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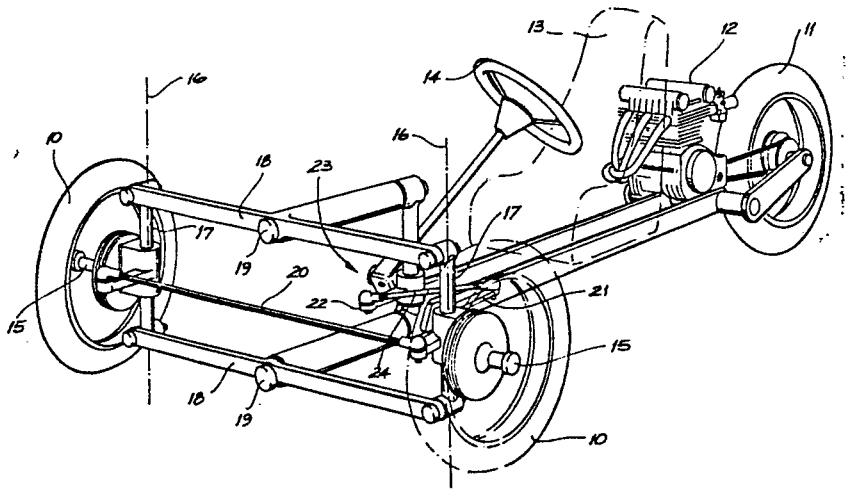
(54) Title: SELF STABILIZING CAMBERING VEHICLE



(57) Abstract

Three or four wheeled vehicle which leans into corners so as to remain stable even when the vehicle has a narrow track. The steering mechanism is such that leaning of the vehicle to either respective side of the vertical causes the front steering wheels (10) to turn in the same steering direction, e.g. a lean to the left causes an anticlockwise, when viewed from above, turning of the front wheels (10). The front wheels (10) can be supported on a parallelogram linkage system (17, 18) so that the steering axis (16) of the wheels (10) remain parallel with the vehicle body as the vehicle leans. Steering can be controlled through a steering wheel (14) which, disregarding the influence of body lean, turns the front wheels (10) in a steering direction relative to the turn of the steering wheel which is opposite in sense, e.g. an anticlockwise turn of the steering wheel (14) produces a clockwise turn, when viewed from above, of the front wheels (10). In order to produce a predetermined steering characteristic the ratio between the angle of lean of the vehicle and the responsive angle of turn of the front wheels (10) varies with the forward velocity of the vehicle.

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"SELF STABILIZING CAMBERING VEHICLE"

Technical Field

The invention relates to road-going vehicles which are designed for optimum weight distribution during cornering by cambering or leaning the vehicle towards the centre of the turn at an angle appropriate to the cornering force.

Background Art

A number of vehicles have been produced which attempt to maintain full cornering stability by including mechanisms which lean the body of the vehicle to the inside of a turn. The mechanisms for leaning the vehicle have varied considerably and include computer controlled electro-servo, pneumatic and hydraulic systems supported by a fairly conventional three or four-wheeled chassis. Such an arrangement takes all responsibility of the amount of lean of the vehicle from the driver leaving the driver free to concentrate only on the amount of turn required and not the balance of the vehicle. Another system in the prior art is similar to that previously described except that the lean is controlled physically by the driver, for example, by pushing against pedals which are connected so as to produce a responsive body lean. In such a system the responsibility of controlling the balance, or lean of the body, is with the driver.

In general the prior art vehicles, including the two general types described above, either possess no inherent stability or obtain some degree of stability in systems more prone to failure than purely mechanical systems.

Disclosure of the Invention

It is therefore an object of the present invention to provide a self stabilizing cambering vehicle which will ameliorate disadvantages of the prior art.

Accordingly, one broad form of the invention may be said to provide a vehicle comprising:

a generally longitudinal body; at least two laterally spaced apart front wheels; at least two steering pivot structures, one for each respective front wheel, allowing side to side steering movement of the front wheels; leaning linkage structure between the body and the front wheels providing interdependent side to side leaning of the body and wheels relative to the ground; a steering control having control movements corresponding to respective left and right direction turns of the vehicle; steering control linkage structures between the steering control and the steering pivot structures such that control movements cause an increase in the turning of the front wheels in a steering direction of opposite sense to the corresponding direction of the control movement; lean-steer linkage structures between the steering pivot structures and the body such that a leaning movement of the body causes an increase in the turning of the wheels in a steering direction of the same sense as the direction of leaning movement; wherein the total angle of turn of the front wheels corresponds to the algebraic sum of the respective angles of turn of the front wheels resulting from the respective total control movement and body lean angle.

Alternatively the invention can be exemplified in a vehicle executing a right turn, the vehicle including:

at least two front wheels steerable about steering pivot structures; a steering control and steering linkage structure between the steering control and the pivot structures such that movement of the steering control corresponding to a right turn causes steering displacement of the pivot structures to the left; leaning linkage structure between the body and the front wheel pivot structures such that the body and the pivot structures all lean relative to the horizontal towards the right as the front wheels move out to the left; and lean-steer linkage

structures between the body and the pivot structures such that as the vehicle deviates from the straight path the lean steer linkage structures increase the pivoting of the front wheels to the right so as to reduce a radius of turn of the vehicle to the right independent of the pivoting resulting from operation of the steering control.

In the above description, and throughout the specification, a steering turn of the front wheels or the steering control will be taken as being in the left direction if the turn is anticlockwise when viewed from above and in the right direction if clockwise when viewed from above.

It is preferable that the steering control is a steering wheel.

In a particular embodiment the front wheels are supported by a linkage system (optionally a parallelogram linkage system) maintaining the rotary axes of the wheels at a constant relative angle (normally zero) while allowing lean of the front wheels relative to the ground surface. The body is attached to the linkage system in a manner allowing the lean of the body in a controlled relationship with the wheels relative to the ground surface. The body optionally leans at a greater rate than the wheels.

One method of obtaining the necessary steering mechanism performance includes the steering mechanism being attached to the body so as to lean with the body. The steering mechanism output includes an output arm and at least one of the front wheels includes a lever arm pivotally attached to the output arm by a tie rod. The pivoted attachment of the tie rod to the output arm is closer to the ground surface than is the pivotal attachment of the tie rod to the lever arm if the lever arm is behind the steering axis and vice versa if the lever arm is in front of the steering axis.

It is further preferred that a vehicle in accordance with the invention operates as described above only at normal operating speeds. When stationary or travelling at very low speed the body and front wheels are preferably locked so that they remain vertical, thus negating the need for the driver's feet to be placed on the ground as is the case in a motorcycle.

Brief Description of the Drawings

Fig. 1 is a schematic representation of a simple embodiment of the invention; and

Fig. 2 is a schematic representation of a portion of a body locking mechanism of an improved embodiment of the invention.

Best Mode for Carrying Out the Invention

The concept of a vehicle in accordance with the invention will be described with reference to the embodiment of Fig. 1. The embodiment includes two front wheels 10 and a rear wheel 11 driven by motor 12. A control position includes a seat 13 and a steering wheel 14. The front wheels rotate about respective axles 15 when the vehicle is moving. The front wheels also pivot about respective steering axes 16. The steering axes 16 are defined in lateral end members 17 of a parallelogram linkage system further including transverse members 18. The mutual joints between the members 17 and 18 pivot about axes parallel to the longitudinal axis of the vehicle. The bulk of the vehicle including the motor 12, rear wheel 11, seat 13 and steering wheel 14, are pivotally attached to the transverse members 18 at points 19 so that the general plane of the parallelogram linkage system remains transverse to the vehicle as a whole while the vehicle will lean to either side simultaneously with the lateral end members 17.

A tie rod 20 maintains the two front wheels 10 in steering alignment. One of the wheels 10 has a lever arm

21 running rearwardly of the steering axis 16. The steering wheel 14 is attached to a steering mechanism 23 which is constrained to lean with the vehicle and includes an output arm 22 extending in a forward direction. A tie rod 24 extends between the output arm 22 and the lever arm 21, the output arm 22 being closer to the ground than lever arm 21.

At normal forward speed a left turning force applied to the steering wheel 14 will result in a right turning force applied to the front wheels 10. As with a motorcycle, or bicycle, such action results in the vehicle leaning to the left. As the vehicle leans to the left the lever arm 21, being relatively distant from the ground, travels to the left through a longer arc than does the output arm 22 which is relatively close to the ground. The fixed length of the tie rod 24 therefore results in the turning of the front wheels 10 in a left direction if the steering wheel 14 is held stationary. The vertical height of the output arm 22 may be adjusted according to the speed of the vehicle, and the characteristics of individual vehicles, so that a turn at any operating speed is achieved by a simple smooth turn of the steering wheel 14 in the desired conventional direction. The radius of the turn will be dictated by the amount of turn of the steering wheel 14. This arrangement provides lean stability under all operating conditions with no driver input required. Any external leaning force tending to alter the lean from its currently stable angle causes additional vehicle lean which in turn produces a turn of the wheels in the direction of the additional lean and of an amount sufficient to cause correction of the leaning. Of course, a movement of the steering wheel will alter the actual angle, and therefore the radius of turn, at which this lean stability occurs.

One problem of a cambering vehicle is maintaining

stability at very low speeds. In Fig. 2 there is schematically shown a suitable device for preventing the vehicle from leaning, which can be used when the vehicle is stationary or travelling at very low speed in order to maintain stability. Attached to the lower horizontal member 18 of the parallelogram linkage is an arcuate portion 25 of a gear wheel. As will be appreciated after considering parallelogram linkage of Fig. 1, any point on the upper transverse member 18 will rotate about a circular path centred on a point of the lower transverse member 18 during leaning action of the vehicle. Thus the radius of the arcuate member 25 is such that its centre of curvature is a point in the lower member 18. Attached to the upper member 18 is a longitudinally movable catch 26 which is positioned and shaped so as to be engageable with teeth of the arcuate member 25. The leading edge of the catch 26 may be tapered so as to allow ease of alignment of the catch 26 and arcuate member 25. When the vehicle is at standstill the catch 26 will be engaged with the arcuate member 25 so as to lock the vehicle in a preferably vertical attitude. Once a driver starts to move the vehicle towards normal operating speeds the catch 26 is withdrawn from the member 25 so as to allow normal operation of the steering mechanism. Upon slowing down to very low speed or a complete stop the catch 26 is engaged in the arcuate member 25 preferably at a time when the vehicle is in a vertical attitude. In the low speed steering mode it is preferred to reverse the steering wheel action so that a turning force applied to the wheel in a conventional direction results in a steering turn of the front wheels in a similar conventional direction. This change of steering operation could, for example, be obtained by using a geared transmission between the steering wheel 14 and the steering mechanism 23, the geared transmission running through an engageable/

disengageable idler gear. Such reversing mechanisms are well known in the general engineering field and will not be described herein.

The cornering force applied to the vehicle (centripetal force) is dependent upon the radius of the turn and the square of the forward speed. Thus, if a predetermined response characteristic to steering wheel input is to be maintained the ratio of the angle of the lean to the resulting angle of turn of the front wheels (with no further movement of the steering wheel) must be gradually increased in relation to the increasing forward speed of the vehicle. This change of ratio can be obtained by appropriate raising and lowering of the steering mechanism 23 in accordance with the change of the speed of the vehicle.

Thus the invention allows the construction of a vehicle which can be fully enclosed for weather and accident protection as in a conventional motor car, but further possesses the advantages in cornering of a motor cycle being better weight distribution and the absence of a transverse force applied to the driver, while retaining conventional motor car steering controls and avoiding the more complex reverse steering characteristic of the motor cycle. Moreover, this invention provides these advantages by simple mechanical means which are not prone to failure as are more complex electrically controlled vehicles which have in the past attempted to obtain these results.

Although described with reference to a wheeled vehicle the invention has broader application. Snow water and ice borne vehicles having a pair of front skies or pontoons can also embody the invention.

CLAIMS

1. A vehicle comprising:

a generally longitudinal body; at least two laterally spaced apart front wheels; at least two steering pivot structures, one for each respective front wheel, allowing side to side steering movement of the front wheels; leaning linkage structure between the body and the front wheels providing interdependent side to side leaning of the body and wheels relative to the ground; a steering control having control movements corresponding to respective left and right direction turns of the vehicle; steering control linkage structures between the steering control and the steering pivot structures such that control movements cause an increase in the turning of the front wheels in a steering direction of opposite sense to the corresponding direction of the control movement; lean-steer linkage structures between the steering pivot structures and the body such that a leaning movement of the body causes an increase in the turning of the wheels in a steering direction of the same sense as the direction of leaning movement; wherein the total angle of turn of the front wheels corresponds to the algebraic sum of the respective angles of turn of the front wheels resulting from the respective total control movement and body lean angle.

2. A vehicle as in claim 1 further comprising a transversely running linkage system with transverse members and lateral-end members pivoted therebetween, a wheel axle extending outwardly from each lateral end member and rotatably supporting a respective said front wheel.

3. A vehicle as in claim 2, wherein a vehicle body is attached to the linkage system in a manner maintaining a lean of the body in a predetermined relationship to a lean in the front wheels and attached lateral-end members.

4. A vehicle as in claim 3, wherein the predetermined relationship is such that the angle of lean of the wheels from the vertical is less than the angle of lean of the body excepting that when the angle of lean equals zero both the body and wheels are vertical.

5. A vehicle as in claim 1, wherein the steering control is a steering wheel.

6. A vehicle as in claim 1, wherein the ratio of the angle of the lean to the pivoting of the front wheels varies with the forward speed of the vehicle so that at varying speeds and in varying radius turns a predetermined response to steering control input is maintained.

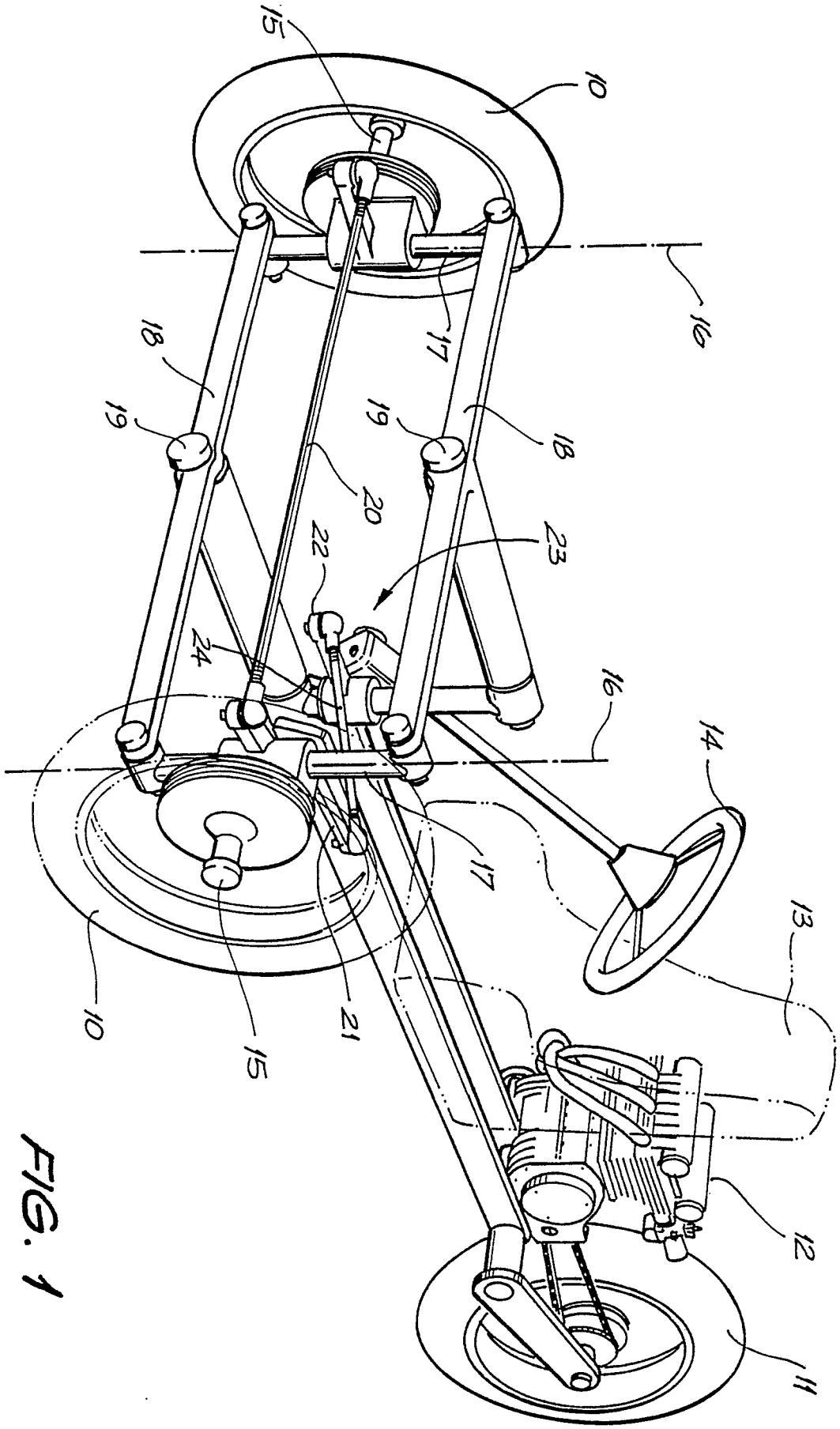

FIG. 1

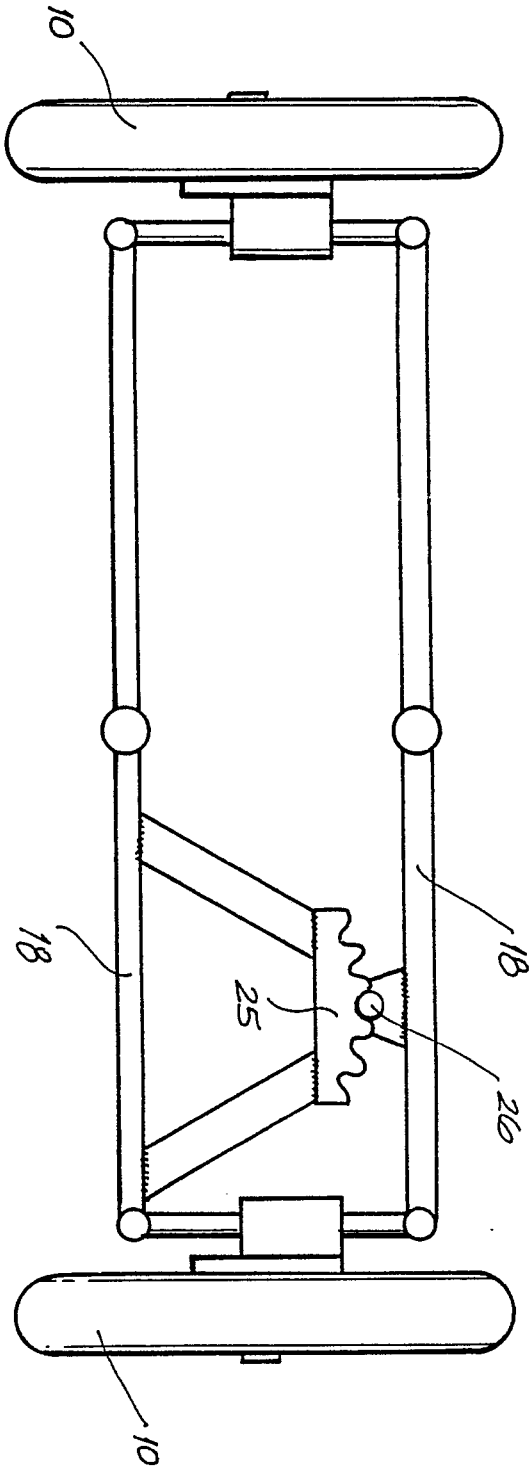

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 86/00347

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] B62D 9/02

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B62D 9/02, 9/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US,A, 4550926 (MACISAAC) 5 November 1985 (05.11.85)	
A	GB,A, 2155411 (HONDA GIKEN KOGYO K.K.) 25 September 1985 (25.09.85)	
A	DE,A, 2455183 (CARSTON) 26 May 1976 (26.05.76)	
A	DE,A, 452792 (DRESDEN) 19 November 1927 (19.11.27)	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
10 February 1987 (10.02.87)	(19.02.87) 19 FEBRUARY 1987
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	P. WARD

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU **86/00347**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
US 4550926	EP 163382	JP 60219107	
GB 2155411	AU 38941/85	FR 2562479	JP 60176803
	US 4632413	JP 60179318	US 4632413

END OF ANNEX