ROLL BUMPER STABILIZER BAR LINKS

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ABSTRACT

A vehicle suspension is provided that includes a frame supporting a pair of laterally spaced apart suspension members pivotally supported on the frame and movable in a vertical direction. Each of a pair of wheel ends is supported respectively on one of the suspension members. A stabilizer bar is supported on the frame laterally between the suspension members. The stabilizer bar includes opposing ends each respectively proximate one of the suspension members. Each of a pair of resilient stabilizer bar links respectively interconnects one of the ends and one of the suspension members and transmits torsional force to the stabilizer bar in response to movement of the suspension members in the vertical direction during roll conditions. The links have first and second deflection rates during the roll condition with the first rate being less than the second deflection rate. The links transition from the first deflection rate to the second deflection rate and from the second deflection rate to an effective zero deflection rate.
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[0001] This is a Divisional of U.S. patent application Ser. No. 10/143,289, filed May 10, 2002.

BACKGROUND OF THE INVENTION

[0002] This invention relates to a stabilizer bar for a vehicle suspension system, and more particularly, the invention relates to stabilizer bar links used to attach the ends of the stabilizer bar to a vehicle suspension member.

[0003] Stabilizer bars are used in vehicle suspension systems to stabilize the vehicle laterally during vehicle turning and maneuvers in which the vehicle rolls side to side. In addition to stabilizing the vehicle, the stabilizer bar provides feedback to the vehicle operator regarding the stability of the vehicle during the turning maneuver. Providing a soft feel in which the vehicle rolls appreciably during a turning maneuver, the driver is made aware of the vehicle’s instability thereby encouraging the driver to operate the vehicle more conservatively to prevent loss of control of the vehicle during the turning maneuver. By way of contrast, a firm or hard feel provides the vehicle operator with feedback that the vehicle is stable by rolling very little during the turning maneuver. In this manner, the vehicle operator may drive more aggressively than desired causing the vehicle to suddenly lose traction and spin out of control.

[0004] The roll feel provided by the suspension assembly is determined by the stiffness of the suspension springs, the stiffness of the stabilizer bar itself, and the stiffness of the bushings used in the connections of the stabilizer bars and suspension members such as lower control arms. The roll stiffness is typically selected to provide either a soft feel or a firm or hard feel depending upon the particular vehicle application and expectation of the driver. It would be desirable to provide a variable roll stiffness and feedback to the driver during various roll conditions.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0005] The present invention provides a vehicle suspension including a frame supporting a pair of laterally spaced apart suspension members pivotally supported on the frame and movable in a vertical direction. Each of a pair of wheel ends is supported respectively on one of the suspension members. A stabilizer bar is supported on the frame laterally between the suspension members. The stabilizer bar includes opposing ends each respectively proximate one of the suspension members. Each of a pair of resilient stabilizer bar links respectively interconnects one of the ends and one of the suspension members and transmits torsional force to the stabilizer bar in response to movement of the suspension members in the vertical direction during roll conditions. The links have first and second deflection rates during the roll condition with the first rate being less than the second deflection rate. The links transition from the first deflection rate to the second deflection rate and from the second deflection rate to an effective zero deflection rate.

[0006] Accordingly, the above invention provides a variable roll stiffness and feedback to the driver during various roll conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Other advantages of the present invention can be understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0008] FIG. 1 is a perspective view of a vehicle suspension system;

[0009] FIG. 2 is a chart depicting the link deflection versus roll input for the present invention stabilizer bar links;

[0010] FIG. 3 is a stabilizer bar link having a bushing with a variable deflection rate;

[0011] FIG. 4 is an alternative bushing;

[0012] FIG. 5 is another stabilizer bar link of the present invention;

[0013] FIG. 6 is yet another stabilizer bar link of the present invention;

[0014] FIG. 7 is still another stabilizer bar link of the present invention; and

[0015] FIG. 8 is yet another stabilizer bar link of the present invention having active control.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] A vehicle suspension system 10 is shown in FIG. 1. The system 10 includes a frame 12 that supports the suspension members including a lower control arm 14 and an upper control arm 16. A knuckle 18 is secured between the lower control arm 14 and upper control arm 16. A spring 20 may be arranged between the lower control arm 14 and the frame 12. Wheel ends 22 are supported by the knuckles 18. Although a four-bar suspension arrangement is shown, it is to be understood that the present invention may be utilized with any suspension arrangement.

[0017] A stabilizer bar 24 is arranged laterally between the lower control arms 14 on either side of the vehicle. The stabilizer bar 24 includes a lateral bar portion 25 supported on the frame 12 by brackets 26. The stabilizer bar 24 also includes arms 28 that are secured to the lower control arms 14 by stabilizer bar links 30. The stabilizer bar links 30 transmit the vertical inputs from the lower control arms 14 to the stabilizer bar 24 to realize stability to a vehicle during roll conditions and provide feedback to the vehicle operator indicative of the vehicle stability. The present invention provides a roll curve shown in FIG. 2 that provides at least a soft feel (shown by curve A), a firm feel (shown by curve B), and a hard feel (shown by curve C).

[0018] The stabilizer bar link 30 includes a first end 32 and a second end 34 defining a first connection 36 and a second connection 38. Each of the connections may include a first resilient member 40 and second resilient member 42 that are coaxial with one another that define a bushing. The bushing includes a hole 44 for receiving a fastener that attaches the stabilizer bar link 30 between the lower control arm 14 and the stabilizer bar 24. The first resilient member 40 and second resilient member 42 may be made out of a rubber material. The first resilient member 40 may be softer than the second resilient member 42 such that the first resilient
member 40 deflects greater than the second resilient member 42. In this manner, the first resilient member 40 will begin deflecting first and provide a soft feel. The second resilient member 42 will then begin to deflect after the first resilient member 40 has deflected and provide a firmer feel. Finally, the first resilient member 40 and second resilient member 42 will no longer deflect and provide an effectively zero deflection rate which provides a high feel to the vehicle operator.

[0019] The bushing 46 shown in FIG. 4 may also be used with the stabilizer bar link 30 to provide a variable deflection rate. For example, the bushing 46 includes arcuate apertures 48 arranged about the hole 44. The bushing 46 will deflect until the arcuate apertures 48 become closed and the inner portion of the hole 44 engages the outer portion of the bushing 46 to provide a firm feel. The bushing 46 will cease deflecting and provide a hard feel to the vehicle operator.

[0020] Another stabilizer bar link arrangement is shown in FIG. 5. The stabilizer bar link 30 includes a link 50 having flanges 52. Resilient members 54 are arranged about the lower control arm 14 and the stabilizer bar 24 to effectively sandwich the suspension member and bar between the flanges 52. The fasteners 56 such as nuts are secured to the link 50 to connect the stabilizer bar 24 to the lower control arm 14. The resilient members 54 adjacent to the lower control arm 14 and stabilizer bar 24 may have a first deflection rate, and the resilient members 54 adjacent to the flanges 52 may have a second deflection rate different than the first deflection rate.

[0021] Another stabilizer bar link arrangement is shown in FIG. 6. The stabilizer bar link 30 may include a rigid member 58 telescopically received within a housing 60. The housing 60 may be secured to the stabilizer bar 24 and the rigid member 58 may be secured to the lower control arm 14. A first resilient member 62 and a second resilient member 64 may be coaxially arranged relative to one another. The first resilient member 62 and second resilient member 64 may be secured to one another and secured between the rigid member 58 and the housing 60. The first resilient member 62 has a first deflection rate, and the second resilient member 64 has a second deflection rate different than the first resilient member 62. The housing 60 may include a stop 65 to limit the motion of the rigid member 58 to the housing 60.

[0022] The first stabilizer bar links 30 are shown in FIGS. 7 and 8. Referring to FIG. 7, the stabilizer bar link 30 may include a housing 66 having a piston 68 disposed therein. A rod 70 is secured to the piston 68 and may be attached to the lower control arm 14. The housing 66 may be attached to the stabilizer bar 24. The housing 66 defines a fluid cavity 72 that is separated into a first chamber 92 and a second chamber 94 by the piston 86. The piston 86 may include an orifice 96 for providing damping. A coil 97 may be arranged about the housing 84 and is connected to a controller 98. The controller 98 energizes the coil 97 and creates a magnetic field about the housing 84 to change the viscosity of the magneto-rheological fluid thereby changing the fluid flow through the orifice 96. Accelerometers 100 and 102 are connected to the controller 98 and provide lateral and forward/rearward acceleration. The controller 98 is programmed to selectively control the magnetic field produced by the coil 97 in response to the accelerometers 100 and 102 to provide variable roll damping. In this manner an infinitely variable damping or deflection rate may be provided by the magneto-rheological fluid stabilizer bar link 30.

[0023] The invention has been described in an illustrative manner, and it is to be understood that the terminology that has been used is intended to be in the nature of words of description rather than of limitation. Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A vehicle suspension system comprising:
   - a frame;
   - a pair of laterally spaced apart suspension members pivotally supported on the frame and movable in a vertical direction;
   - a stabilizer bar supported on the frame laterally between the suspension members, the stabilizer bar including opposing stabilizer bar ends each respectively proximate to one of the suspension members; and
   - a pair of stabilizer bar links each respectively interconnecting one of the opposing stabilizer bar ends with one of the suspension members and transmitting a torsional force to the stabilizer bar in response to movement of the suspension members in the vertical direction during a roll condition, each of the pair of stabilizer bar links having a fluid with a viscosity that is selectively variable in order to change a damping rate.

2. The vehicle suspension system according to claim 1, wherein each of the pair of stabilizer bar links includes opposing link ends, with one of the opposing link ends secured to one of the opposing stabilizer bar ends and the other of the opposing link ends secured to one of the suspension members.

3. The vehicle suspension system of claim 2, wherein each of the pair of stabilizer bar links includes a housing connected to one of the opposing link ends and a piston connected to the other of the opposing link ends, the housing defining a fluid cavity containing the fluid, the piston disposed in the fluid cavity, the piston separating the fluid cavity into a first chamber and a second chamber.

4. The vehicle suspension system of claim 3 wherein the piston includes an orifice fluidly connecting the first chamber and the second chamber.

5. The vehicle suspension system of claim 1 wherein the fluid is a magneto-rheological fluid.
6. The vehicle suspension system of claim 5 further including an electromagnetic field source for generating an electromagnetic field to control the viscosity of the magnetorheological fluid.

7. The vehicle suspension system according to claim 1 wherein a controller is connected to a magnetic source cooperating with the fluid, the controller controlling the magnetic source in order to change the viscosity of the fluid.

8. The vehicle suspension system according to claim 7, wherein an accelerometer is connected to the controller to provide a vehicle rate of roll signal to the controller, the controller controlling the magnetic source to change the viscosity of the fluid based upon the vehicle rate of roll signal.

9. A method of providing driver feedback during vehicle roll maneuvers comprising the steps of:

   a) providing a stabilizer bar attached to a suspension member by a stabilizer bar link, the stabilizer bar link having a fluid with a selectively variable viscosity;

   b) effecting a first viscosity of the fluid during a first vehicle roll; and

   c) effecting a second viscosity of the fluid during a second vehicle roll, the first viscosity greater than the second viscosity.

10. The method of claim 9 wherein said steps b) and c) are performed by altering a magnetic field in which the fluid is at least partially disposed.

11. The method of claim 10 further including the step of measuring acceleration and effecting the first viscosity of the fluid in said step b) based upon the acceleration.

12. The method of claim 11 wherein the second viscosity is effected in said step c) based upon the acceleration.

13. A stabilizer bar link assembly comprising:

   a) a housing having a first connection area;

   b) a magneto-rheological fluid in the housing; and

   c) a piston having a first end disposed within the housing and a second end having a second connection area.

14. The stabilizer bar link assembly of claim 13 wherein the housing defines a fluid cavity divided into a first chamber and a second chamber by the piston.

15. The stabilizer bar link assembly of claim 14 wherein the piston includes an orifice providing fluid communication between the first chamber and the second chamber.

16. The stabilizer bar link assembly of claim 15 further including a magnetic source generating a magnetic field in which the fluid is at least partially disposed.

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