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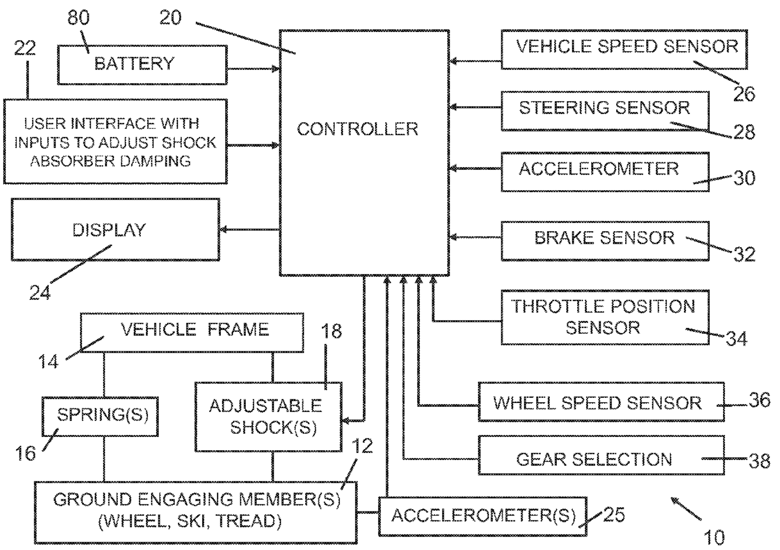

FIG. 1

(57) Abstract: A damping control system for a vehicle having a suspension located between a plurality of ground engaging members and a vehicle frame includes at least one adjustable shock absorber having an adjustable damping characteristic. The system also includes a controller coupled to each adjustable shock absorber to adjust the damping characteristic of each adjustable shock absorber, and a user interface coupled to the controller and accessible to a driver of the vehicle. The user interface includes at least one user input to permit manual adjustment of the damping characteristic of the at least one adjustable shock absorber during operation of the vehicle. Vehicle sensors may also be coupled to the controller to adjust the damping characteristic of the at least one adjustable shock absorber based on sensor output signals.

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VEHICLE HAVING SUSPENSION WITH CONTINUOUS DAMPING CONTROL

Background and Summary of the Disclosure

[0001] The present disclosure relates to improved suspension for a vehicle having continuous "on-the-go" damping control for shock absorbers.

[0002] Currently some off-road vehicles include adjustable shock absorbers. These adjustments include spring preload, high and low speed compression damping and/or rebound damping. In order to make these adjustments, the vehicle is stopped and the operator makes an adjustment at each shock absorber location on the vehicle. A tool is often required for the adjustment. Some on-road automobiles also include adjustable electric shocks along with sensors for active ride control systems. However, these systems are normally controlled by a computer and are focused on vehicle stability instead of ride comfort. The system of the present disclosure allows an operator to make real time "on-the-go" adjustments to the shocks to obtain the most comfortable ride for given terrain and payload scenarios.

[0003] Vehicles often have springs (coil, leaf, or air) at each wheel, track, or ski to support a majority of the load. The vehicle of the present disclosure also has electronic shocks controlling the dynamic movement of each wheel, ski, or track. The electronic shocks have a valve that controls the damping force of each shock. This valve may control compression damping only, rebound damping only, or a combination of compression and rebound damping. The valve is connected to a controller having a user interface that is within the driver's reach for adjustment while operating the vehicle. In one embodiment, the controller increases or decreases the damping of the shock absorbers based on user inputs received from an operator. In another embodiment, the controller has several preset damping modes for selection by the operator. The controller may also be coupled to sensors on the suspension and chassis to provide an actively controlled damping system.

[0004] According to one illustrated embodiment of the present disclosure, a damping control system is provided for a vehicle having a suspension located between a plurality of ground engaging members and a vehicle frame. The damping control system includes a plurality of springs coupled between the ground engaging members and the frame, and a plurality of shock absorbers coupled between the ground engaging members and the frame. At least one of the plurality of shock absorbers is an adjustable shock absorber having an adjustable damping characteristic. The system also includes a controller coupled to each adjustable shock absorber to adjust the damping characteristic of each adjustable shock absorber, and a user interface coupled to the controller and accessible to a driver of the vehicle. The user interface includes at least one user input to permit manual adjustment of the damping characteristic of the at least one adjustable shock absorber during operation of the vehicle.

[0005] According to an illustrated embodiment of the present disclosure, the system also includes at least one sensor selected from a vehicle speed sensor, a steering sensor, an accelerometer, a brake sensor, a throttle position sensor, a wheel speed sensor and a gear selection sensor. The at least one sensor has an output signal coupled to the controller. The controller uses the sensor output signals to adjust the damping characteristics of the at least one adjustable shock absorber based on driving conditions of the vehicle. Therefore, in this embodiment, the system is semi-active and uses the manual user inputs from the user interface combined with vehicle sensors output signals to control the damping characteristics of the adjustable shock absorbers. For example, the controller may set a damping characteristic adjustment range for the at least one adjustable shock absorber. The least one user input of the user interface then provides a manual adjustment of the damping characteristic of the at least one adjustable shock absorber within the damping characteristic adjustment range.

[0006] According to another illustrated embodiment of the present disclosure, the user interface provides a plurality of driving condition modes. Each driving condition mode has different damping characteristics for the at least one adjustable shock absorber based on a type of road or off-road trail on which the vehicle is expected to travel. The user input permits selection of one of the driving condition modes, and the controller automatically adjusts damping characteristics of the at least one adjustable shock absorber based upon the selected driving condition mode.

[0007] Additional features of the present disclosure will become apparent to those skilled in the art upon consideration of the following detailed description of illustrative embodiments exemplifying the best mode of carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The foregoing aspects and many additional features of the present system and method will become more readily appreciated and become better understood by reference to the following detailed description when taken in conjunction with the accompanying drawings.

[0009] Fig. 1 is a block diagram illustrating components of a vehicle of the present disclosure having a suspension with a plurality of continuous damping control shock absorbers and a plurality of sensors integrated with the continuous damping controller;

[0010] Fig. 2 illustrates an exemplary user interface for controlling damping at a front axle and a rear axle of the vehicle;

[0011] Fig. 3 illustrates another exemplary embodiment of a user interface for continuous damping control of shock absorbers of the vehicle;

[0012] Fig. 4 illustrates yet another user interface for setting various modes of operation of the continuous damping control depending upon the terrain being traversed by the vehicle; and

[0013] Fig. 5 illustrates an adjustable damping shock absorber coupled to a vehicle suspension.

[0014] Corresponding reference characters indicate corresponding parts throughout the several views. Although the drawings represent embodiments of various features and components according to the present disclosure, the drawings are not necessarily to scale and certain features may be exaggerated in order to better illustrate and explain the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[0015] For the purposes of promoting an understanding of the principles of the present disclosure, reference will now be made to the embodiments illustrated in the drawings, which are described below. The embodiments disclosed below are not intended to be exhaustive or limit the invention to the precise form disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. It is understood that no limitation of the scope of the invention is thereby intended. The invention includes any alterations and further modifications in the illustrated devices and described methods and further applications of the principles of the invention which would normally occur to one skilled in the art to which the invention relates.

[0016] Referring now to Fig. 1, the present disclosure relates to a vehicle 10 having a suspension located between a plurality of ground engaging members 12 and a vehicle frame 14. The ground engaging members 12 include wheels, skis, guide tracks, treads or the like. The suspension typically includes springs 16 and shock absorbers 18 coupled between the ground engaging members 12 and the frame 14. The springs 16 may include, for example, coil springs, leaf springs, air springs or other gas springs. The air or gas springs 16 may be adjustable. See, for example, U.S. Patent No. 7,950,486 incorporated herein by reference. The springs 16 are often coupled between the vehicle frame 14 and the ground engaging members 12 through an A-arm linkage 70 (See Fig. 5) or other type linkage. Adjustable shock absorbers 18 are also coupled between the ground engaging members 12 and the vehicle frame 14. An illustrating embodiment, a spring 16 and shock 18 are located adjacent each of the ground engaging members 12. In an ATV, for example, four springs 16 and adjustable shocks 18 are provided adjacent each wheel 12. Some manufacturers offer adjustable springs 16 in the form of either air springs or hydraulic preload rings. These adjustable springs 16 allow the operator to adjust the ride height on the go. However, a majority of ride comfort comes from the damping provided by shock absorbers 18.

[0017] In an illustrated embodiment, the adjustable shocks 18 are electrically controlled shocks for adjusting damping characteristics of the shocks 18. A controller 20 provides signals to adjust damping of the shocks 18 in a continuous or dynamic manner. The adjustable shocks 18 may be adjusted to provide differing compression damping, rebound damping or both.

[0018] In an illustrated embodiment of the present disclosure, a user interface 22 is provided in a location easily accessible to the driver operating the vehicle. Preferably, the user interface 22 is either a separate user interface mounted adjacent the driver's seat on the dashboard or integrated onto a display within the vehicle. User interface 22 includes user inputs to allow the driver or a passenger to manually adjust shock absorber 18 damping during operation of the vehicle based on road conditions that are encountered. In another illustrated embodiment, the user inputs are on a steering wheel, handle bar, or other steering control of the vehicle to facilitate actuation of the damping adjustment. A display 24 is also provided on or next to the user interface 22 or integrated into a dashboard display of the vehicle to display information related to the shock absorber damping settings.

[0019] In an illustrated embodiment, the adjustable shock absorbers 18 are model number CDC (continuous damping control) electronically controlled shock absorbers available from ZF Sachs Automotive. See Causemann, Peter; *Automotive Shock Absorbers: Features, Designs, Applications*, ISBN 3-478-93230-0, Verl. Moderne Industrie, Second Edition, 2001, pages 53-63, incorporated by reference herein for a description of the basic operation of the shock absorbers 18 in the illustrated embodiment. It is understood that this description is not limiting and there are other suitable types of shock absorbers available from other manufacturers.

[0020] The controller 20 receives user inputs from the user interface 22 and adjusts the damping characteristics of the adjustable shocks 18 accordingly. As discussed below, the user can independently adjust front and rear shock absorbers 18 to adjust the ride characteristics of the vehicle. In certain other embodiments, each of the shocks 18 is independently adjustable so that the damping characteristics of the shocks 18 are changed from one side of the vehicle to another. Side-to-Side adjustment is desirable during sharp turns or other maneuvers in which different damping characteristics for shock absorbers 18 on opposite sides of the vehicle improves the ride. The damping response of the shock absorbers 18 can be changed in a matter of microseconds to provide nearly instantaneous changes in damping for potholes, dips in the road, or other driving conditions.

[0021] A plurality of sensors are also coupled to the controller 20. For example, the global change accelerometer 25 is coupled adjacent each ground engaging member 12. The accelerometer provides an output signal coupled to controller 20. The accelerometers 25 provide an output signal indicating movement of the ground engaging members and the suspension components 16 and 18 as the vehicle traverses different terrain.

[0022] Additional sensors may include a vehicle speed sensor 26, a steering sensor 28 and a chassis accelerometer 30 all having output signals coupled to the controller 20. Accelerometer 30 is illustratably a three-axis accelerometer located on the chassis to provide an indicating of forces on the vehicle during operation. Additional sensors include a brake sensor 32, a throttle position sensor 34, a wheel speed sensor 36, and a gear selection sensor 38. Each of these sensors has an output signal coupled to the controller 20.

[0023] In an illustrated embodiment of the present disclosure, the user interface 22 shown in Fig. 2 includes manual user inputs 40 and 42 for adjusting damping of the front and rear axle shock absorbers 18. User interface 22 also includes first and second displays 44 and 46 for displaying the damping level settings of the front shock absorbers and rear shock absorbers, respectively. In operation, the driver or passenger of the vehicle can adjust user inputs 40 and 42 to provide more or less damping to the shock absorbers 18 adjacent the front axle and rear axle of the vehicle. In the illustrated embodiment, user inputs 40 and 42 are rotatable knobs. By rotating knob 40 in a counter clockwise direction, the operator reduces damping of the shock absorbers 18 adjacent the front axle of the vehicle. This provides a softer ride for the front axle. By rotating the knob 40 in a clockwise direction, the operator provides more damping on the shock absorbers 18 adjacent the front axle to provide a stiffer ride. The damping level for front axle is displayed in display 44. The damping level may be indicated by any desired numeric range, such as for example, between 0-10, with 10 being the most stiff and 0 the most soft.

[0024] The operator rotates knob 42 in a counter clockwise direction to reduce damping of the shock absorbers 18 adjacent the rear axle. The operator rotates the knob 42 in a clockwise direction to provide more damping to the shock absorbers 18 adjacent the rear axle of the vehicle. The damping level setting of the rear shock absorbers 18 is displayed in display window 46.

[0025] Another embodiment of the user interface 22 is illustrated in Fig. 3. In this embodiment, push buttons 50 and 52 are provided for adjusting the damping level of shock absorbers 18 located adjacent the front axle and push buttons 54 and 56 are provided for adjusting the damping of shock absorbers 18 located adjacent rear axle. By pressing button 50, the operator increases the damping of shock absorbers 18 located adjacent the front axle and pressing button 52 reducing the damping of shock absorbers 18 located adjacent front axle. The damping level of shock absorbers 18 adjacent front axle is displayed within display window 57. As discussed above, the input control switches can be located any desired location on the vehicle. For example, in other illustrated embodiments, the user inputs are on a steering wheel, handle bar, or other steering control of the vehicle to facilitate actuation of the damping adjustment.

[0026] Similarly, the operator presses button 54 to increase damping of the shock absorbers located adjacent the rear axle. The operator presses button 56 to decrease damping of the shock absorbers located adjacent the rear axle. Display window 58 provides a visual indication of the damping level of shock absorbers 18 adjacent the rear axle. In other embodiments, different user inputs such as touch screen controls, slide controls, or other inputs may be used to adjust the damping level of shock absorbers 18 adjacent the front and rear axles. In other embodiments, different user inputs such as touch screen controls, slide controls, or other inputs may be used to adjust the damping level of shock absorbers 18 adjacent all four wheels at once.

[0027] Fig. 4 illustrates yet another embodiment of the present disclosure in which the user interface 22 includes a rotatable knob 60 having a selection indicator 62. Knob 60 is rotatable as illustrated by double-headed arrow 64 to align the indicator 62 with a particular driving condition mode. In the illustrated embodiment, five modes are disclosed including a smooth road mode, a rough trail mode, a rock crawl mode, a chatter mode, and a whoops/jumps mode. Depending on the driving conditions, the operating rotates the control knob 60 to select the particular driving mode. Controller 20 automatically adjusts damping levels of adjustable shocks 18 adjacent front and rear axles of the vehicle based on the particular mode selected.

[0028] It is understood that various other modes may be provided including a sport mode, trail mode, or other desired mode. In addition, different modes may be provided for operation in two-wheel drive, four-wheel drive, high and low settings for the vehicle. Illustrative operation modes include:

- Smooth Road Mode – Very stiff settings designed to minimize transient vehicle pitch and roll through hard acceleration, braking, and cornering.
- Normal Trail Mode – Similar to smooth road mode, but a little bit softer set-up to allow for absorption of rocks, roots, and potholes but still have good cornering, accelerating, and braking performance.
- Rock Crawl Mode – This would be the softest setting allowing for maximum wheel articulation for slower speed operation. In one embodiment, the rock crawl mode is linked to vehicle speed sensor 26.
- High Speed Harsh Trail (Chatter) – This setting is between Normal Trail Mode and Rock Crawl Mode allowing for high speed control but very plush ride (bottom out easier).

- Whoops and Jumps Mode – This mode provides stiffer compression in the dampers but less rebound to keep the tires on the ground as much as possible.
- These modes are only examples one skilled in the art would understand there could be many more modes depending on the desired/intended use of the vehicle.

[0029] In addition to the driving modes, the damping control may be adjusted based on outputs from the plurality of sensors coupled with the controller 20. For instance, the setting of adjustable shock absorbers 18 may be adjusted based on vehicle speed from speed sensor 26 or outputs from the accelerometers 25 and 30. In vehicles moving slowly, the damping of adjustable shock absorbers 18 is reduced to provide a softer mode for a better ride. As vehicle's speed increases, the shock absorbers 18 are adjusted to a stiffer damping setting. The damping of shock absorbers 18 may also be coupled and controlled by an output from a steering sensor 28. For instance, if the vehicle makes a sharp turn, damping of shock absorbers 18 on the appropriate side of the vehicle may be adjusted instantaneously to improve ride.

[0030] The continuous damping control of the present disclosure may be combined with adjustable springs 16. The springs 16 may be a preload adjustment or a continuous dynamic adjustment based on signals from the controller 20.

[0031] An output from brake sensor 32 may also be monitored and used by controller 20 to adjust the adjustable shocks 18. For instance, during heavy braking, damping levels of the adjustable shocks 18 adjacent the front axle may be adjusted to reduce "dive" of the vehicle. In an illustrated embodiment, dampers are adjusted to minimize pitch by determining which direction the vehicle is traveling, by sensing an input from the gear selection sensor 38 and then adjusting the damping when the brakes are applied as detected by the brake sensor 32. In an illustrative example, for improved braking feel, the system increases the compression damping for shock absorbers 18 in the front of the vehicle and adds rebound damping for shock absorbers 18 in the rear of the vehicle for a forward traveling vehicle.

[0032] In another embodiment, an output from the throttle position sensor is used by controller 20 to adjust the adjustable shock absorbers 18 to adjust or control vehicle squat which occurs when the rear of the vehicle drops or squats during acceleration. For example, controller 20 may stiffen the damping of shock absorbers 18 adjacent rear axle during rapid acceleration of the vehicle. Another embodiment includes driver-selectable modes that control a vehicle's throttle map and damper settings simultaneously. By linking the throttle map and the CDC damper calibrations together, both the throttle (engine) characteristics and the suspension settings simultaneously change when a driver changes operating modes.

[0033] In another embodiment, a position sensor is provided adjacent the adjustable shock absorbers 18. The controller 20 uses these position sensors to stiffen the damping of the adjustable shocks 18 near the ends of travel of the adjustable shocks. This provides progressive damping control for the shock absorbers. In one illustrated embodiment, the adjustable shock position sensor is an angle sensor located on an A-arm of the vehicle suspension. In another embodiment, the adjustable shocks include built in position sensors to provide an indication when the shock is near the ends of its stroke.

[0034] In another illustrated embodiment, based on gear selection detected by gear selection sensor 38, the system limits the range of adjustment of the shock absorbers 18. For example, the damping adjustment range is larger when the gear selector is in low range compared to high range to keep the loads in the accepted range for both the vehicle and the operator.

[0035] Fig. 5 illustrates an adjustable shock absorber 18 mounted on an A-arm linkage 70 having a first end coupled to the vehicle frame 14 and a second end coupled to a wheel 12. The adjustable shock absorber 18 includes a first end 72 pivotably coupled to the A-arm 70 and a second end (not shown) pivotably coupled to the frame 14. A damping control activator 74 is coupled to controller 20 by a wire 76.

DEMONSTRATION MODE

[0036] In an illustrated embodiment of the present disclosure, a battery 80 is coupled to controller 20 as shown in Fig. 1. For operation in a demonstration mode in a showroom, the controller 20, user interface 22 and display 24 are activated using a key in an ignition of the vehicle or a wireless key to place the vehicle in accessory mode. This permits adjustment of the adjustable shock absorbers 18 without starting the vehicle. Therefore, the operation of the continuous damping control features of the present disclosure may be demonstrated to customers in a show room where it is not permitted to start the vehicle due to the enclosed space. This provides an effective tool for demonstrating how quickly the continuous damping control of the present disclosure works to adjust damping of front and rear axles of the vehicle.

[0037] As described herein, the system of the present disclosure includes four levels or tiers of operation. In the first tier, the adjustable shock absorbers 18 are adjusted by manual input only using the user interface 22 and described herein. In the second tier of operation, the system is semi-active and uses user inputs from the user interface 22 combined with vehicle sensors discussed above to control the adjustable shock absorbers 18. In the third tier of operation, input accelerometers 25 located adjacent the ground engaging members 12 and a chassis accelerometer 30 are used along with steering sensor 28 and shock absorber stroke position sensors to provide additional inputs for controller 20 to use when adjusting the adjustable shock absorbers 18. In the forth tier of operation, the controller 20 cooperates with a stability control system to adjust the shock absorbers 18 to provide enhanced stability control for the vehicle 10.

[0038] In another illustrated embodiment, vehicle loading information is provided to the controller 20 and used to adjust the adjustable shock absorbers 18. For instance, the number of passengers may be used or the amount of cargo may be input in order to provide vehicle loading information. Passenger or cargo sensors may also be provided for automatic inputs to the controller 20. In addition, sensors on the vehicle may detect attachments on the front or rear of the vehicle that affect handling of the vehicle. Upon sensing heavy attachments on the front or rear of the vehicle, controller 20 adjusts the adjustable shock absorbers 18. For example, when a heavy attachment is put on to the front of a vehicle, the compression damping of the front shocks may be increased to help support the additional load.

[0039] While embodiments of the present disclosure have been described as having exemplary designs, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the disclosure using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

[0040] Comprises/comprising and grammatical variations thereof when used in this specification are to be taken to specify the presence of stated features, integers, steps or components or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

CLAIMS:

1. A damping control system for a vehicle having a suspension located between a plurality of ground engaging members and a vehicle frame, the damping control system comprising:

a plurality of springs coupled between the ground engaging members and the frame;

a plurality of shock absorbers coupled between the ground engaging members and the frame, at least one of the plurality of shock absorbers being an adjustable shock absorber having an adjustable damping characteristic;

a controller coupled to each adjustable shock absorber to adjust the damping characteristic of each adjustable shock absorber; and

a user interface coupled to the controller and accessible to a driver of the vehicle, the user interface including at least one user input to permit manual adjustment of the damping characteristic of the at least one adjustable shock absorber during operation of the vehicle, the user interface providing a plurality of selectable driving condition modes, each driving condition mode having different damping characteristics for the at least one adjustable shock absorber based on a type of road or off-road trail on which the vehicle is expected to travel, wherein the user input permits manual selection of one of the driving condition modes, the controller adjusting damping characteristics of the at least one adjustable shock absorber based upon the manually selected driving condition mode, one of the driving condition modes being a first mode in which the at least one adjustable shock absorber is set at a stiff damping level to minimize transient vehicle pitch and roll through hard acceleration, braking, and cornering and another one of the driving condition modes being a second mode in which the at least one adjustable shock absorber is set at a less stiff damping level compared to the smooth road mode to allow for

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absorption of bumps encountered by the vehicle, the at least one adjustable shock absorber including a moveable piston located within a cylinder, and further comprising a position sensor to indicate a position of the piston of the adjustable shock absorber, the position sensor having an output coupled to the controller, the controller being programed to stiffen a damping characteristic of the at least one adjustable shock absorbers near an end of a range of travel of the piston within the cylinder to provide progressive damping control.

2. The system of claim 1, wherein the ground engaging members include at least one of wheels, skis, guide tracks and treads.

3. The system of claim 1, wherein the plurality of springs include at least one of coil springs, leaf springs, air springs and gas springs.

4. The system of claim 1, wherein the plurality of springs and the plurality of shock absorbers are coupled between the vehicle frame and the ground engaging members through an A-arm linkage of the suspension.

5. The system of claim 1, wherein a spring and a shock absorber are located adjacent each of the ground engaging members of the vehicle.

6. The system of claim 5, wherein the vehicle has four wheels used as the ground engaging members, four springs, and four adjustable shock absorbers, with one spring and one adjustable shock absorber being located adjacent each of the four wheels.

7. The system of claim 1, further comprising an accelerometer coupled to the vehicle adjacent each ground engaging member, each accelerometer providing an output signal coupled to the controller and used to adjust the damping characteristic of the at least one adjustable shock absorber, the output signal indicating movement of the associated ground engaging member upon movement of the vehicle.

8. The system of claim 1, wherein the user interface is integrated with a display on a dashboard of vehicle.

9. The system of claim 1, wherein the at least one user input of the user interface is located on one of a steering wheel, a handle bar, or a steering control of the vehicle to facilitate adjustment of the damping characteristic of the at least one adjustable shock absorber by a driver of the vehicle.

10. The system of claim 1, wherein at least one front adjustable shock absorber is coupled between the ground engaging members and the frame at a front portion of the vehicle and at least one rear adjustable shock absorber is coupled between the ground engaging members and the frame at a rear portion of the vehicle, and wherein the controller controls damping characteristics of the front and rear adjustable shock absorbers independently based signals received from the user inputs of the user interface.

11. The system of claim 10, wherein the user interface includes first and second manual user inputs for independently adjusting damping characteristics of the front and rear adjustable shock absorbers, respectively.

12. The system of claim 11, wherein the user interface includes first and second display portions to display information related to damping characteristics of the front and rear adjustable shock absorbers, respectively.

13. The system of claim 11, wherein the first and second user inputs are first and second rotatable knobs, and wherein rotation of the first and second knobs in a first direction reduces a damping level of the front and rear adjustable shock absorbers, respectively, to provide a softer ride and rotation of the first and second knobs in second direction, opposite the first

direction, increases a damping level of the front and rear adjustable shock absorbers, respectively, to provide a stiffer ride.

14. The system of claim 11, wherein the first and second manual user inputs include at least one of a touch screen control, a slide control, and a push button to adjust damping characteristics of the front and rear adjustable shock absorbers.

15. The system of claim 1, further comprising at least one sensor selected from a vehicle speed sensor, a steering sensor, a chassis accelerometer, a brake sensor, a throttle position sensor, a wheel speed sensor and a gear selection sensor, the at least one sensor having an output signal coupled to the controller, the controller using the sensor output signals to adjust the damping characteristics of the at least one adjustable shock absorber based on driving conditions of the vehicle.

16. The system of claim 15, wherein first side and second side front adjustable shock absorbers are coupled between the ground engaging members and the frame at the front portion of the vehicle and first side and second side rear adjustable shock absorbers are coupled between the ground engaging members and the frame at the rear portion of the vehicle, and wherein the controller controls damping levels of the first side front adjustable shock absorber, the second side front adjustable shock absorber, the first side rear adjustable shock absorber, the second side rear adjustable shock absorber independently based signals received from the user inputs of the user interface and the at least one sensor.

17. The system of claim 15, wherein the controller sets a damping characteristic adjustment range for the at least one adjustable shock absorber, the least one user input of the user interface providing manual adjustment of the damping characteristic of the at least one adjustable shock absorber within the damping characteristic adjustment range.

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18. The system of claim 1, wherein the user interface also includes a display to display information related to the damping characteristic the at least one adjustable shock absorber.

19. The system of claim 18, wherein the display information includes at least one numerical value related to the damping characteristic of the at least one adjustable shock absorber.

20. The system of claim 1, wherein one of the driving condition modes is a smooth road mode in which the at least one adjustable shock absorber is set at a stiff damping level to minimize transient vehicle pitch and roll through hard acceleration, braking, and cornering.

21. The system of claim 20, wherein one of the driving condition modes is a normal trail mode in which the at least one adjustable shock absorber is set at a less stiff damping level compared to the smooth road mode to allow for absorption of bumps encountered by the vehicle.

22. The system of claim 21, wherein one of the driving condition modes of operation is a rock crawl mode in which the at least one adjustable shock absorber is set at a soft damping level to allow for increased articulation of the ground engaging members during slow speed operation of the vehicle.

23. The system of claim 22, wherein one of the driving condition modes is a high speed harsh trail in which the at least one adjustable shock absorber is set at a damping level between normal trail mode damping level and rock crawl mode damping level.

24. The system of claim 23, wherein one of the driving condition modes is a whoops and jumps mode in which the at least one adjustable shock absorber is set at a damping level to provide stiffer compression but less rebound than the other driving condition modes.

25. The system of claim 1, wherein the plurality of springs have an adjustable spring force.

26. The system of claim 1, further comprising a vehicle speed sensor having an output coupled to the controller, the controller being programed to reduce a damping level of the at least one adjustable shock absorber as vehicle speed decreases and to increase a damping level of the at least one adjustable shock absorber as the vehicle speed increases.

27. The system of claim 1, further comprising a steering sensor having an output coupled to the controller, the controller selectively adjusting the damping characteristics of adjustable shock absorbers adjacent a first side of the vehicle and a second side of the vehicle independently based upon the steering sensor detecting a sharp turn of the vehicle.

28. The system of claim 1, further comprising a brake sensor having an output coupled to the controller, the controller increasing compression damping of adjustable shock absorbers adjacent a front portion of the vehicle and increasing rebound damping of adjustable shock absorbers adjacent a rear portion of the vehicle during braking of the vehicle.

29. The system of claim 1, further comprising a battery coupled to the controller, the controller being programed to operate in a demonstration mode activated by a key of the vehicle to permit adjustment of the at least one adjustable shock absorber without starting an engine of the vehicle.

30. The system of claim 1, further comprising a stability control system coupled to the controller, the controller adjusting damping characteristics of the at least one adjustable shock absorber based on output signals from the stability control system to provide enhanced stability control for the vehicle.

31. The system of claim 1, further a vehicle loading sensor having an output coupled to the controller, the controller adjusting damping characteristics of the at least one adjustable shock absorber based on output signals from the vehicle loading sensor.

32. The system of claim 1, further comprising a throttle position sensor having an output coupled to the controller, the controller increasing damping of at least one adjustable shock absorber adjacent a rear portion of the vehicle during acceleration of the vehicle to reduce vehicle squat.

33. The system of claim 32, further comprising a driver-selectable mode on the user interface to controls a throttle map of the vehicle and settings for the damping characteristic of the at least one shock absorber simultaneously.

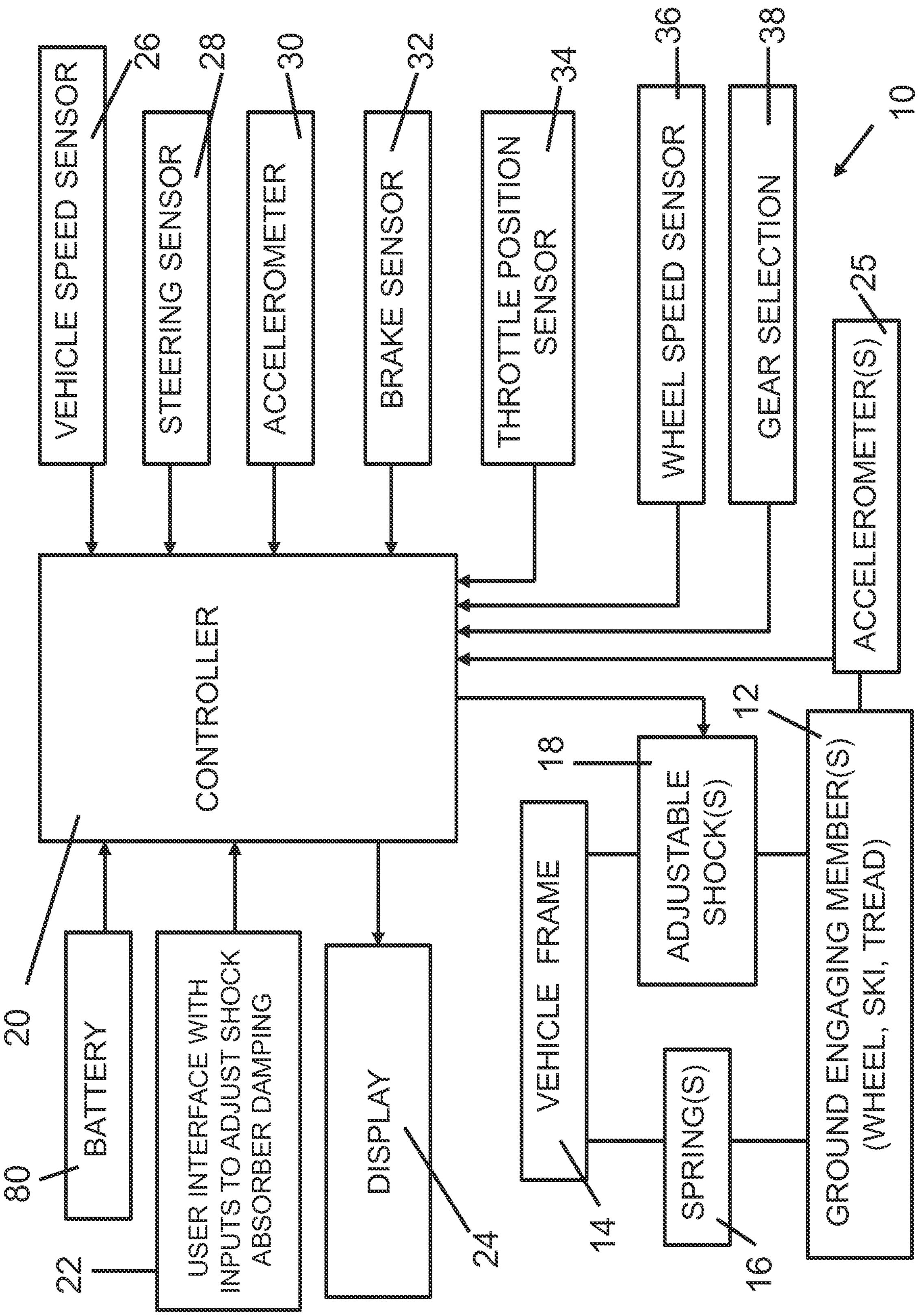
VEHICLE SPEED SENSOR
26
STEERING SENSOR
28
ACCELEROMETER
30
BRAKE SENSOR
32
THROTTLE POSITION SENSOR
34
WHEEL SPEED SENSOR
36
GEAR SELECTION
38
10
ACCELEROMETER(S)
25
CONTROLLER
20
12
18
ADJUSTABLE SHOCK(S)
VEHICLE FRAME
14
SPRING(S)
16
GROUND ENGAGING MEMBER(S) (WHEEL, SKI, TREAD)
BATTERY
80
USER INTERFACE WITH INPUTS TO ADJUST SHOCK ABSORBER DAMPING
22
DISPLAY
24

FIG. 1

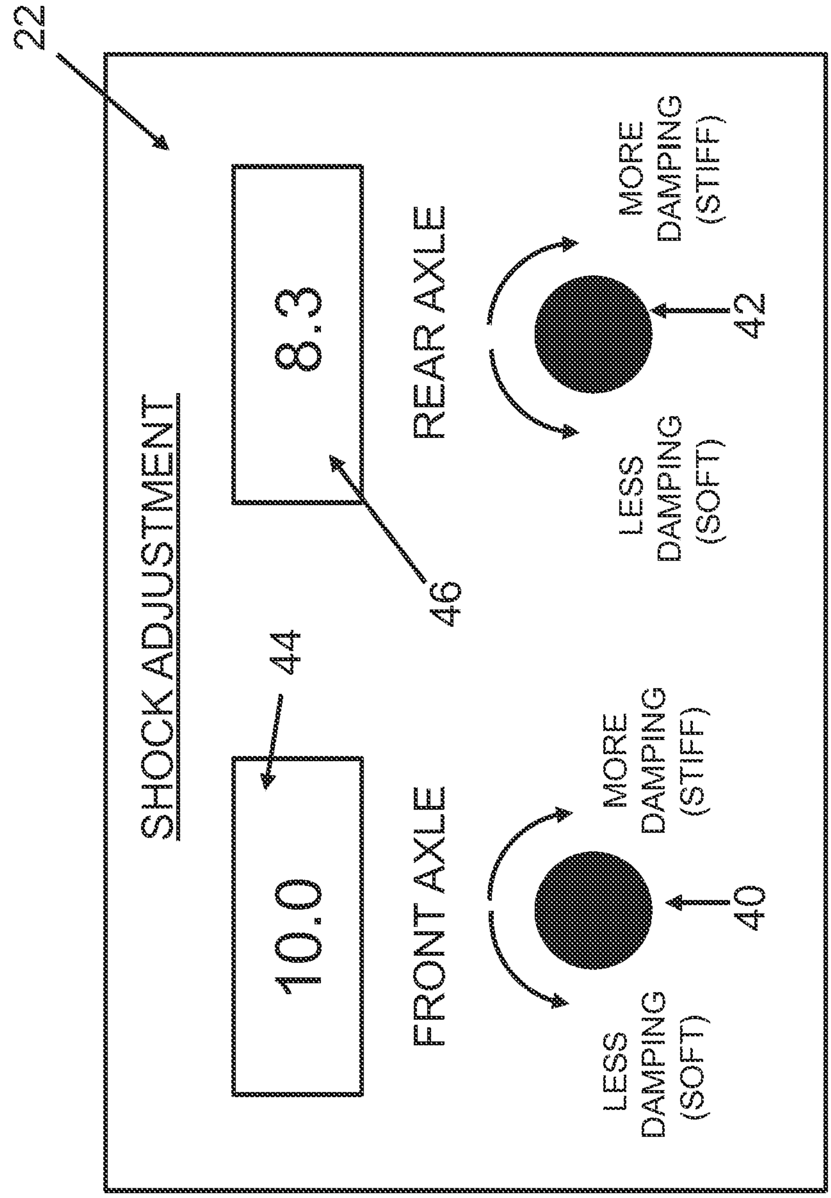
22
SHOCK ADJUSTMENT
10.0
44
8.3
46
FRONT AXLE
REAR AXLE
LESS DAMPING (SOFT)
MORE DAMPING (STIFF)
40
LESS DAMPING (SOFT)
MORE DAMPING (STIFF)
42

FIG. 2

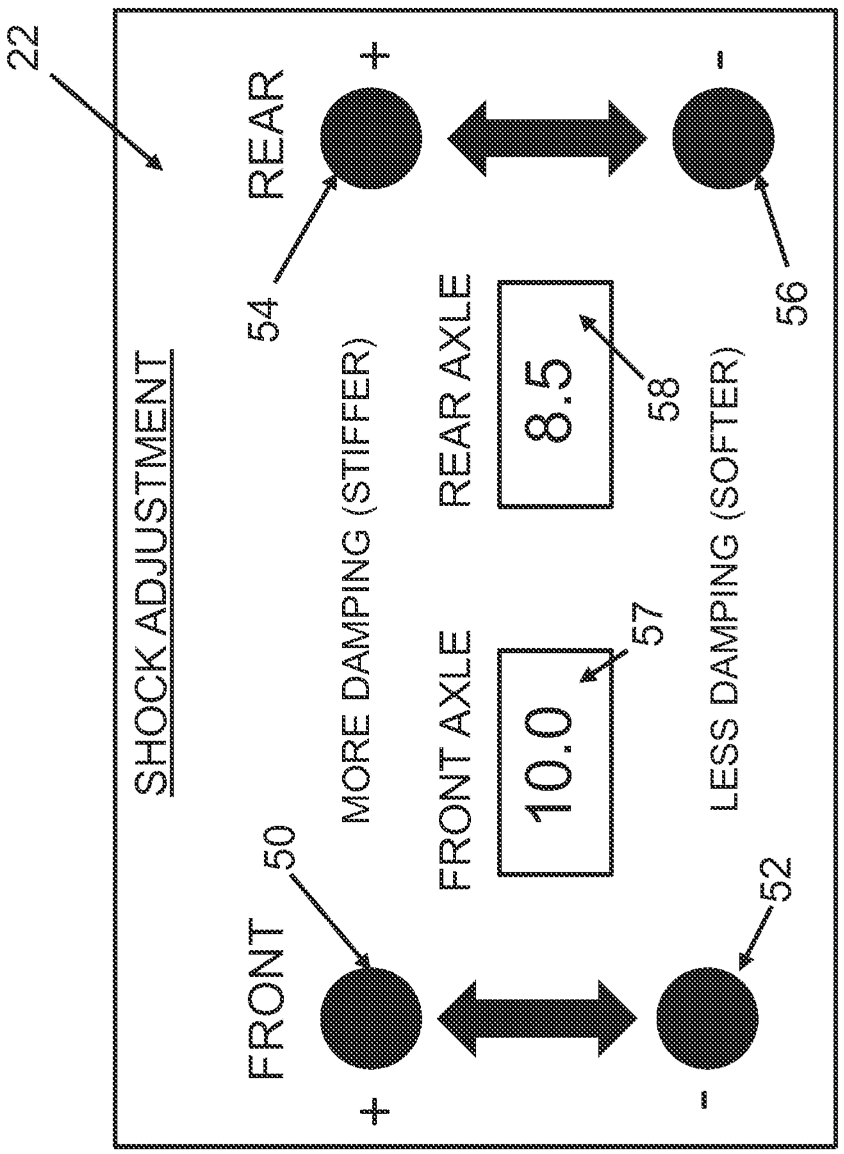
22
SHOCK ADJUSTMENT
FRONT
REAR
+
-
+
-
50
52
54
56
MORE DAMPING (STIFFER)
FRONT AXLE
REAR AXLE
10.0
8.5
57
58
LESS DAMPING (SOFTER)

FIG. 3

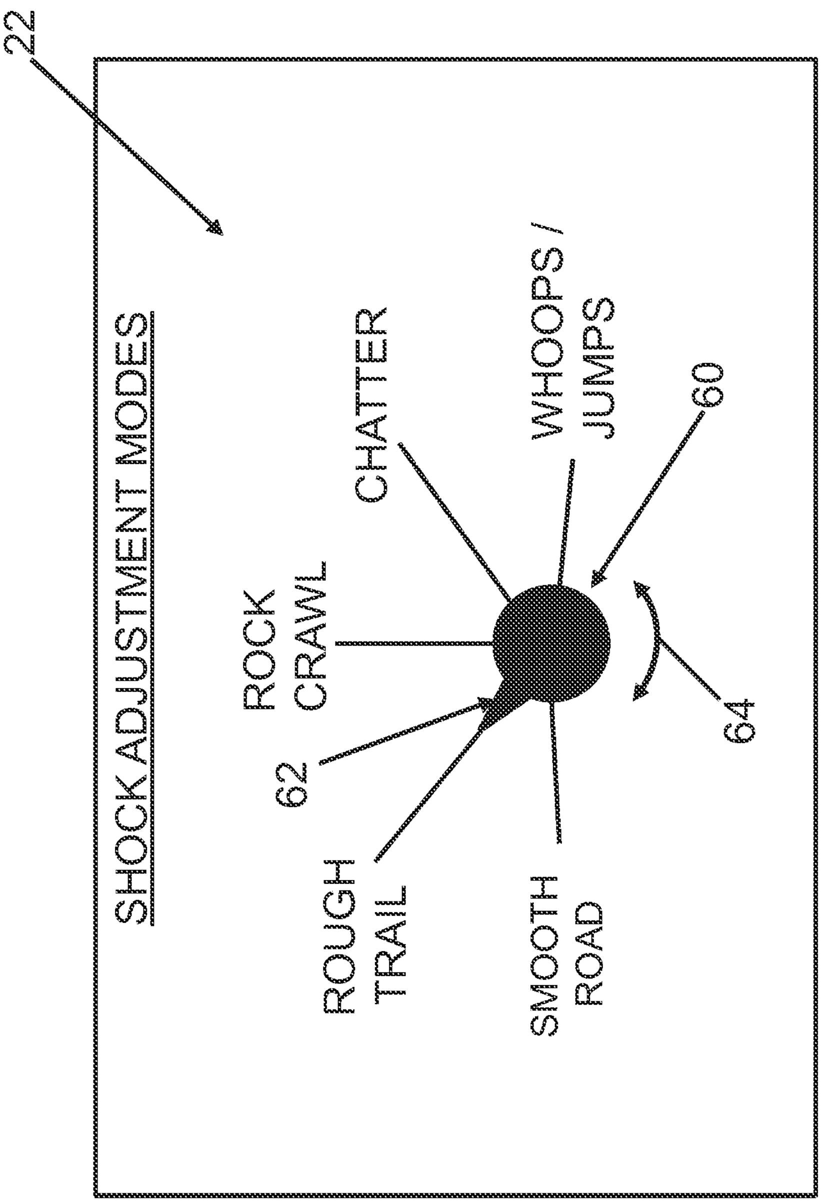
22
SHOCK ADJUSTMENT MODES
ROCK CRAWL
CHATTER
WHOOPS / JUMPS
60
62
ROUGH TRAIL
SMOOTH ROAD
64

FIG. 4

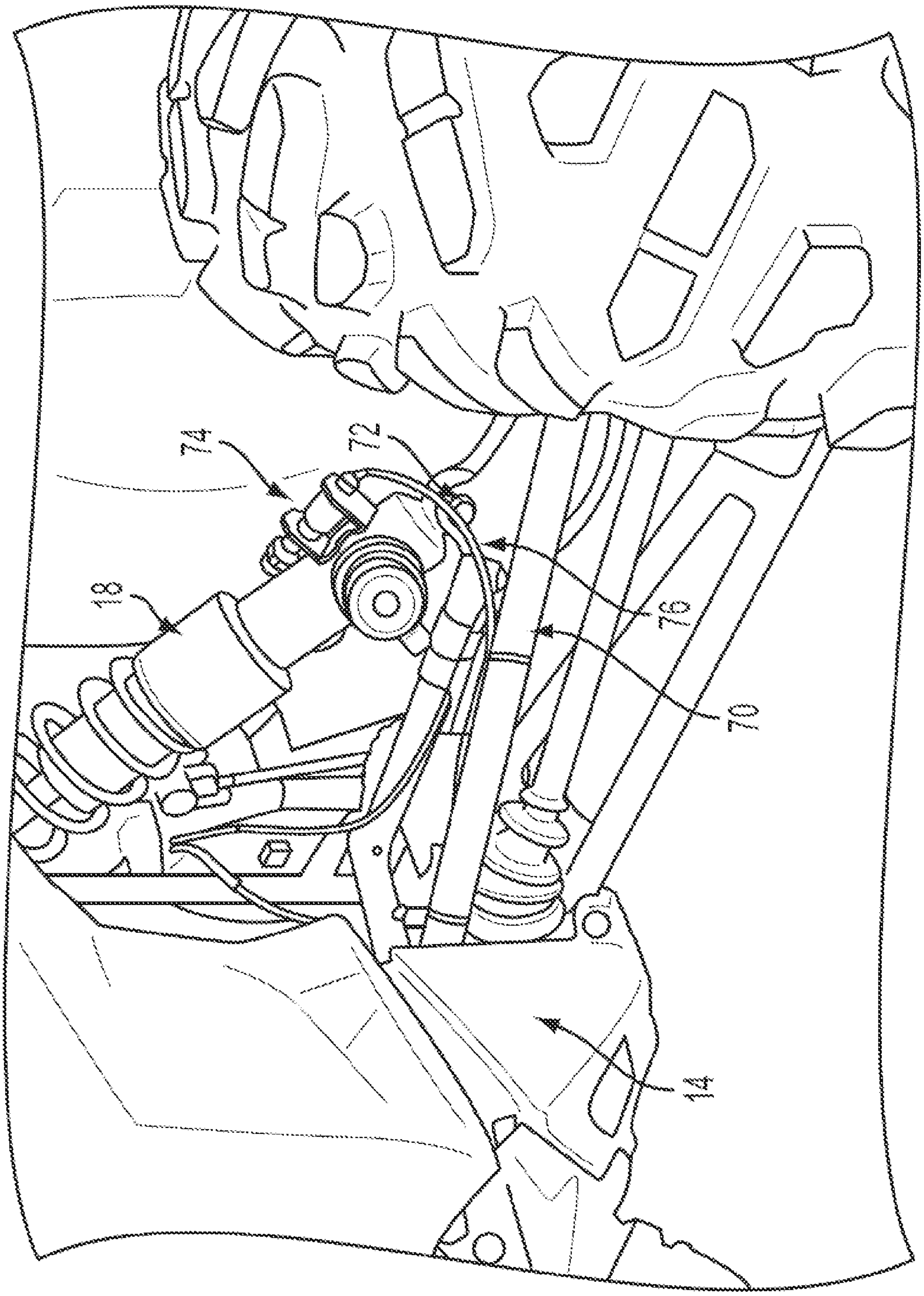

FIG. 5