Steering system for the rear wheels of a vehicle.

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Proprietor: FORD FRANCE S. A. B.P. 307 F-92506 Rueil-Malmaison Cédex (FR)
Designated Contracting States: FR

Proprietor: FORD-WERKE AKTIENGESELLSCHAFT
D-50725 Köln (DE)
Designated Contracting States: DE

Inventor: Oslapas, Algis
6904 Lafayette
Dearborn Heights
Michigan 48127 (US)
Inventor: Rumpel, Manfred
4494, Chamberlain Drive
Birmingham
Michigan 48010 (US)

Representative: Messulam, Alec Moses et al
A. Messulam & Co.
24 Broadway
Leigh on Sea
Essex SS9 1BN (GB)

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Description

This invention relates to a steering system for the rear wheels of a vehicle, and more particularly to a subsystem for selectively overriding the rear steering system prime mover so as to prevent the rear steering gear from exceeding a predetermined fractional component of its total angular range in the event that the operating condition of the vehicle warrants such limitation.

Rear wheel steering systems typically respond to steering of the front wheels of the vehicle. Certain systems respond to other vehicle inputs such as steering torque, vehicle speed, transmission gear or other parameters.

U.S. 4,871,523 discloses a system which immobilises the rear steering gear in response to inputs from a steering torque sensor associated with the front wheels and a front wheel turn angle sensor. The system of the '523 patent limits the usefulness of the rear steering system because it is capable only of disabling the rear steering gear entirely; it will not serve to restrict the range of authority of the steering gear while still allowing a limited steering capability of the rear steering gear.

U.S. 4,566,711 and U.S. 4,705,135 disclose shaft-driven rear wheel steering systems in which a drive shaft couples the front and rear steering gears of a vehicle. The '711 and '135 patents further disclose motor operated devices for changing the front-to-rear steering ratio. In the event that these motor-driven ratio changing devices were to malfunction, a serious problem could be encountered by the driver because the driver could be unaware of the resetting of the front-to-front/rear steering ratio, and as a result, vehicle handling changes could cause a loss of vehicle control.

US-4,105,086 and US-4,657,102 disclose another type of system in which the power for actuating the rear wheel steering system is derived from a hydraulically controlled means. The '086 patent discloses a linkage-operated system, whereas the '102 patent discloses a purely hydraulically operated system. Each of the systems disclosed in the '086 and '102 patents suffers from a potential infirmity inasmuch as a malfunction in the control hydraulics of the systems could cause an unexpected slewing of the rear wheels in one direction or another, with concomitant loss of vehicle control.

DE-A-3,383,700 discloses a four-wheeled vehicle in which both the front and rear wheels are turned in response to operation of the steering wheel. The turning angle of the rear wheels is controlled in accordance with a turning angle ratio characteristic curve. The turning angle ratio characteristic curve is substantially a broken line having a positive inclination in the region where the value of the front wheel turning angle is smaller than a predetermined value and having a smaller inclination in the region where the value of the front wheel turning angle is larger than the predetermined value. The turning angle ratio characteristic curve is changed according to the vehicle speed so that the turning angle ratio is increased as the vehicle speed increases.

It is an object of the present invention to provide a system for selectively limiting the range of authority of a rear wheel steering gear.

It is an advantage of the present invention that a steering system according to this invention will have a limited capacity to steer the rear wheels once the vehicle has exceeded a threshold speed.

It is a further advantage of the present invention that a rear wheel steering gear according to this invention will not impair vehicle control even if the steering gear's control system becomes disable.

The present invention relates to a steering system for the rear wheels of a vehicle having a longitudinal axis, comprising an electric motor driven, dual-range steering gear for steering said rear wheels. Such dual-range steering gears are known; they are operable within greater and lesser angular steering ranges, with each such angular range having a different predetermined maximum steering angle, control means being provided for operating said steering gears, with said control means comprising means for sensing at least one vehicle operating parameter. According to the present invention, said steering system comprises means responsive to said at least one vehicle operating parameter for permitting said steering gear to extend only to the maximum steering angle of said lesser angular steering range in the event that a threshold of said at least one vehicle operating parameter has been exceeded, said means comprising at least one electromechanical travel limitation block adapted to positively engage a sliding member contained within said steering gear so that when said at least one vehicle operating threshold has been exceeded said travel limiting block engages said sliding member to permit said steering gear to extend only to said maximum steering angle of said lesser angular steering range.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a steering system for the rear wheels of a vehicle according to the present invention.

Figure 2 is a cutaway view of a rear steering gear according to the present invention.

Figure 3 is a block diagram showing the major component parts of the system according to the present invention.
As shown in Figure 1, rear steering gear 10 is coupled to a pair of spindles, 16, by means of tie rods, 14. Accordingly, as the tie rods are driven reciprocally by steering gear 10, road wheels 12 will be caused to rotate about the kingpin axes defined by ball joints 18 and as a result road wheels 12 will be steered by steering gear 10.

Figure 2 illustrates the internal parts of a steering gear suitable for use with a system according to the present invention. Those skilled in the art will appreciate that a system according to the present invention would be useful not only with the illustrated gear but also with other types of steering gears employing hydraulic, mechanical or electrical operating systems and prime movers.

The steering gear shown in Figure 2 has an electrically driven prime mover. Accordingly, motor 20 drives motor pinion 22, which in turn meshes with face gear 24. The face gear is mounted to a common shaft with rack pinion 26, which in turn meshes with teeth formed on rack 28. Accordingly, as motor 20 revolves, rack 28 will reciprocate. An inner tie rod end, 40, is mounted at either end of rack 28. These tie rod ends allow tie rods 14 to be mounted to steering gear 10.

During operation of a rear wheel steering system according to this invention, control module 18 (Figure 3) will receive inputs from rear steering gear position sensor 42, which in this case comprise a linear variable differential transformer (LVDT). The LVDT is coupled between rack 28 and the steering gear’s housing so that reciprocation of the rack will be accompanied by a change in the voltage level of the signal which is output by the LVDT. Control module 18 also receives inputs from front steering gear position sensor 44, vehicle speed sensor 46 and transmission gear sensor 48. Those skilled in the art will appreciate in view of this disclosure that a system according to the present invention could be employed with or without speed sensor 46 or transmission gear sensor 48. It will be further appreciated that a system according to the present invention could be employed with yet other types of sensors capable of detecting appropriate vehicular operating parameters.

As is further shown in Figure 3, control module 18 provides control signals to rear steering gear drive motor 20. In the normal course of events, control module 18 senses the front steering gear position and speed or transmission gear being used and provides a rear steering signal. A number of known control strategies have been employed for determining a desired angular steering position of the rear roadwheels required for any particular front wheel steering position at a given speed or other vehicular operating condition. As an example, it is known to steer the rear wheels in phase at high speeds and out of phase at lower vehicle speeds. At lower vehicle speeds, rear wheel steering is usually subject to a greater angular range of authority. For example, at low speeds, it is known to steer the rear wheels with some systems in excess of 5° from the straight-ahead position. At high speeds, however, the steering of the rear wheels at 5° could seriously impair the stability of the vehicle. The present invention provides a means for positively preventing the steering gear’s motor drive or other prime mover from exceeding the maximum steering angle corresponding to a lesser range, for example 1.5° of steering angle, in the event that a threshold speed has been exceeded. Those skilled in the art will appreciate in view of the disclosure that with certain chassis combinations it may be desirable to provide a first threshold, for example, 10 mph, for limiting rear wheel capability in the forward direction, but perhaps a lower threshold, for example, 5 mph, for limiting rear wheel steering while operating the vehicle in the reverse direction.

One example of a limit mechanism for impeding the motion of a rear steering gear according to the present invention comprises the electromechanical travel limiting blocks or solenoids, 30, illustrated in Figure 2. Each travel limiting solenoid comprises a coil, 32, which acts upon a plunger, 34. Each plunger has a crown 36 applied thereto. The plunger and crown are biased into the blocking position by means of biasing springs 38. Accordingly, in the event that no signal is received by coil 32 from control module 18, each travel limiting solenoid will automatically be urged into the limiting position by means of biasing springs 38. As a result, if the wiring connections between travel limiting solenoids 30 and control module 18 become compromised — e.g., open circuited, the travel limiting solenoids will be automatically applied.

As previously noted, control module 18 will receive vehicle speed information from speed sensor 46 and transmission gear selection information from transmission gear sensor 48. Accordingly, in the event that the vehicle speed is less than a threshold which is appropriate for the chosen direction of movement, whether forward or reverse, travel limiting solenoids 30 will be energised, thereby removing crowns 36 from the path of inner tie rod ends 40. If, however, the vehicle speed exceeds a given threshold appropriate for the direction of movement, power will not be provided to the travel limiting solenoids and, as a result, the maximum steering angle will be limited to a lesser angular range. This control scheme thus operates the rear steering gear as a dual range steering gear with greater and lesser angular ranges of authority, with each range corresponding to a different predetermined maximum rear wheel steering angle. It has
been determined that a maximum steering angle of 5°/right or left (out of phase) is appropriate for certain passenger vehicles operating at low speeds, whereas the travel limiting mechanism has been useful for limiting the maximum steering angle to 1.5°/right or left, (in phase) at higher speeds. Accordingly, once the threshold speed has been exceeded, travel limiting solenoids 30 will be de-energised and crowns 36 will be deployed, with the consequence that steering gear motor 20 will be overridden and will therefore be incapable of steering roadwheels 12 in excess of the limited 1.5° range of authority allowed by the travel limiting solenoids. Limiting the range of authority to 1.5° will allow the driver of the vehicle to maintain control over the vehicle even should the rear steering gear control system fail.

Claims

1. A steering system for the rear wheels (12) of a vehicle having a longitudinal axis, comprising an electric motor driven, dual-range steering gear (10) for steering said rear wheels (12), with said steering gear being operable within greater and lesser angular steering ranges, with each such angular range having a different predetermined maximum steering angle, and control means (18) for operating said steering gear, with said control means (18) comprising, means (44,46,48) for sensing at least one vehicle operating parameter (44,46,48), and means responsive to said at least one vehicle operating parameter for permitting said steering gear to extend only to the maximum steering angle of said lesser angular steering range in the event that a threshold of said at least one vehicle operating parameter has been exceeded, said means comprising at least one electromechanical travel limitation block (30) adapted to positively engage a sliding member (40) contained within said steering gear so that when said at least one vehicle operating threshold has been exceeded said travel limiting block (30) engages said sliding member (40) to permit said steering gear to extend only to said maximum steering angle of said lesser angular steering range.

2. A steering system according to claim 1, wherein said at least one vehicle operating parameter comprises the velocity of said vehicle, so that the steering capability of said motor drive will be limited according to the velocity of said vehicle.

3. A steering system according to claim 1, wherein said at least one vehicle operating parameter comprises the transmission gear in which the vehicle is being operated, so that the steering capability of said motor drive will be limited according to a transmission operating condition.

4. A steering system according to claim 1, wherein said at least one vehicle operating parameter comprises the velocity of said vehicle, as well as the transmission gear in which the vehicle is being operated, so that the steering capability of said motor drive will be limited according to the velocity of said vehicle and according to the transmission gear in which the vehicle is being operated.

5. A steering system according to claim 1, wherein said steering gear (10) comprises an electric motor (20) driving a gearset (22,24,26,28) operatively connected with said wheels (12).

6. A steering system according to claim 2, wherein the magnitude of said threshold vehicle velocity is dependent upon the direction of travel of said vehicle.

7. A steering system according to claim 1, wherein said at least one electromechanical travel limiting block (30) comprises a solenoid including a coil (32), a plunger (34), a crown disposed (36) on said plunger and adapted to engage said sliding member (40), and a biasing spring (38).

8. A steering system according to claim 1, wherein said maximum steering angle of said greater angular steering range extends five degrees laterally from the longitudinal axis of said vehicle.

9. A steering system according to claim 1, wherein said maximum steering angle of said lesser angular steering range extends one and one-half degrees laterally from the longitudinal axis of said vehicle.

Patentansprüche

1. Lenksystem für die Hinterländer (12) eines Fahrzeuges mit einer Längsachse, ein über einen Elektromotor angetriebenes Zweiblehr-Lenkgetriebe (10) zur Lenkung der besagten Hinterländer (12) enthaltend, wobei besagtes Lenkgetriebe in größeren und kleineren Lenkwinkelbereichen betrieben werden kann, wobei jeder dieser Lenkwinkelbereiche einen anderen vorbestimmten maximalen Lenk-
schlagwinkel aufweist, sowie Steuermittel (18) zur Steuerung des besagten Lenkgetriebes, wobei besagte Steuermittel (18) Mittel (44, 46, 48) zum Abtasten wenigstens eines der Fahrzeugbetriebsparameter (44, 46, 48) aufweist, und auf besagten wenigstens einen Fahrzeugbetriebsparameter ansprechende Mittel, welche ermöglichen, daß besagtes Lenkgetriebe nur den maximalen Lenkeinschlagwinkel des besagten kleineren Lenkzwecke erreicht, wenn ein Schwellenwert des besagten wenigstens einen Fahrzeugbetriebsparameters über- schritten worden ist, wobei besagte Mittel wenigstens einen elektromechanischen Ausschlagbegrenzungsblock (30) aufweisen, der geeignet ist, mit dem in dem besagten Lenkgetriebe enthaltenen Gleitelement (40) in Zwangseingriff zu treten, so daß, wenn der besagte wenigstens eine Fahrzeugbetriebsparameter überschritten worden ist, der besagte Ausschlagbegrenzungsblock (30) mit besagtem Gleitelement (40) in Eingriff gelangt, so daß er dem besagten Lenkgetriebe erlaubt, nur den besagten maximalen Lenkeinschlagwinkel des besagten kleineren Lenkzwecke zu erreichen.

2. Lenksystem nach Anspruch 1, worin besagter wenigstens ein Fahrzeugbetriebsparameter die Geschwindigkeit des besagten Fahrzeuges beinhaltet, so daß das Lenkvermögen des besagten Antriebsohrs entsprechend der Geschwindigkeit des besagten Fahrzeuges begrenzt wird.

3. Lenksystem nach Anspruch 1, worin besagter wenigstens ein Fahrzeugbetriebsparameter den Getriebegang beinhaltet, in welchem das Fahrzeug betrieben wird, so daß das Lenkvermögen des besagten Antriebsohrs entsprechend einer Betriebsbedingung des Getriebes begrenzt wird.

4. Lenksystem nach Anspruch 1, worin besagter wenigstens ein Fahrzeugbetriebsparameter die Geschwindigkeit des besagten Fahrzeuges sowie den Getriebegang beinhaltet, in welchem das Fahrzeug betrieben wird, so daß das Lenkvermögen des besagten Antriebsohrs entsprechend der Geschwindigkeit des besagten Fahrzeuges und entsprechend des Getriebeganges, in welchem das Fahrzeug betrieben wird, begrenzt wird.

5. Lenksystem nach Anspruch 1, worin besagtes Lenkgetriebe (10) einen Elektromotor (20) aufweist, welcher einen betriebsmäßig mit besagten Rädern (12) verbundenen Zahnradssatz (22, 24, 26, 28) enthält.


7. Lenksystem nach Anspruch 1, worin besagter wenigstens ein elektromechanischer Ausschlagbegrenzungsblock (30) einen Elektromagnet mit einer Wicklung (32), einem Tauchkern (34), einer auf besagtem Tauchkern angeordneten und für den Eingriff in besagtes Gleitelement (40) ausgelegten Krone (36), und einer Vorspannfeder (38).

8. Lenksystem nach Anspruch 1, worin besagter maximaler Lenkeinschlagwinkel des besagten größeren Lenkzwecke bis zu einem Ausschlag von fünf Grad seitlich von der Längsachse des besagten Fahrzeuges reicht.

9. Lenksystem nach Anspruch 1, worin besagter maximaler Lenkeinschlagwinkel des besagten kleineren Lenkzwecke bis zu einem Ausschlag von einerhalb Grad seitlich von der Längsachse des besagten Fahrzeuges reicht.

**Revendications**

1. Système de direction pour les roues arrière (12) d'un véhicule ayant un axe longitudinal, comprenant un mécanisme de direction (10) à deux plaques de braquage entraîné par un moteur électrique destiné à diriger lesdites roues arrière (12), ledit mécanisme de direction pouvant être actionné selon des plaques de direction angulaires plus ou moins grandes, chaque plaque angulaire ayant un angle de braquage maximal prédéterminé, et des moyens de commande (18) destinés à actionner ledit mécanisme de commande, ledits moyens de commande (18) comprenant des moyens (44, 46, 48) destinés à capter au moins un paramètre de fonctionnement du véhicule (44, 46, 48) et des moyens répondant audit au moins un paramètre de fonctionnement destinés à permettre audit mécanisme de direction de s'étendre uniquement à l'angle de braquage maximal de ladite plaque de direction angulaire inférieure au cas où une valeur seuil dudit au moins un paramètre de fonctionnement du véhicule est dépassée, ledits moyens comprenant au moins un bloc de limitation de déplacement électromécanique (30) destiné à engager de manière positive un élément coulissant (40) contenu dans ledit mécanisme de direction, de sorte que lorsque ladite au moins
une valeur seuil de fonctionnement du véhicule est dépassée, ledit bloc de limitation de déplacement (30) s'engage avec ledit élément coulissant (40) afin de permettre audit mécanisme de direction de s'étendre uniquement audit angle de braquage maximal de ladite plage de direction angulaire inférieure.

2. Système de direction selon la revendication 1, dans lequel ledit au moins un paramètre de fonctionnement du véhicule comprend la vitesse dudit véhicule, de sorte que la capacité de direction dudit entraînement moteur sera limitée en fonction de la vitesse dudit véhicule.

3. Système de direction selon la revendication 1, dans lequel ledit au moins un paramètre de fonctionnement du véhicule comprend le mécanisme de direction dans lequel le véhicule est actionné, de sorte que la capacité de direction dudit entraînement moteur sera limitée en fonction des conditions de fonctionnement de la transmission.

4. Système de direction selon la revendication 1, dans lequel ledit au moins un paramètre de fonctionnement du véhicule comprend la vitesse du véhicule, de même que le rapport de transmission dans lequel le véhicule est actionné, de sorte que la capacité de direction dudit entraînement moteur sera limitée en fonction de la vitesse du véhicule et en fonction du mécanisme de direction dans lequel le véhicule est actionné.

5. Système de direction selon la revendication 1, dans lequel ledit mécanisme de direction (10) comprend un moteur électrique (20) entraînant une commande centrale (22,24,26,28) reliée de manière active aux dites roues (12).

6. Système de direction selon la revendication 2, dans lequel la magnitude de ladite vitesse seuil du véhicule dépend du sens du déplacement dudit véhicule.

7. Système de direction selon la revendication 1, dans lequel ledit au moins un bloc de limitation de déplacement électromécanique (30) comprend un solénoïde incluant une bobine (32), un piston (34), une couronne (36) déposée sur ledit piston et destinée à s'engager avec ledit élément coulissant (40) et un ressort de chargement (38).

8. Système de direction selon la revendication 1, dans lequel ledit angle de braquage maximal de ladite plage de direction angulaire supérieure s'étend de cinq degrés latéralement depuis l'axe longitudinal dudit véhicule.

9. Système de direction selon la revendication 1, dans lequel ledit angle de braquage maximal de ladite plage de direction angulaire inférieure s'étend de un degré et demi latéralement depuis ledit axe longitudinal du véhicule.