

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
3 March 2005 (03.03.2005)

PCT

(10) International Publication Number
WO 2005/019687 A2

- (51) International Patent Classification⁷: **F16H**
- (21) International Application Number:
PCT/US2004/026933
- (22) International Filing Date: 20 August 2004 (20.08.2004)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
60/496,472 20 August 2003 (20.08.2003) US
- (71) Applicant (for all designated States except US): **SYNK-
INETICS, INC.** [US/US]; 5 Whittier Street, #4 Floor,
Framingham, MA 01701 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **FOLINO, Frank,
A.** [US/US]; 17 Indian Hill Lane, Salem, MA 01970 (US).
MCCLELLAND, John, M. [US/US]; 6201 Fairview
Road, Suite 200, Charlotte, NC 28210 (US).
- (74) Agents: **COHEN, Jerry** et al.; Perkins, Smith & Cohen,
LLP, One Beacon Street, Boston, MA 02108 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

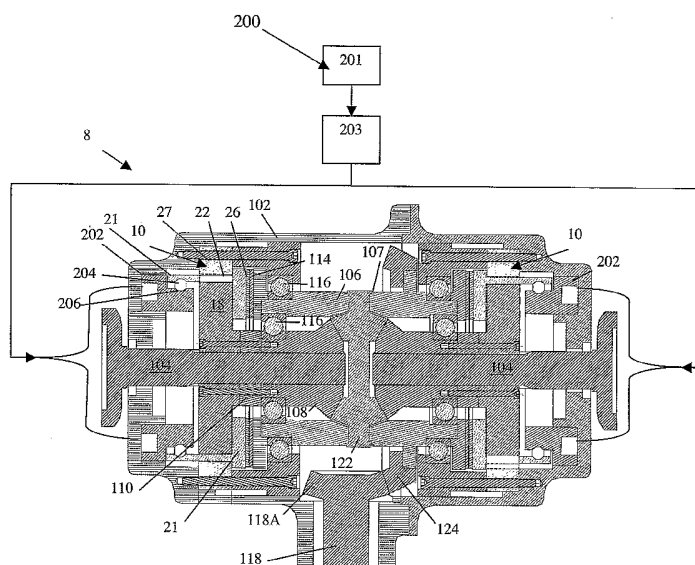
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: YAW CONTROL DIFFERENTIAL SYSTEM



(57) Abstract: A system for correcting undesirable yaw of a vehicle including a torque (or speed) converter adapted to a conventional differential. The torque converter reduces the axle rotation or alternatively increases driving torque for rear wheel, front wheel and all wheel drive systems. The torque converter includes an inner cam, retainer, and outer cam. A piston/clutch interface system engages the torque converter with the differential splitting and varying driving torque unequally between the left and right wheels when cornering or when tire slippage is sensed. A computer system actuates a piston instantaneously to an indication of a yaw moment to prevent the vehicle from reaching an unstable condition that could result in the vehicle going into an uncontrolled skid. A reaction force equivalent to the increased amount of torque is directed to the axle as a braking force and varying the lateral distribution of driving torque between the two axles.

WO 2005/019687 A2

YAW CONTROL DIFFERENTIAL SYSTEM

BACKGROUND OF THE INVENTION

[0001] The present invention relates to mechanical power vehicular differentials, and more particularly, to a system for applying bias torque to drive wheels to correct for the undesirable yaw of a vehicle to enhance vehicle stability and control.

[0002] Motor vehicles behave well when operated under normal conditions such as on a straight course, on high friction roadways, in a controlled cornering maneuver, and at moderate speeds. However, when operated outside of the normal condition range, vehicles can become difficult to control while, for example, trying to avoid an unexpected obstacle on a slippery road. Vehicle handling response to driver steering inputs is to a large extent determined by the forces between the tires and the road surface. The vehicle's reaction entails all kinds of complications, such as understeer, oversteer, or simply losing the tires' grip. The vehicle stability is impacted by such events, which may cause the vehicle to become uncontrollable.

[0003] Several means of actively controlling a vehicle's behavior have emerged from the automotive industry. These include antilock braking systems, traction control, four-wheel steering, active and semi-active suspensions, and yaw control through active braking and differential torque biasing. With regards to differential torque biasing to control yaw, automobile manufactures have not been successful in the development of a simple design that is cost effective and easy to manufacture.

[0004] The differential applies power as needed to the wheels while they rotate at different speeds on curves. The difference in speeds is necessary because the outer wheels must travel both farther and faster than the inner wheels when

the vehicle is going around a turn. This could not occur if the two wheels were rigidly attached to a solid axle. It should be understood that the differential applies to all types of drives, such as front wheel, rear wheel and all wheel drives. For simplicity, this description deals primarily to rear wheel drive vehicles. In the rear wheel drive, the two front wheels present no problem, as each is mounted on its own spindle and rotate independently. The rear wheels, however, drive the car, and they must be attached to a strong axle supplying torque from the engine. The rear axle, therefore, is in two pieces connected through the differential.

[0005] The differential works similar to planetary gears, for, depending on need, some gears will move slower or faster than others or even remain stationary. The system turns the wheel that is easiest to turn.

[0006] Of primary concern is the amount of torque and time required to apply torque bias. Very low torque bias is required because excessive amounts could over correct the vehicular uncontrolled condition. Also, it is desirable to apply the bias torque as quickly as possible.

[0007] It is an object of the present invention to provide a vehicle axle torque biasing device adaptable to a conventional differential.

[0008] It is another object of the present invention to provide an in-line speed or torque converter (reducer or increaser) that is simple in design, light robust, cost effective to produce, and easy of manufacture.

[0009] It is yet another object of the present invention to provide a torque biasing device having a fast response time to restore the vehicle to a desirable path.

[0010] It is yet another object of the present invention to provide fast reaction time that allows for a much more active system increasing vehicle stability/safety.

SUMMARY OF THE INVENTION

[0011] The present invention is a yaw control differential system which incorporates standard differential components adapted to cooperate with a speed (or torque) converter that reduces the axle rotation or alternatively increases driving torque for rear wheel, front wheel and all wheel drive systems. A reaction force equivalent to the increased amount of torque is directed to the axle as a braking force and varying the lateral distribution of driving torque between the two axles. The present invention applies the torque biasing directly at the torque transfer location of the differential directly onto the vehicles axles. Thereby, splitting and varying driving torque unequally between the left and right wheels when cornering or when tire slippage is sensed. By applying the torque bias here, the effectiveness is increased and overall yaw correction time decreased.

[0012] The differential system of the present invention reduces or increases the speed of one axle coupled with the torque increase or reduction of that axle provides a bias torque between the two axles and produces a counter yaw moment to correct the undesirable yaw moment induced on a vehicle as it makes a turn. The present invention responds instantaneously to an indication of a yaw moment to prevent the vehicle from reaching an unstable condition that could result in the vehicle going into an uncontrolled skid.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0013] Figure 1 is side cross-sectional view of the differential system of the present invention illustrated the position of two single-stage nested torque converters, one per axle;

[0014] Figure 2A is a side cross-section view of one of the single-stage nested torque converters used with the present invention of FIG. 1;

[0015] Figure 2B is a partial cross-section view of one of the single-stage nested torque converter used with the present invention taken along line 2B-2B of FIG. 1; and

[0016] Figure 2C is a pictorial illustration of one of the single-stage nested torque converter used with the present invention of Fig. 1 showing a partial sectional view of the outer cam.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Now referring to FIG. 1, the differential system 8 of the present invention acts as a yaw control differential and includes a pair of independent single-stage nested torque converters 10 of the type described, but not limited to, the converters in U.S. Patent No. 5,989,145 entitled "In-line Speed Converter with Low Parts Count" assigned to the present assignee of this invention and which is incorporated by reference herein. Torque converters (also referred to as SynkDrive Torque Converters) 10 operate a control system 200 to reduce or increase one of the pair of axles 104 rotational speed by increasing or reducing the torque supplied to such axle. The control system 200 will actuate only one of the pair of single-stage nested torque converters 10 depending on the required speed reduction or increase of a predetermined axle 104.

[0018] The term torque converter is meant to refer to torque increaser or reducer, and is also used synonymously with rotational speed increaser or reducer.

[0019] Further, components of differential system 8 also include, for example, housing 102, ring gear 124, differential gear casing 106, spider gear 122, two side gears 108, and two axles 104. Input shaft 118 transmits torque load from the engine drive shaft (not shown) to the present invention 8. The input pinion 118A meshes with ring gear 124, which reduces the input speed by a predetermined ratio, for example 3.73:1. When neither of the single-stage torque converters 10 are engaged (discussed in detail below) the ring gear 124 conveys

the reduced speed at a 1:1 ratio to the axles 104 via the load path through the differential gear casing 106 to the spider gears 122 to the side gear 108. The side gear 108 is coupled to the axles 104 by conventional joining means, such as a spine connection or a pressed fit. The differential gear casing 106 includes features similar to those of a standard differential gear casing, such as spider gear support openings 107. Additionally, the differential gear casing 106 includes elements to interface and couple with the single-stage nested torque converter 10, such as a clutch face 114. The differential gear casing clutch face 114 frictionally couples the single-stage nested torque converter 10 to the differential gear casing 106 when the single-stage nested torque converter 10 is engaged (discussed in detail below). The differential gear casing 106 is referred to as the driving member with regards to the input torque of single-stage nested torque converter 10. Therefore, the differential system 8, via the differential gear casing 106 and mating components, provides the input torque to the single-stage nested torque converter 10. The differential gear casing clutch face 114 is made of any suitable material that is durable and has a moderate to high coefficient of friction. Although a signal-stage torque converter is described, it may be possible to use multiple stage torque converters as well with the present invention. In addition, for simplicity, only a single stage torque converter is described in detail in operation, with the other operating in a similar manner.

[0020] Additionally, bearings 116 are disposed between the housing 102 and the differential gear casing 106 and between the side gear 108 and the differential gear casing 106 to maintain the position of the differential gear casing 106 and side gear 108 under torsional loading conditions when the single-stage nested torque converter 10 is engaged.

[0021] Alternatively, the single-stage nested torque converter 10 can be fixedly connected, with for example, bolts, to the differential gear casing 106.

[0022] Upon engagement of one of the single-stage nested torque converters 10, the torque is diverted through the single-stage nested torque converter 10 to the axle 104 instead of going through the spider gear 122. The speed is further reduced by the single-stage nested torque converter 10, for example 1.08:1, which results in lower speed/higher torque being transmitted to axle 104.

[0023] The control system 200 may be an independent system used with differential system 8 or considered part of the differential system 8. Control system 200 includes, but is not limited to, a computer 201, a piston 202 (preferably part of differential system 8), piston actuator 203, and bearings 204 (preferably part of differential system 8). The computer 201 includes several sensors such as a vehicle speed sensor, steering wheel position sensor, wheel speed sensors, lateral acceleration (g) sensor, and the engine rpm and torque sources (all not shown), which determines the driver's intention by such factors as steering input, vehicle speed, lateral acceleration, and engine performance, and controls driving torque distribution between the wheels. The piston actuator 203 can be any conventional actuation system including hydraulic, pneumatic, or electronic. The piston 202, is preferably incorporated within the housing 102, and includes a bearing race 206 to support bearing 204. Alternative embodiments of the differential system 8 may include the piston 202 external to housing 102. The bearing 204 interconnects the piston 202 with the retainer 21 of the single-stage nested torque converter 10. Therefore, any longitudinal displacement of the piston 202 results in the same longitudinal displacement of the retainer 21. Although this description may refer to certain components in the "singular" it should be realized identical components operate the same as their counterpart components.

[0024] Now turning to FIG. 2A illustrating the single-stage nested torque converter 10 removed from housing 102. The retainer 21 includes a base 29 and an annular section 25 having a bearing race 24 along its inner diameter sufficient

to seat bearing 204 (FIG. 1), which interconnects the piston 202 with the retainer 21. The retainer 21 further includes a clutch face 26 attached to the retainer base 29. The clutch face 26 is made of material compatible with physical characteristics of the differential interface plate clutch face 114 (FIG. 1), such as coefficient of friction and hardness.

[0025] FIG. 2B shows a partial cross-sectional view of the single-stage nested torque converter 10 taken along line 2B-2B of FIG. 2A. More specifically, FIG. 2B illustrates the nested components of the single-stage nested torque converter 10, including inner cam 18, retainer 21, and outer cam 27. Any of the three in-line or nested components can function as an input source or an output source or a grounded member. Holding any one of the three components stationary (grounded) results in the other two components forming the input source and output source. The configuration illustrated in the figures and disclosed in detail below presents the outer cam 27 as the grounded member with the retainer 21 acting as the input source and the inner cam 18 acting as the output source. (See above referenced U.S. Patent Number 5,989,145, incorporated herein by reference, for a detailed disclosure of the nested component functional interaction.)

[0026] Now referring to FIG. 2C, retainer 21 further includes rolling element slots 19 spatially disposed substantially evenly through the annular section 25. A compliment of rolling elements 22 (shown here as rollers, but not limited thereto, such as the rolling elements 22 may be ball bearing, for example) is located in rolling element slots 19. Rolling elements 22 disposed between the three in-line components provide interdependency among the three components.

[0027] Now returning the FIG. 2A, the inner cam 18 includes at least one bolt hole 36 to connect the single-stage nested torque converter 10 to axle 104 and a bore 38 to receive axle 104 (FIG. 1). In the preferred embodiment of the present invention illustrated in FIG. 1, the inner cam 18 is bolted to

the side gear 108, which in turn is coupled to the axle 104 by conventional means as discussed above. Spacer 110 (shown in FIG. 1) illustrates an optional component to adjust for longitudinal variations of components in different models.

[0028] Alternatively, the inner cam 18 (See FIGS. 1 and 2A-2C) can be connected directly to the axle 104 by conventional joining means, such as bolting or spline connection or pressed fit.

[0029] Another alternative embodiment of the present invention may include an inner cam embodiment include an integral inner cam/axle and integral inner cam/side gear interconnected via conventional joining means or machined from a single piece of metal.

[0030] The outer cam 27 is fixedly connected to the housing 102 as discussed above. The preferred embodiment includes boltholes 41 to attach the outer cam 27 to the housing 102. The fixed outer cam 27 acts as the grounded member in this embodiment that cooperates with the inner cam 18 and retainer 21 in reducing the axle speed (discussed in further detail below).

[0031] In the embodiment shown in FIG. 2B, input cam 18 has, for example, twenty-six lobes 30 formed on its outer diameter 32, while outer cam 27 has, for example, two lobes 28 formed on its inner diameter 34. In various embodiments, the number of lobes and slots may vary in accordance with the intended use or desired speed conversion ratio.

[0032] As an example of the operation of the present invention, when one of the single-stage nested torque converter 10 is engaged, the retainer 21 rotates with a first input speed causing the rolling elements 22 to radially displaced in the retainer slots 19, which in turn interact with the lobes 28 of the outer cam 27 and lobes 30 of inner cam 18 to produce a second output speed of inner cam 18. The torsional load path flows from the differential gear casting 106 through the differential interface plate clutch face 114

to the retainer clutch face 26 through the retainer 21 to the rolling elements 22 to the inner cam 18 to the side gear 108 to the axle 104. This action creates conjugate action between the inner and outer cams. (See above referenced U.S. Patent Number 5,989,145, incorporated herein by reference, for a detailed disclosure of conjugate cams.) The present invention applies the torque biasing directly at the torque transfer location of the differential directly onto the vehicles axles. By applying the torque bias here, the effectiveness is increased and overall yaw correction time decreased.

[0033] Speed ratios are determined by the number of lobes 30 on the inner cam 18 versus the number of lobes 28 on the outer cam 27 and the number of rolling elements 22. As shown the example of in FIG. 2B and discussed above, there are twenty-four lobes on the inner cam 18 and two lobes 28 on the outer cam 27 with twenty-six rolling elements 22. There are many speed ratios possible for the configuration of inner cam 18, outer cam 27, and rolling elements 22. The present invention can provide a percentage of speed reduction or speed increase less than 10% for yaw control, where greater percentages tend to over-correct the undesirable yaw moment.

[0034] Examples of a few possible speed conversion ratios are illustrated in Table 1 below:

	Inner Cam lobes 30	Outer Cam lobes 28	Rolling Elements 22	Speed Ratio
1	2	18	20	10:1
2	2	20	18	9:1
3	18	2	18	1.11:1
4	20	2	18	1:1.11
5	24	2	26	1.08:1

Table 1

[0035] Now returning the FIG. 1, the process of introducing a torque bias into the differential system 8 when used in a vehicle (not shown) is initiated by the control system 200. The computer 201 determines which axle 104 requires torque conversion to induce a counter yaw moment to the vehicle. The computer 201 generates a signal to the piston actuator 203 to actuate one of the two pistons 202, which traverses longitudinally along a parallel axis with respect to axle 104 for a predetermined displacement. Since piston 202 is interconnected to the retainer 21 through bearing 204, the retainer 21 traverses longitudinally the same predetermined displacement as the piston 202 until the retainer clutch face 26 of retainer 21 contacts differential interface plate clutch face 114. Friction loading on the two faces cause the retainer 21 and differential case 106 to rotate at the same speed. The actuation of the piston 202 from an idle (unengaged) to fully deployed (engaged) state can occur, for example, in milli-seconds after the generation of the signal from computer 201. Conventional Anti-lock Braking Systems employ hydraulic pressure to communication the signal to the wheels to engage for countering the yaw moment, which can take tenths of a second.

[0036] By engaging the clutch faces 26 and 114 the differential casing 106 and the retainer 21 are coupled, and the single-stage nested torque converter 10 becomes active or engaged. The transition from unengaged to engaged is substantially instantaneous because the retainer 21 and differential casing 106 are rotating in the same direction at approximately the same speed relative to one another. Engagement of retainer 21 and differential casing 106 rotating essentially together significantly reduces the time required to go from the unengaged (inactive) state to the engaged (active) state. Through the use of fast acting clutches, the total reaction time for the yaw control system of this invention is substantially faster than other yaw control systems. Other yaw control systems, such as anti-lock braking systems (ABS), require a significant amount of time to react due to the hydraulic actuation mechanism being the same as

used for normal or ABS braking. As the hydraulic actuation occurs at the brake master cylinder, it takes much longer to fully activate the yaw control function than the present invention. The reaction time of the present invention is measured in 10's of milliseconds compare to 100's of milliseconds for conventional yaw control braking systems.

[0037] For example, ABS braking systems do not respond as quickly as the present invention to create the desired counter yaw. This is due to the static or grounded state of the ABS system. The ABS system is modulated on the wheel to create a speed reduction. Since the ABS system is grounded (no rotation relative to the axle or wheel), the wheel speed must be reduced relative to the zero speed of the ABS system, which takes a finite period of time depending on the rotational speed of the wheel or axle. Whereas, the single-stage nested torque converter 10 only requires sufficient reduction in the differential component rotational speed to couple housing 102 to the single-stage nested torque converter 10 rotating at about the same rotational speed. The time difference between complete rotational speed stoppage of the differential components (ABS braking system) and only a speed reduction of the differential components (single-stage nested torque converter 10) can be significant in terms of responding to an emergency situation.

[0038] At the moment of engagement of the single-stage nested torque converter 10 of the present invention, the torsional load path of torque from the input shaft 118 to the axle 104 changes. The torque load now travels through the single-stage nested torque converter 10 instead of spider gears 122. The effect is a modified torque based on a predetermined increase or decrease of torque dependent on the number of lobes 30 of the inner cam 18, number of lobes 28 of the outer cam 27, and the number of rolling elements 22. An example of a modified torque includes the increased torque to one of the axles 104 causes that wheel to rotate at a reduced rotational speed than the other wheel, and induces a counter active yaw moment.

[0039] Although the invention has been described with respect to various embodiments, it should be realized this invention is also capable of a wide variety of further and other embodiments within the spirit and scope of the invention.

CLAIMS:

1. A vehicle yaw control system for maintaining stability and control of a vehicle, said system being adaptable to a drive train of the vehicle having a first axle, a second axle, and a differential system that provides an input torque to said system, said system comprising:

first biasing torque means operably connected to the differential system and substantially directly connected to the first axle for modifying the input torque by a predetermined speed ratio and for transferring said modified input torque to the first axle to counter undesirable yaw moment induced on the vehicle;

second biasing torque means operably connected to the differential system and substantially directly connected to the second axle for modifying the input torque by a predetermined speed ratio and for transferring said modified input torque to the second axle to counter undesirable yaw moment induced on the vehicle; and

means operably connected to said first biasing torque means and said second biasing torque means for determining yaw moment induced on the vehicle and for actuating independently said first biasing torque means and said second biasing torque means, based upon determination of yaw moment,

whereby vehicle stability and control are maintained.

2. The system according to claim 1 wherein:

said first biasing torque means comprises,
a torque converter having at least three rotatable components being operably connected together;
a first component of said at least three rotatable components being an input part to said torque converter, wherein said input part is operably

- connected to the differential system;
 - a second component of said at least three rotatable components being an output part of said torque converter, wherein said output part is operably connected to the first axle;
 - a third component of said at least three rotatable components being interposed within said first component and said second component to form a nested configuration of said at least three rotatable components, wherein said third component is operably connected to said means for determining yaw moment and for actuating said first biasing torque means and said second biasing torque means;
 - a grounding member being operably connected to a groundable component for selectively grounding said groundable component, wherein said groundable component is at least one of said at least three rotatable; and
- said at least three rotatable components comprise an inner cam, a retainer, and an outer cam; and
- said second biasing torque means comprises,
- a torque converter having at least three rotatable components being operably connected together;
 - a first component of said at least three rotatable components being an input part to said torque converter, wherein said input part is operably connected to the differential system;
 - a second component of said at least three rotatable components being an output part of said torque converter, wherein said output part is operably connected to the second axle;
 - a third component of said at least three rotatable components being interposed within said first component and said second component to form a nested configuration of said at least three rotatable components, wherein said third component

is operably connected to said means for determining yaw moment and for actuating said first biasing torque means and said second biasing torque means;

a grounding member being operably connected to a groundable component for selectively grounding said groundable component, wherein said groundable component is at least one of said at least three rotatable components; and

said at least three rotatable components comprise an inner cam, a retainer, and an outer cam.

3. The system according to claim 1 wherein

said first biasing torque means is interposed between the differential and the first axle; and

said second biasing torque means is interposed between the differential and the second axle.

4. The system according to claim 1 wherein said predetermined speed ratio ranges from approximately 10:1 to 1:1.11.

5. The system according to claim 1 wherein said means for determining yaw moment and for actuating said first biasing torque means and said second biasing torque means comprises:

a computer, said computer includes a plurality of sensors for determining the vehicles dynamics relative to a driver's intention;

a first piston being operably connected to said first biasing torque means;

a second piston being operably connected to said second biasing torque means;

a first piston actuator in communication with said first piston and said computer, said first piston

actuator being responsive to a signal generated by said computer to actuate said first piston longitudinally for a predetermined displacement along a substantial parallel axis with respect to the first axle based upon determination of yaw moment; and

a second piston actuator in communication with said second piston and said computer, said second piston actuator being responsive to a signal generated by said computer to actuate said second piston longitudinally for a predetermined displacement along a substantial parallel axis with respect to the second axle based upon determination of yaw moment.

6. The system according to claim 2 further comprising a housing, said housing being said groundable component.
7. The system according to claim 2 further comprising:
a plurality of slots in said retainers; and
a contact member selectively disposed within at least one of said plurality of slots.
8. The system according to claim 5 wherein:
said first piston being operably connected to said retainer of said first biasing torque means; and
said second piston being operably connected to said retainer of said second biasing torque means.
9. A vehicle yaw control system for maintaining stability and control of a vehicle, said system being adaptable to a drive train of the vehicle having a first axle, a second axle, and a differential system that provides an input torque to said system, said system comprising:
first biasing torque means operably connected to the differential system and directly connected to the

first axle for modifying the input torque by a predetermined speed ratio and for transferring said modified input torque to the first axle to counter undesirable yaw moment induced on the vehicle;

second biasing torque means operably connected to the differential system and directly connected to the second axle for modifying the input torque by a predetermined speed ratio and for transferring said modified input torque to the second axle to counter undesirable yaw moment induced on the vehicle; and

means operably connected to said first biasing torque means and said second biasing torque means for determining yaw moment induced on the vehicle and for actuating independently said first biasing torque means and said second biasing torque means, based upon determination of yaw moment,

whereby vehicle stability and control are maintained.

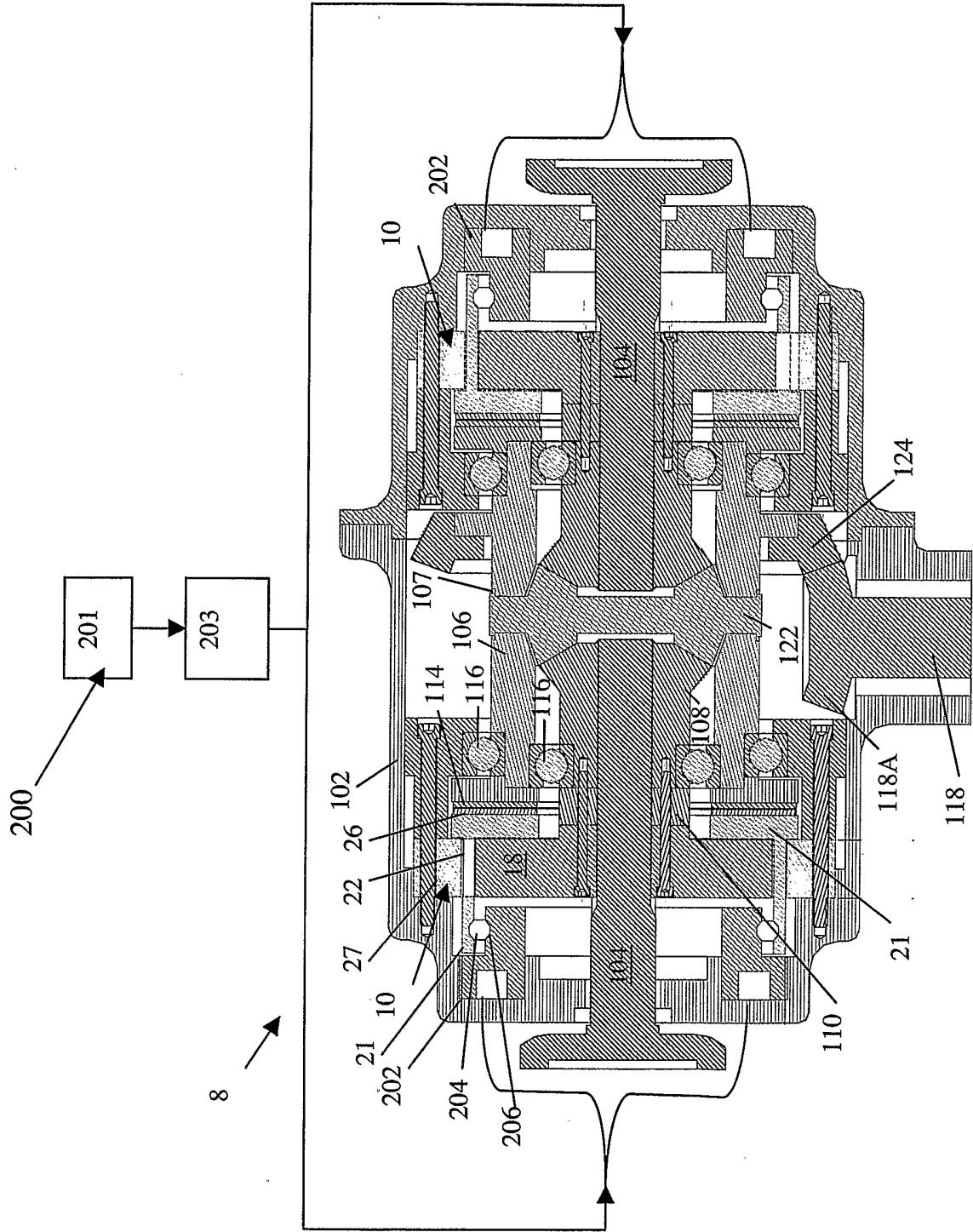


FIG. 1

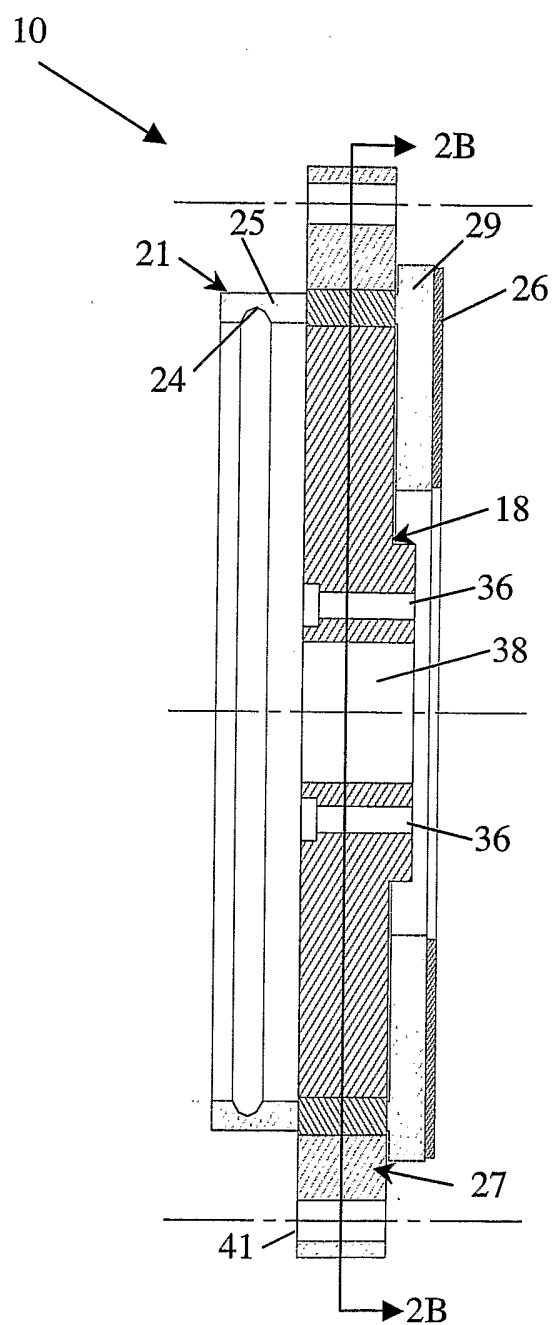


FIG. 2A

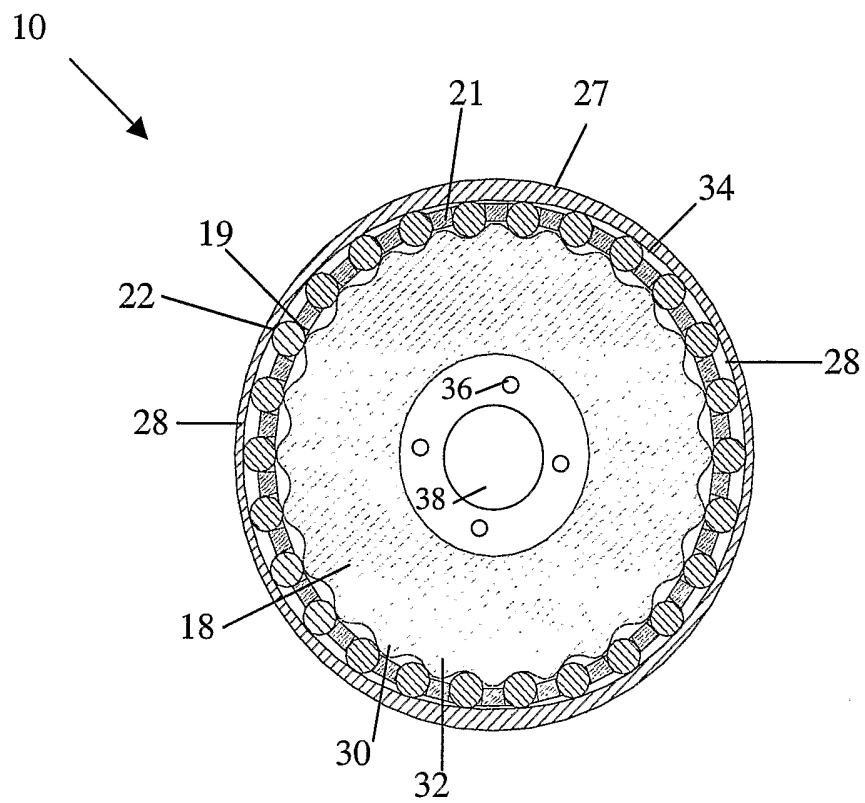


FIG. 2B

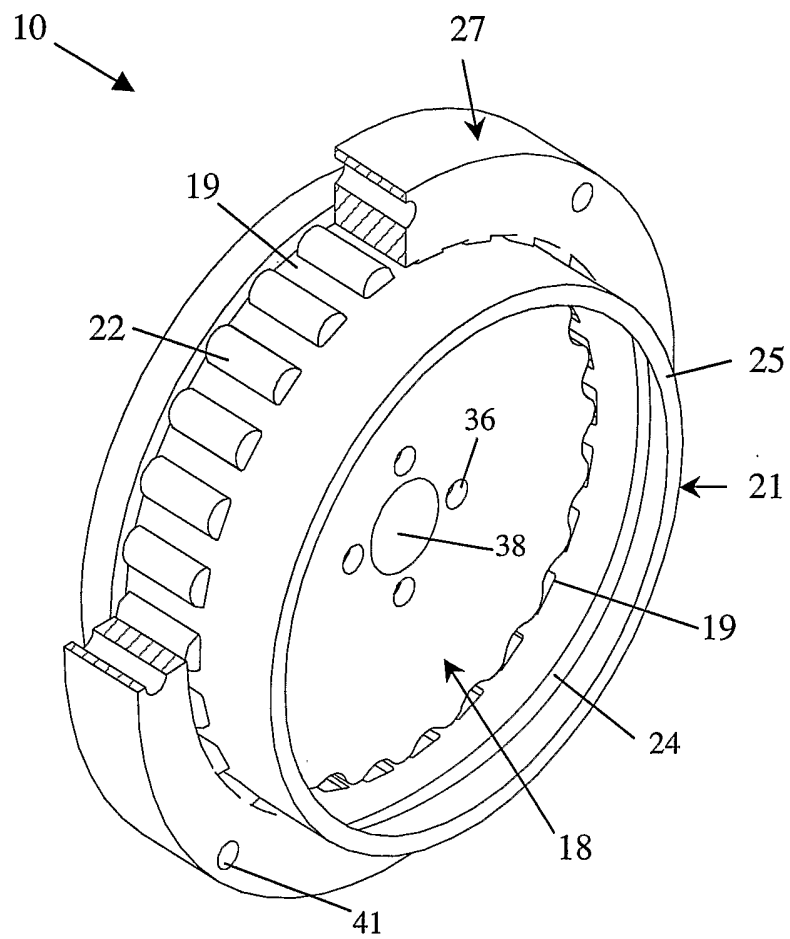


FIG. 2C