclosure. The electronic controller 144 can be used to produce different braking profiles according to the relative position of the actuating mechanism 106 (e.g., the brake pedal). For example, the electronic controller 144 can be programmed to produce a linear braking output as shown by line 253. Furthermore, additional examples of how the electronic controller 144 can be used to create braking profiles are shown by lines 252, 253 and 254.

[0044] It will be understood that a wide variety of specific configurations and applications are feasible, using the techniques disclosed herein. The operation of the hydraulic brake system of the present disclosure will now be described in connection with various particular embodiments.

Example One

[0045] In one embodiment, the ratio of braking output to manual input can be continuously adjusted according to various vehicle conditions, such as vehicle speed, vehicle payload or operator preference. Accordingly, the hydraulic braking system of the present disclosure can be used to vary the brake pressure in a variety of ways that improve the operation of the vehicle on which it is used. Alternatively, the braking system can provide additional stopping pressure when necessary based on commands from a vehicle system controller or wheel speed sensors.

[0046] FIG. 10 shows a view of the ratio of output braking pressure percentage to pedal rotation percentage. Line 300 shows a standard slope (e.g., mechanically produced braking output) of a brake valve without electronic control according to the principles of the present disclosure. Line 301 shows the braking output where the hydraulic brake valve produces a fully linear output from 0 percent pedal rotation through 100 percent pedal rotation using the electronic controller as described above. Alternatively, FIGS. 11 and 12 illustrate braking outputs that have been adjusted by the electronic controller in response to specific vehicle conditions, for example, vehicle speed. For example, FIG. 11 shows the braking output (e.g., line 302) adjusted for higher speeds. In this view, the electronically controlled brake valve of the present disclosure allows more accurate braking at high speeds. Similarly, FIG. 12 shows the braking output (e.g., line 304) adjusted for lower speeds. In this view, the electronically controlled brake valve allows more accurate braking at lower speeds.

[0047] The control system can be made to give oper-
ators the brake "feel" that they desire. For example, the system can be programmed to give more aggressive braking, as shown in FIG. 11 (e.g., line 302) or it can be programmed to give less aggressive, or "spongier," brake feel as shown in FIG. 12 (e.g., line 304). Different slopes can be stored in the controller or a input can come from the system controller or additional inputs (e.g. a potentiometer or discrete electrical inputs) into the programmable electronic controller.

Example Two

[0048] FIG. 13 illustrates the braking output of the electronically controlled hydraulic brake valve of the present disclosure being programmed to provide output according to digital input from the vehicle antilock braking system. Line 310 illustrates the mechanical output of the brakes system provided without electrical enhancement from the electronic controller. Line 311 illustrates the rotation percentage of the brake pedal. Line 312 illustrates the actual electronically enhanced braking output provided by the brake valve of the present disclosure. As the brakes are applied, the wheel slippage is detected 313. Accordingly, the electronic controller sends signals to the brake valve to decrease the braking force to the vehicle wheels. Once the wheels regain traction 314, the electronic control sends input signals to the brake valve to increase the braking output, thereby further decelerating the vehicle.

Example Three

[0049] FIG. 14 illustrates the braking output of the electronically controlled hydraulic brake valve of the present disclosure being programmed to provide output according to digital input from a traction control system. Line 320 illustrates the actual electronically enhanced braking output produced by the brake valve of the present disclosure. As wheel traction lose is detected 321 the electronic controller sends signals to the brake valve to increase the braking force to the slipping wheels. Once the wheels regain traction 322, the electronic control sends input signals to the brake valve to decrease the braking output.

Claims

1. A braking system (100), comprising:
   (a) an actuator mechanism (106) configured to provide a manual control input, the manual control input including a range of input values;
   (b) a primary valve assembly (102)(114)(202) interconnected to the actuator mechanism (106), the primary valve assembly (102)(114)(202) being configured to operate upon receipt of the manual control input;
   (c) a secondary valve assembly (104)(126)(204) arranged in fluid communication with the primary valve assembly (102)(114)(202), the secondary valve assembly (104)(126)(204) being configured to operate upon receipt of an electronic input from a controller (144)(234);
   (d) wherein the braking system (100) provides:
      (i) a first braking output and a corresponding first force that acts upon the actuation mechanism (106) when the manual control input is operated at a first input value of the range of input values; and
      (ii) a second braking output and a corresponding second force that acts upon the actuation mechanism (106) while the manual control input is operated at the first input value of the range of input values.

2. The braking system (100) of claim 1, wherein:
   (a) the first braking output and corresponding first force are provided when only the primary valve assembly (102)(114)(202) is operated.

3. The braking system (100) of claim 1, wherein:
   (a) the second braking output and corresponding second force are provided when the secondary valve assembly (104)(126)(204) modulates the braking output produced by the primary valve assembly (102)(114)(202).

4. The braking system (100) of claim 1, wherein:
   (a) the manually controlled input is produced by a pedal mechanism (106).

5. The braking system (100) of claim 4, wherein:
   (a) the manually controlled input corresponds to a rotational position of the pedal mechanism (106).

6. The braking system (100) of claim 4, wherein:
   (a) the first and second forces acting upon the pedal mechanism (106) are produced by a spring arrangement.

7. The braking system (100) of claim 4, wherein:
   (a) the system defines an operating ratio of feedback force to input value, the feedback force acting upon the pedal mechanism (106), the input value being provided by the manually controlled input, and
   (b) the secondary valve assembly (104)(126)(204) being configured to increase the operating
ratio from an initial operating ratio to a second operating ratio.

8. The braking system (100) of claim 7, wherein:
   (a) the operating ratio increases from the initial operating ratio to the second operating ratio while the input value of the manually controlled input remains constant.

9. The braking system (100) of claim 7, wherein:
   (a) operation of only the primary valve assembly (102)(114)(202) provides an initial operating ratio, and operation of the secondary valve assembly (104)(126)(204) in conjunction with the primary valve assembly (102)(114)(202) increases the operating ratio from the initial operating ratio to the second operating ratio.

10. The braking system (100) of claim 7, wherein:
    (a) the operating ratio corresponds to the braking output of the system such that increasing the operating ratio also increases the braking output of the system.

11. The braking system (100) of claim 1, wherein the system is suitable to supply a braking output to a vehicle having at least one wheel (205), and wherein:
    (a) the primary valve assembly (102)(114)(202) includes a first spool valve (102)(114)(202) configured to vary the braking output according to the manually controlled input; and
    (b) the secondary valve assembly (104)(126)(204) is integral with the primary valve assembly (102)(114)(202), is configured to receive input signals (145)(232) from a programmable electronic controller (144)(230), and includes:
        (i) a second spool valve (104)(126)(204) configured to operate with the primary valve assembly (102)(114)(202); and
        (ii) an actuator (138)(234) for engaging and actuating the second spool valve (104)(126)(204) according to the input signals (145)(232) received from the programmable electronic controller (144)(230) such that the second spool valve (104)(126)(204) modulates the braking output produced by the primary valve assembly (102)(114)(202).

12. The braking system (100) of claim 11, wherein:
    (a) the first spool valve (102)(114)(202) is positionable between a first position, a second position, and intermediate positions between the first and second positions;

    (i) the first position providing fluid communication between at least one of the wheels (205) and a first pressure source (208);
    (ii) the second position providing fluid communication between at least one of the wheels (205) and a second pressure source (206); and
    (iii) the intermediate positions restricting fluid communication between the vehicle wheels (205) and the first and second pressure sources (208)(206);

    (b) the second spool valve (104)(126)(204) is positionable between a first position, a second position, and intermediate positions between the first and second positions;

    (i) the first position providing fluid communication between the primary valve assembly (102)(114)(202) and the first pressure source (208);
    (ii) the second position providing fluid communication between the primary valve assembly (102)(114)(202) and the second pressure source (206); and
    (iii) the intermediate position restricting fluid communication between the vehicle wheels (205) and the first and second pressure sources (208)(206);

13. The hydraulic braking system (100) of claim 12, wherein:
    (a) the second spool valve (104)(126)(204) being constructed and arranged to modulate between the secondary valve assembly (104)(126)(204) first and intermediate positions such that the secondary valve assembly (104)(126)(204) pilot assists the primary valve assembly (102)(114)(202) to intensify the braking output provided by the primary valve assembly (102)(114)(202) when the actuator (234)(138) urges the second spool valve (104)(126)(204) to the second position.

    (A) the second spool valve (104)(126)(204) further being constructed and arranged to modulate between the secondary valve assembly (104)(126)(204) second and intermediate positions such that the secondary valve assembly (104)(126)(204) decreases the braking output produced by the primary valve assembly (102)(114)(202).
14. The hydraulic braking system (100) of claim 11, wherein:
   (a) the actuator (138)(234) is a solenoid actuator having a coil (140) and an armature (142) for engaging and actuating the second spool valve (104)(126)(204) according to the input signals (145)(232) received from the programmable electronic controller (144)(230) such that the second spool valve (104)(126)(204) modulates the braking output produced by the primary valve assembly (102)(114)(202).

15. The hydraulic braking system (100) of claim 11, wherein:
   (a) the programmable electronic controller (144) (230) is configured to receive input from one or more vehicle control systems such that the secondary valve assembly (104)(126)(204) modulates the braking output produced by the primary valve assembly (102)(114)(202) according to preset values.

16. The hydraulic braking system (100) of claim 15, wherein:
   (a) the vehicle control system is an anti-lock brake system.

17. The hydraulic braking system (100) of claim 15, wherein:
   (a) the vehicle control system is a traction control brake system.

18. The hydraulic braking system (100) of claim 11, wherein:
   (a) the programmable electronic controller (144) (230) is configured to receive input from a serial control device such that the secondary valve assembly (104)(126)(204) modulates the braking output produced by the primary valve assembly (102)(114)(202) in real-time.

19. The hydraulic braking system (100) of claim 11, wherein:
   (a) the programmable electronic controller (144) (230) is configured to receive input from one or more electronic sensors such that the secondary valve assembly (104)(126)(204) modulates the braking output produced by the primary valve assembly (102)(114)(202) in real-time.

20. The brake valve of claim 12, wherein:
   (a) the first pressure source (150)(208) is system pressure; and
   (b) the second pressure source (152)(206) is ambient pressure.

Patentansprüche

1. Ein Bremssystem (100), aufweisend:
   (a) eine Aktuatorvorrichtung (106), eingerichtet, um eine manuelle Steuerungseingabe bereitzustellen, die manuelle Steuerungseingabe aufweisend einen Bereich von Eingabewerten;
   (b) eine primäre Ventilanordnung (102) (114) (202) verbunden mit der Aktuatorvorrichtung (106), wobei die primäre Ventilanordnung (102) (114) (202) derart eingerichtet ist, bei Erhalt der manuellen Steuerungseingabe betreibbar zu sein;
   (c) eine sekundäre Ventilanordnung (104) (126) (204), eingerichtet in Fluidverbindung mit der primären Ventilanordnung (102) (114) (202), wobei die sekundäre Ventilanordnung (104) (126) (204) derart eingerichtet ist, bei Erhalt einer elektronischen Eingabe eines Kontrollelementes (144) (234) betreibbar zu sein;
   (d) wobei das Bremssystem (100) bereitstellt:
      (i) eine erste Bremsleistung und eine zugehörige erste Kraft, welche auf die Aktuatorvorrichtung (106) wirkt im Falle dass die manuelle Steuerungseingabe bei einem ersten Eingabewert des Bereichs der Eingabewerte betrieben wird; und
      (ii) eine zweite Bremsleistung und eine zugehörige zweite Kraft, welche auf die Aktuatorvorrichtung (106) wirkt, während die manuelle Steuerungseingabe in einem ersten Wert des Bereichs der Eingabewerte betrieben wird.

2. Das Bremssystem (100) gemäß Anspruch 1, wobei
   (a) die erste Bremsleistung und die zugehörige erste Kraft nur bereitgestellt werden, wenn die primäre Ventilanordnung (102) (114) (202) betrieben wird.

3. Das Bremssystem (100) gemäß Anspruch 1, wobei:
   (a) die zweite Bremsleistung und die zugehörige zweite Kraft bereitgestellt werden, wenn die sekundäre Ventilanordnung (104) (126) (204) die Bremsleistung, welche von der primären Ventilanordnung (102) (114) (202) erzeugt wird, moduliert.
4. Das Bremssystem (100) gemäß Anspruch 1, wobei:
   (a) die manuell gesteuerte Eingabe unter Verwendung eines Pedalmechanismus (106) bereitgestellt wird.

5. Das Bremssystem (100) gemäß Anspruch 4, wobei:
   (a) die manuell gesteuerte Eingabe einer Rotationsposition des Pedalmechanismus (106) entspricht.

6. Das Bremssystem (100) gemäß Anspruch 4, wobei:
   (a) die erste und die zweite Kraft, welche auf den Pedalmechanismus (106) wirken, unter Verwendung einer Federanordnung erzeugt werden.

7. Das Bremssystem (100) gemäß Anspruch 4, wobei:
   (a) das System eine Betriebsübersetzung von Rückkopplungskraft zu Eingabewert definiert, wobei die Rückkopplungskraft auf den Pedalmechanismus (106) wirkt, wobei der Eingabewert unter Verwendung der manuell gesteuerten Eingabe bereitgestellt wird, und
   (b) die sekundäre Ventilanordnung (104) (126) (204) derart eingerichtet ist, die Betriebsübersetzung von einer initialen Betriebsübersetzung zu einer zweiten Betriebsübersetzung zu erhöhen.

8. Das Bremssystem (100) gemäß Anspruch 7, wobei:
   (a) die Betriebsübersetzung von der initialen Betriebsübersetzung zu der zweiten Betriebsübersetzung erhöht wird, während der Eingabewert der manuell gesteuerten Eingabe konstant bleibt.

9. Das Bremssystem (100) gemäß Anspruch 7, wobei:
   (a) der Betrieb von nur der primären Ventilanordnung (102) (114) (202) eine initiale Betriebsübersetzung bereitstellt, und der Betrieb der sekundären Ventilanordnung (104) (126) (204) zusammen mit der primären Ventilanordnung (102) (114) (202) die Betriebsübersetzung von der initialen Betriebsübersetzung zu der zweiten Betriebsübersetzung erhöht.

10. Das Bremssystem (100) gemäß Anspruch 7, wobei:
    (a) die Betriebsübersetzung einer Bremsleistung des Systems entspricht, so dass eine Erhöhung der Betriebsübersetzung auch die Bremsleistung des Systems erhöht.

11. Das Bremssystem (100) gemäß Anspruch 1, wobei das System eingerichtet ist, eine Bremsleistung für ein Fahrzeug aufweisend zumindest ein Rad (205) bereitzustellen, und wobei:
    (a) die primäre Ventilanordnung (102) (114) (202) einen ersten Schieber (102) (114) (202) aufweist, welcher derart eingerichtet ist, die Bremsleistung entsprechend der manuell gesteuerten Eingabe zu variieren; und
    (b) die sekundäre Ventilanordnung (104) (126) (204) mit der primären Ventilanordnung (102) (114) (202) integral ausgebildet ist und eingerichtet ist, Eingabesignale (145) (232) eines programmierbaren elektronischen Kontollelements (144) (230) zu erhalten, aufweisend:
       (i) einen zweiten Schieber (104) (126) (204), welcher derart eingerichtet ist, der primären Ventilanordnung (102) (114) (202) betrieben zu werden; und
       (ii) ein Aktuator (138) (234) zum Eingreifen in und Betätigen des zweiten Schiebers (104) (126) (204) gemäß den Eingabesignalen (145) (232), empfangen vom programmierbaren elektronischen Kontollelement (144) (230), so dass der zweite Schieber (104) (126) (204) eine Bremsleistung, generiert durch die primäre Ventilanordnung (102) (114) (202), moduliert.

12. Das Bremssystem (100) gemäß Anspruch 11, wobei:
    (a) der erste Schieber (102) (114) (202) positionierbar zwischen einer ersten Position, einer zweiten Position und Zwischenliegende Positionen zwischen der ersten und der zweiten Position ist;
       (i) wobei die erste Position eine Fluidverbindung zwischen zumindest einem der Räder (205) und einer ersten Druckquelle (208) bereitstellt;
       (ii) wobei die zweite Position eine Fluidverbindung zwischen zumindest einem der Räder (205) und einer zweiten Druckquelle (206) bereitstellt; und
       (iii) die zwischenliegenden Positionen eine Fluidkommunikation zwischen den Fahrzeugräder (205) und der ersten und zweiten Druckquelle (208) (206) beschränken; und
    (b) der zweite Schieber (104) (126) (204) positionierbar zwischen einer ersten Position, einer zweiten Position und zwischenliegenden Positionen zwischen der ersten und der zweiten Po-
12. Das hydraulische Bremssystem (100) gemäß Anspruch 11, wobei:

(a) das programmierbare elektronische Kontrollelement (144) (230) eingerichtet ist, eine Eingabe von einem oder mehreren Fahrzeugkontrollsystemen zu empfangen, so dass die sekundäre Ventilanordnung (104) (126) (204) die Bremsleistung, welche von der primären Ventilanordnung (102) (114) (202) erzeugt wird, gemäß vorgegebenen Werten moduliert.

13. Das hydraulische Bremssystem (100) gemäß Anspruch 12, wobei:

(a) der zweite Schieber (104) (126) (204) weiterhin ausgebildet und eingerichtet ist, zwischen der zweiten und zwischenliegenden Positionen der zweiten Ventilanordnung (104) (126) (204) zu modulieren, so dass die zweite Ventilanordnung (104) (126) (204) die Bremsleistung, welche von der primären Ventilanordnung (102) (114) (202) bereitgestellt wird, verringert.

14. Das hydraulische Bremssystem (100) gemäß Anspruch 11, wobei:

(a) der Aktuator (138) (234) ein Magnetantrieb ist, aufweisend eine Spule (140) sowie einen Anker (142) zum Eingreifen in und Betätigen des zweiten Schiebers (104) (126) (204) gemäß den Eingabesignalen (145) (232), empfangen vom programmierbaren elektronischen Kontrollelement (144) (230), so dass der zweite Schieber (104) (126) (204) die Bremsleistung, welche durch die primäre Ventilanordnung (102) (114) (202) erzeugt wird, moduliert.

15. Das hydraulische Bremssystem (100) gemäß Anspruch 11, wobei:

(a) das programmierbare elektronische Kontrollelement (144) (230) derart eingerichtet ist, eine Eingabe von einer seriellen Kontrollvorrichtung zu erhalten, so dass die sekundäre Ventilanordnung (104) (126) (204) die Bremsleistung, welche durch die primäre Ventilanordnung (102) (114) (202) erzeugt wird, in Echtzeit moduliert.

16. Das hydraulische Bremssystem (100) gemäß Anspruch 15, wobei:

(a) das Fahrzeugkontrollsystem ein Antiblockier-Bremssystem ist.

17. Das hydraulische Bremssystem (100) gemäß Anspruch 11, wobei:

(a) das Fahrzeugkontrollsystem ein Antriebschlupfregelungs-Bremssystem ist.

18. Das hydraulische Bremssystem (100) gemäß Anspruch 11, wobei:

(a) das programmierbare elektronische Kontrollelement (144) (230) derart eingerichtet ist, eine Eingabe von einem oder mehreren elektronischen Sensoren zu erhalten, so dass die sekundäre Ventilanordnung (104) (126) (204) die Bremsleistung, welche durch die primäre Ventilanordnung (102) (114) (202) erzeugt wird, in Echtzeit moduliert.

19. Das hydraulische Bremssystem (100) gemäß Anspruch 11, wobei:

(a) das programmierbare elektronische Kontrollelement (144) (230) derart eingerichtet ist, eine Eingabe von einem oder mehreren elektronischen Sensoren zu erhalten, so dass die sekundäre Ventilanordnung (104) (126) (204) die Bremsleistung, welche durch die primäre Ventilanordnung (102) (114) (202) erzeugt wird, in Echtzeit moduliert.

20. Das Bremsventil gemäß Anspruch 12, wobei:

(a) die erste Druckquelle (150) (208) ein Systemdruck ist; und
(b) die zweite Druckquelle (152) (206) ein Umgebungsdruck ist.

Revendications

1. Système de freinage (100) comprenant :
(a) un mécanisme actionneur (106) configuré pour fournir une entrée de commande manuelle, l’entrée de commande manuelle incluant une plage de valeurs d’entrée ;
(b) un ensemble de soupape principal (102)(114)(202) interconnecté avec le mécanisme actionneur (106), l’ensemble de soupape principal (102)(114)(202) étant configuré pour fonctionner à la réception de l’entrée de commande manuelle ;
(c) un ensemble de soupape secondaire (104)(126)(204) agencé en communication fluidique avec l’ensemble de soupape principal (102)(114)(202), l’ensemble de soupape secondaire (104)(126)(204) étant configuré pour fonctionner à la réception d’une entrée électronique provenant d’un dispositif de commande (144)(234) ;
(d) dans lequel le système de freinage (100) fournit :
   (i) une première sortie de freinage et une première force correspondante qui agit sur le mécanisme d’actionnement (106) lorsque l’entrée de commande manuelle fonctionne pour une première valeur d’entrée de la plage de valeurs d’entrée ; et
   (ii) une seconde sortie de freinage et une seconde force correspondante qui agit sur le mécanisme d’actionnement (106) alors que l’entrée de commande manuelle fonctionne pour la première valeur d’entrée de la plage de valeurs d’entrée.

2. Système de freinage (100) selon la revendication 1, dans lequel :
   (a) la première sortie de freinage et la première force correspondante sont fournies seulement lorsque l’ensemble de soupape principal (102)(114)(202) fonctionne.

3. Système de freinage (100) selon la revendication 1, dans lequel :
   (a) la seconde sortie de freinage et la seconde force correspondante sont fournies seulement lorsque l’ensemble de soupape secondaire (104)(126)(204) module la sortie de freinage produite par l’ensemble de soupape principal (102)(114)(202).

4. Système de freinage (100) selon la revendication 1, dans lequel :
   (a) l’entrée commandée manuellement est produite par un mécanisme à pédale (106).

5. Système de freinage (100) selon la revendication 4, dans lequel :
   (a) l’entrée commandée manuellement correspond à une position de rotation du mécanisme à pédale (106).

6. Système de freinage (100) selon la revendication 4, dans lequel :
   (a) les première et seconde forces qui agissent sur le mécanisme à pédale (106) sont produites par un agencement de ressort.

7. Système de freinage (100) selon la revendication 4, dans lequel :
   (a) le système définit un rapport de fonctionnement de la force de réaction sur la valeur d’entrée, la force de réaction agissant sur le mécanisme à pédale (106), la valeur d’entrée étant fournie par l’entrée commandée manuellement, et
   (b) l’ensemble de soupape secondaire (104)(126)(204) étant configuré pour augmenter le rapport de fonctionnement d’un rapport de fonctionnement initial à un second rapport de fonctionnement.

8. Système de freinage (100) selon la revendication 7, dans lequel :
   (a) le rapport de fonctionnement augmente du rapport de fonctionnement initial au second rapport de fonctionnement alors que la valeur d’entrée de l’entrée commandée manuellement reste constante.

9. Système de freinage (100) selon la revendication 7, dans lequel :
   (a) le fonctionnement du seul ensemble de soupape principal (102)(114)(202) fournit un rapport de fonctionnement initial, et le fonctionnement de l’ensemble de soupape secondaire (104)(126)(204), conjointement avec l’ensemble de soupape principal (102)(114)(202), augmente le rapport de fonctionnement du rapport de fonctionnement initial au second rapport de fonctionnement.

10. Système de freinage (100) selon la revendication 7, dans lequel :
    (a) le rapport de fonctionnement correspond à la sortie de freinage du système de telle sorte que le fait d’augmenter le rapport de fonctionnement augmente également la sortie de frei-
nage du système.

11. Système de freinage (100) selon la revendication 1, dans lequel le système convient pour fournir une sortie de freinage à un véhicule ayant au moins une roue (205), et dans lequel :

(a) l’ensemble de soupape principal (102)(114)(202) inclut une première électrovalve (102)(114)(202) configurée pour faire varier la sortie de freinage en fonction de l’entrée commandée manuellement ; et

(b) l’ensemble de soupape secondaire (104)(126)(204) est d’une pièce avec l’ensemble de soupape principal (102)(114)(202), il est configuré pour recevoir des signaux d’entrée (145)(232) provenant d’un dispositif de commande électronique programmable (144)(230), et il inclut :

(i) une seconde électrovalve (104)(126)(204) configurée pour fonctionner avec l’ensemble de soupape principal (102)(114)(202) ; et


12. Système de freinage (100) selon la revendication 11, dans lequel :

(a) la première électrovalve (102)(114)(202) peut être positionnée entre une première position, une seconde position, et une position intermédiaire entre les première et seconde positions ;

(i) la première position fournissant une communicationfluidique entre au moins l’une des roues (205) et une première source de pression (208) ;

(ii) la seconde position fournissant une communication fluidique entre au moins l’une des roues (205) et une seconde source de pression (206) ; et

(iii) la position intermédiaire restreignant la communication fluidique entre les roues (205) du véhicule et les première et seconde sources de pression (208)(206) ; et

(b) la seconde électrovalve (104)(126)(204) étant construite et agencée pour moduler entre les deuxième position et position intermédiaire de l’ensemble de soupape secondaire (104)(126)(204) de telle sorte que l’ensemble de soupape secondaire (104)(126)(204) diminue la sortie de freinage produite par l’ensemble de soupape principal (102)(114)(202).

13. Système de freinage hydraulique selon la revendication 12, dans lequel :

(a) la seconde électrovalve (104)(126)(204) est en outre construite et agencée pour moduler entre les deuxième position et position intermédiaire de l’ensemble de soupape secondaire (104)(126)(204) de telle sorte que l’ensemble de soupape secondaire (104)(126)(204) diminue la sortie de freinage produite par l’ensemble de soupape principal (102)(114)(202).

14. Système de freinage hydraulique (100) selon la revendication 11, dans lequel :

(a) l’actionneur (138)(234) est un actionneur solénoïde ayant une bobine (140) et un induit (142) destiné à s’engager avec, et actionner la seconde électrovalve (104)(126)(204) en fonction des signaux d’entrée (145)(232) reçus du dispositif de commande électronique programmable (144)(230) de telle sorte que la seconde électrovalve (104)(126)(204) module la sortie de freinage produite par l’ensemble de soupape principal (102)(114)(202).

15. Système de freinage hydraulique (100) selon la re-
vendication 11, dans lequel :

(a) le dispositif de commande électronique programmable (144) (230) est configuré pour recevoir des entrées provenant d’un ou de plusieurs système(s) de commande du véhicule, de telle sorte que l’ensemble de soupape secondaire (104)(126)(204) module la sortie de freinage produite par l’ensemble de soupape principal (102)(114)(202) en fonction de valeurs prédéterminées.

16. Système de freinage hydraulique (100) selon la revendication 15, dans lequel :

(a) le système de commande du véhicule est un système de freinage à anti-blocage.

17. Système de freinage hydraulique (100) selon la revendication 15, dans lequel :

(a) le système de commande du véhicule est un système de freinage à anti-patinage.

18. Système de freinage hydraulique (100) selon la revendication 11, dans lequel :

(a) le dispositif de commande électronique programmable (144)(230) est configuré pour recevoir une entrée provenant d’un dispositif de commande en série, de telle sorte que l’ensemble de soupape secondaire (104)(126)(204) module la sortie de freinage produite par l’ensemble de soupape principal (102)(114)(202) en temps réel.

19. Système de freinage hydraulique (100) selon la revendication 11, dans lequel :

(a) le dispositif de commande électronique programmable (144)(230) est configuré pour recevoir une entrée provenant d’un ou de plusieurs capteur(s) électronique(s), de telle sorte que l’ensemble de soupape secondaire (104)(126)(204) module la sortie de freinage produite par l’ensemble de soupape principal (102)(114)(202) en temps réel.

20. Soupape de frein selon la revendication 12, dans laquelle :

(a) la première source de pression (150) (208) est la pression du système ; et
(b) la seconde source de pression (152) (206) est la pression ambiante.
FIG. 13

Wheel Slip Detected 313

Wheel Regains Traction 314

Time

% |
0 |
25 |
50 |
75 |
100 |

FIG. 14

Wheel Loses Traction 321

Wheel Regains Traction 322

Time

% |
0 |
25 |
50 |
75 |
100 |
REFERENCES CITED IN THE DESCRIPTION

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