

Design and Manufacturing of Tilting Trike Tiltra Msx-1

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ABSTRACT : A tilting preferably three wheel, vehicle is disclosed that has a tilting mechanism that allows the vehicle to have leaning characteristics substantially similar to those offered by an inline two wheel vehicle, but that does not require complex linkages or control system to operate effectively. A tilting linkage is operably secured to a frame to allow a pair of spaced apart wheel to remain substantially aligned with the plane of the vehicle throughout its range of movements while still allowing the steering axes of each wheel to intersect the vertical center line of each wheel. The linkage also allows caster angle of each wheel's pivot axes can be optimized independently of the angle of vehicle's handle bar steering shaft.

KEYWORDS: Steering Axes , Wheel ,Three Wheeled Vehicle

I. INTRODUCTION

A three wheeled vehicle, with two steerable front wheels and a driven rear wheel which may be either rider- or motor-powdered, includes steering/coupling linkage disposed adjacent to the lower end of a steering column having a handle bar attached to its upper end. A three wheeled vehicle, with two steerable front wheels and a driven rear wheel which may be either rider- or motor-powdered, includes steering/coupling linkage disposed adjacent to the lower end of a steering column having a handlebar attached to its upper end. The steering/coupling linkage pivotally couples a forward frame to a rear frame which supports the rider and includes the rear wheel and its means for propulsion. The steering/coupling linkage includes a pivot shaft, a bearing housing and a mechanical connection for leaning the rear frame in the direction of a turn so as to compensate for centrifugal force encountered in turning the vehicle.

The mechanical connection causes the rear frame to lean in a controlled relationship to the amount of rotation of the steering shaft, within rotational limits, to emulate the leaning action of a conventional bike when making a turn.

II. NEED OF PROJECT

The present arrangement overcomes the cornering problems of vehicle by counteracting the centrifugal force exerted upon a vehicle and its rider during a turn. In the present invention the seat moving inward in relation to the amount of turn shifts the center of gravity of the rider inward from a line between where the rear wheel and the outer front wheel contact the road so that the rider's weight has a greater anti-rotational force about the aforementioned line to permit a greater centrifugal force on the rider without the vehicle tipping over or the rider falling outward.

Also, in the present invention centrifugal force acting on the rider moves him outward, causing the rear frame to rotate and the front wheels to swing back so as to lessen the sharpness of the turn and prevent the vehicle from rolling over.

The present vehicle may be used in combination with the rear portion of a conventional bicycle having a five- or ten-speed transmission with available derailed and caliper brakes.

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III. PRESENT SCENARIO

Three-wheel vehicle having a frame pivotally connected to a two-wheel rear suspension assembly, and drive train structured in such a way that, the frame and the front wheel can lean into a corner while the two rear wheels remain substantially vertical. In addition to having the frame lean into a corner while turning a leaning vehicle, the two front or rear wheels of the leaning vehicle may also tilt in the same direction as the frame to reflect the general behavior of a motorcycle. In order to allow the two front or rear wheels to lean to one side or the other, the suspension assembly must be connected to the wheels in such a manner that the suspension components do not interfere with the leaning wheels. An improvement of the vehicle disclosed in U.S. Pat. No. 6,328,125 in which the two rear wheels can lean into a corner is disclosed in U.S. Pat. No. 6,863,288 also to Van Den Brink et al. US Pat Application No. 2005/0167174 A1 discloses a relatively complex front suspension and steering system for a leaning vehicle equipped with a pair of independent front upright suspensions mounted on an 'articulated quadrilateral structure' adapted to tilt the front wheels with the frame when negotiating a curve. The disclosed suspension is adapted to allow the front wheels to independently move up and down while simultaneously remaining parallel to each other and to the frame when the vehicle is leaning into a corner like a motorcycle. This suspension system is bulky and complex and it is specifically designed for two front wheels that are relatively close to one another. This type of suspension would be difficult to employ on a larger vehicle in which the wheels are farther apart.

Another well-known type of front suspension assembly used in leaning vehicles in which the front wheels tilt into the corner is the double A-arm type front suspension. The double A-arm type suspension is adapted to transmit the leaning motion of the vehicle frame to the wheels by virtue of its substantially parallel upper and lower A-arms connected to upper and lower points of the wheels respectively. When the vehicle leans into a right corner for instance, the right upper A-arm pushes on the upper point of the right wheel while the right lower A-arm pulls on the lower point of the right wheel thereby tilting the right wheel towards the corner. At the same time, the left upper A-arm pulls on the upper point of the left wheel while the left lower A-arm pushes on the lower point of the left wheel thereby tilting the left wheel towards the right corner as well. One such vehicle is the Mercedes F300 Life Jet which was first unveiled at the 1997 Frankfurt Motor Show (Germany) but never reached production. This type of front suspension with the appropriate tilting connections allows the wheels and frame to lean, however the angle to which the wheels can lean and thus the angle to which the vehicle frame can lean is limited. Furthermore, the left and right spring and shock absorber assemblies are directly involved in the leaning of the vehicle such that the suspension becomes less effective when the vehicle is leaning. Also, the displacements of multiple A-arms implies that the front of the vehicle must remain substantially free of other components to avoid interferences. Thus, there exists a need for a leaning vehicle having a two-wheel front suspension assembly that permits tilting of the wheels to a greater degree than that of the prior art leaning vehicles and that remains effective when the vehicle is leaning into a corner.

IV. LITERATURE SURVEY

In one aspect, the present provides a leaning vehicle having a frame having a front portion and a rear portion; a straddle seat supported on the frame; an engine supported by the frame; a shock tower having an upper end and a lower end, the lower end of the shock tower being pivotally connected to the front portion of the frame through a pivotal connection that defines a frame leaning axis about which the frame can lean to a right side and to a left side relative to the shock tower; a front left suspension assembly and a front right suspension assembly operatively connected to the front portion of the frame; a steering assembly having a steering column supported by the frame, the steering column being operatively connected to a handlebar to be grasped by a driver straddled on the straddle seat to steer the vehicle in a desired direction; and a rear suspension connected to the rear portion of the frame. Each front suspension assembly includes a lower suspension arm pivotally connected to the frame at a first end and pivotally connected to a ground engaging member at a second end; and a shock absorber having an upper end connected to the upper end of the shock tower and a lower end connected to the lower suspension arm. An actuated lock locks the frame to the shock tower and prevents relative movement between the frame and the shock tower about the frame leaning axis.

In an additional aspect, the actuated lock includes a locking pin adapted to engage a notch plate having at least one notch. The locking pin is mounted to at least one of the frame and the shock tower. The notch plate is mounted to

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another one of the frame and the shock tower. When the locking pin engages the at least one notch, the frame is prevented from moving relative to the shock tower. In a further aspect, the notch plate includes a plurality of notches corresponding to a plurality of locking positions of the frame relative to the shock tower. In an additional aspect, an electronic control unit (ECU) operatively connected to the actuated lock. The ECU sends command signals to the actuated lock to lock and unlocks the frame relative to the shock tower. For the purposes of this application, terms used to locate elements on the vehicle such as front, back, rear, left, right, upper, lower, up, down, above and below are as they would normally be understood by a rider of the vehicle sitting on the vehicle in a forwardly facing, driving position. For the purposes of this application, the term "shock tower" means a supporting structure for a shock absorber assembly. Embodiments of the present invention each have at least one of the abovementioned aspects, but not necessarily have all of them. Additional and/or alternative objects, features, aspects and advantages of the embodiments of the present invention will become apparent from the following description, the accompanying drawings and the appended claims. A brake disk 138 shown in dotted lines is fixed to rotate with the hub. A brake caliper is fixed to be stationary with the spindle. When the caliper applies a braking force to the disc brake to reduce the rotational speed of hub and thus wheel, the spindle is subjected to a torque in the direction of the arrow T (for a forward travelling direction of the vehicle). Because of the orientation of the axis and because the T-joint cannot rotate in the direction of the torque T relative to the lower suspension arm, all of the torque T will be transferred to the lower suspension arm. As mentioned above, the ball joint connections of the leaning rod do not resist any torque generated during braking, thus all the torque must be resisted by the lower suspension arm. Having all the braking forces pass through the lower suspension arm permits the leaning rod to have a small diameter and occupy very little longitudinal space when compared to an upper A-arm of a conventional double A-arm suspension designed to withstand braking forces such as lower suspension arm. This leaves ample space for the wheel to tilt inwards without contacting other components, particularly when simultaneously steering the wheel through large steering angles. This design also allows for the necessary space to easily mount the shock absorber to the shock tower prior art designs having two A-arms, one situated above the other, allow the arms to be smaller since the torsion forces are distributed between the upper and lower A-arms. However this configuration limits the degree of leaning of the wheel. The single lower suspension arm of the present invention is bulkier than typical double A-arms systems but allows the leaning rod to be a small single rod thereby freeing space and allowing the wheels to lean farther than double A-arms systems. The present configuration allows for sufficient space for all the front suspension components to articulate, lean, tilt and turn without interfering with one another. The shock absorber lies in a horizontal plane substantially perpendicular to the frame leaning axis. The upright member of frame lies within a substantially vertical plane which is substantially parallel to plane in which the shock absorber lies. Leaning rod and steering rod also lie within substantially vertical planes which are also substantially parallel to planes and in which the shock absorber and the upright member of frame lie. It is to be understood that while the frame is leaning to the left or right, the wheels are also leaning to the left or right and could also be simultaneously turning. The leaning of the frame and the wheels lowers the steering and leaning rods toward the lower suspension arm. Keeping the components in their respective substantially vertical plane throughout the leaning process ensures no interference between each component. Although the simultaneously turning of the wheel about axis while leaning the wheels about axis will cause some longitudinal movement of the steering and leaning rods the longitudinal distance between the components combined with the components remaining in substantially vertical planes ensures that there is no interference between the components. With reference in operation, the driver turns the handlebars and leans the frame to the right side or left side in the direction of the arrow A to turn the vehicle, in a similar fashion to driving a two-wheeled motorcycle. The leaning rod, which is connected to the upright member of the frame at proximal end, applies a force to leaning arm of the spindle. This force causes the spindle to pivot at the T-joint about wheel tilting axis so that the wheel is forced to tilt in the same direction as the frame. The steering rod which is also connected to the upright member of the frame through the steering linkage, remains substantially parallel to the leaning rod such that no unwanted steering occurs while the vehicle is leaning. In a preferred embodiment, the wheel remains parallel to the frame (tilting right or left with respect with the ground) when the frame is leaning to the right or left, however the scope of the invention should not be so limited. In the preferred embodiment, the wheel tilting axis is parallel to the frame leaning axis 100. Although, does not illustrate the wheel and its tire, the curved portion of the lower suspension arm allows for clearance between the wheel and the suspension arm when the wheel is leaning to the right. Obviously, the same can be said for the left suspension arm when the vehicle is leaning to the left. As can be seen in, when the vehicle is leaning into a corner, the shock tower remains upright while the frame is pivoting about the leaning axis 100 such that the shock absorber assembly of the front suspension is not directly involved in the leaning

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motion of the frame as in prior art leaning vehicles with tilting wheels. The operation of the shock absorber assembly is independent of the leaning motion of the frame. The motion ratio between wheel and the shock absorber assembly remains substantially constant while the frame is leaning to provide unaltered wheel dampening while leaning into a corner and travelling over rough terrain at the same time. The motion ratio is the ratio between the vertical movement of the wheel and the stroke of the shock absorber. A person skilled in the art would recognize that a substantial change in motion ratio due to the leaning of the frame is not desirable.

In a partially assisted mode, the actuator which is connected to the upper end of the shock tower and to the lower member of the frame at pivot point restrains and dampens the leaning motion of the frame to provide a smooth transition and provide a limit or maximum leaning angle between the frame and the shock tower to prevent the vehicle from over leaning and damaging the suspension components. In a preferred embodiment, the maximum leaning angle ϕ is 50° but for safety and in absence of ECU we kept leaning angle 36° .

V. PROJECT SPECIFICATION

A three wheeled vehicle comprising:

- A right front steerable wheel and a left front steerable wheel disposed on respective sides of a central steering shaft having a handlebar attached thereto wherein each of said right and left front steerable wheels has a respective turning pivot;
- A rear wheel positioned on a rear axle and disposed aft of and between said two front wheels;
- A rider seat disposed intermediate said rear axle and said steering shaft, wherein said two front wheels including steering linkage disposed between their respective turning pivots and said central steering shaft;
- A front frame coupled to and supporting said two front wheels, said steering shaft, and steering linkage and said handlebar;
- A rear frame supporting a rider, said rear wheel, and a vehicle propulsion arrangement.
- A pivotable connection between said front frame and said rear frame.



Fig. 6.

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VEHICLE SPECIFICATIONS:

SR. NO.	PARTICULARS	SPECIFICATIONS
1	Vehicle Type	2-Wheel CVT Tadpole
2	Power	7.8BHp
3	Mechanical Dimensions L x W x H (mm)	1875 x 890 x 680
4	Engine	98cc
5	Leaning angle	36 degrees
6	Fuel	Petrol

Table No. 6.1

VI. MATERIAL SELECTION

Material selection is one of the most important aspects of the design procedure of the product or the system. The materials are selected as per the required properties required for the satisfactory performance of the product. The material selected should exhibit these properties satisfactorily, while the product is in operation.

The materials selected for various elements of the project depending upon their requirements are summarized as follows:

PART	PROPERTIES	MATERIAL
Square bar	To sustain load and high torque	M.S Black
Hub plate	Medium strength steel, good tensile strength.	EN 8
Steering Rod	Subjected to crushing load, high bending resistance.	M. S Bright Bar
Wheel	High tensile strength but should be economical.	M.S Black
Clamps	Ease in bending, fabrication and simple forming.	M.S Black
Frame	The material should sustain the compressive & shearing loads acting suddenly i.e. high compressive strength, economical, easily available.	Mild Steel

Table No. 7.1

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ADVANTAGE AND DISADVANTAGES

ADVANTAGES:

- It provides anti-skidding effect.
- Bike can be used for on road as well as for off road purpose.
- Tilting provided is maximum upto 36 degrees.
- Assembly is reliable.
- Bolt on assembly gives redundancy to use vehicle as per requirement.
- Rider is safe while taking sharp turn on the road cause possibility of skidding or falling of bike is almost negligible.
- Normal people can take experience of off road biking.
- Wet road driving with tadpole is easier than two wheel arrangement.

DISADVANTAGES:

- Whole weight of the vehicle increases.
- Fuel consumption increases.
- Stand of the bike is of no use because bike stands easily on three wheels.
- Weight shifting while turning is required.
- Slight misalignment can cause huge difference in turning of wheels.
- RTO Permissions are necessary in some reasons.

APPLICATION :

1. Off Road Driving.
2. Can be suited for Handicapped People.
3. Can be used in rainy season.

VII. CONCLUSION

- We have successfully achieved leaning of wheels upto 36 degrees along with reasonably good performance of trike on road as well as off road.
- The vehicle cornering ability is well tested and gave response as we desired.

REFERENCES

BOOKS:

1. "Design of Machine Element", V.B. Bhandari, Tata McGraw Hill, Third Edition.
2. "Design data book" PSG, KalaikathirAchchagam, 1978 Edition.
3. "Machine Design", R.S. Khurmi & J.K. Gupta, S Chand & Company Ltd., Fourteen Edition.
4. "Theory of Machines", R.S. Khurmi & J.K. Gupta, S Chand & Company Ltd., Fourteen Edition.
5. "Mechanical Engineering Design", Shigley J.E and Mischle C.K, Tata McGraw Hill.
6. "Automobile Engineering", Dr.KripalSingh, Vol 1 & 2, Standard Publication, 11th Edition.

PATENT FILES:

1. US 7967306 B2
2. US6554293 B1
3. US 8141890 B2
4. EP 1798081B1
5. EP2030814B1