

FRONT WHEEL DRIVE AND REAR WHEEL STEERED PEDAL-POWERED VEHICLE AND METHOD OF FORMING THE SAME

Background

In traditional current art bicycles the front wheel is steered and the drive is from the rear wheel. The head tube is set at an angle to the vertical resulting in the handle bar ends and wheel axle ends to rise and fall when turning. With the use of wider handlebars this rise and fall is amplified. This causes one arm to rise and extend and the other arm to fall and retract impacting the riding geometry. Also the rise and fall of the wheel axle causes wheel flop. At some levels of wheel flop, rider input is needed to correct the steering function. In the old fashioned Penny Farthing bicycle the pedals are fixed directly on the front wheel axle and the steering is also directly on the front wheel. The head tube is vertical hence the handlebars and the wheel axle remain in a horizontal plane when turning. Consequently the arms just extend and retract - they do not rise or fall and there is no wheel flop. However one leg falls and extends and the other rises and retracts during turning. Also the Penny Farthing bicycle has a tendency to topple forwards and backwards on steep slopes. In the current art bicycles the wheel base tends to be long, which has led to the folding bikes that can be carried in public transport. Such folding bikes are inherently heavy.

The principles of the invention

By steering the rear wheel, the head tube at the front may be made vertical thus the arms just extend and retract but do not rise or fall. The head tube at the rear may also be made vertical thus eliminating wheel flop. By driving at the front, the legs extend and retract but do not rise or fall when pedaling whilst turning.

Reference is also made to patent titled - Gear Mechanism, Pedal-Powered Vehicle comprising the same, and method for forming the same. Patent application number: SG 10201809244W , PCT/SG2019/050385

By using the teachings of the above patent, the pedals to drive the front wheel may be positioned away from the front wheel axle. This may accord opportunities to adjust the positions of the handlebar, the saddle and the rear wheel relative to the front wheel to lower the center of gravity and/or shorten the wheelbase. Short wheelbases allow more compact bicycles yet avoid the rider's shoe clashing with the front wheel when pedaling whilst turning. Compact bicycles of monolithic construction are simpler and inherently lighter than folding bikes making them easier to be taken in public transport.

A cargo carrying means, for example a shopping trolley, may be built within the overall volume of the bicycle. Such means may be fixed or detachable and have its own wheels that may also aid in the stability of the bicycle. This is an advantage since a shorter wheelbase makes a bicycle unstable, the extreme being a uni-bike. The wheels on the cargo means may be of a small diameter - comparable with those on a child's push along scooter. These may be positioned at the extremity of the rear wheel but within the overall length of the bicycle. Such wheels effectively increase the wheelbase of the bicycle enabling design of safer bicycles with steeper toppling angles.

Act of steering the rear wheel causes the bicycle to turn in the opposite direction. If the handlebars are turned to the right, by the rider, the bicycle will steer to the left. To correct this a means is provided in the steering mechanism.

Summary

The invention is defined in the independent claims. Further embodiments of the invention are defined in the dependent claims.

According to one embodiment, the bicycle may have a large front driving wheel and a small rear steering wheel resembling a Penny Farthing bicycle. Both the front and rear head tubes may be vertical eliminating wheel flop and rising and falling of arms and legs.. The handlebar and the seat may be repositioned to lower the center of gravity of the rider reducing the tendency to topple. The pedal cranks may be fixed on independent axles, away from the wheel axis. It may have a shopping trolley with its independent wheels. All of the above makes a compact bicycle that may be taken on public transport without the need to fold and make it safer without compromising the rider geometry or the experience of riding such a bike. Also a steering means is added to make the bicycle turn in the same direction as the handlebars.

Brief Description of Drawings

In the drawings, like reference numbers, sometimes with suffixes a, b, c,d generally refer to similar elements making them self explanatory. The drawings are not necessarily to scale, emphasis instead generally placed upon illustrating the principles of the invention. In the following description, various embodiments of the invention are described with reference to the following drawings in which

FIG.1 is an elevation view of a Penny Farthing bicycle of this invention.

FIG.2 is the partial plan view of FIG.1.

FIG.3 is an elevation view of a Penny Farthing triangulated frame bicycle of this invention

FIG.4 is the partial plan view of FIG.3.

FIG.5 is a schematic elevation of a current art bicycle of this invention.

FIG.6 is the partial plan view of FIG.5.

FIG.7 is a partial view in the direction of arrow A of FIG.5.

FIG.8 is a block diagram of the drive system

FIG.9 is a schematic of the steering mechanism using universal joints and spur gears.

FIG.10 is a schematic of the steering mechanism using sprockets, chains and spur gears.

FIG.11 is a schematic of the steering mechanism using ball joints

FIG.12 is a schematic of pedal drives using spur gears and a freewheel.

FIG.13 is a schematic of a cargo carrying means and its wheels.

FIG.14 is an example of a table in a spreadsheet used to select the sizes of the prototype bicycles.

Detailed Description

The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the invention may be practiced. The embodiments are shown in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilized and structural changes may be made without departing from the scope of the invention. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form new embodiments.

Embodiments described in the context of one structure are analogously valid for the other structures.

In the context of various embodiments, the term “about” as applied to a numeric value encompasses the exact value and a reasonable variance.

As used herein, the phrase of the form of “at least one of A or B” may include A or B or both A and B. Correspondingly, the phrase of the form of “at least one of A or B or C”, or including further listed items, may include any and all combinations of one or more of the associated listed items.

The frame of the bicycle is made of tubes. The term tube is generic to describe the members of the frame but may be any shape or combination of shapes of any hollow or solid sections. The tubes are joined by any manufacturing method of welding, gluing, bolting or made as a monocoque design by moulding or 3 D printing. They may be made from any materials like steel, aluminium, titanium, carbon fibers or any composite material or their combination. Tubes in the description are named to correspond, as closely as possible, to the tubes in a current art bicycle.

FIG.1 shows a traditional Penny Farthing bicycle. Bicycle 1 has a frame 2 made up of two similar elements straddling the wheels made up of top tubes 4, seat stays 6, chainstays 7 and down tubes 9. Fixed between the elements are a front head tube 3, a seat post tube 5 and a rear head tube 8. The elements are also held together by the front wheel axle 19.

The head tube 3, the top tube 4 and the down tube 9 are connected to form joint 16. The head tube 3 houses a traditional headset - not shown - and a front steerer tube 10. A stem 11 is attached at the top end of the steerer 10 that carries the handle bar 13. The stem and the handlebar are of conventional design. Part of the steering correction means 14 (described later) is fixed at the bottom of the front steerer tube 10.

The seat tube 5 is fixed to the top tube 4 and the seatstay 6. (It is to be noted that top tube 4 and seat stay 6 are one continuous circular element in this embodiment). The seatstay 6, chainstay 7 and the rear head tube 8 form the joint 17. The rear head tube 8 houses a traditional headset (not shown) supporting a rear steerer tube 31 and a steer direction correcting means 30 (described later) fixed at the top end that couples with item 14 via a rod 45. It also supports a fork 32 to carry the rear wheel 33. The assembly of the steerer 31, fork 32 and wheel 33 may be constructed to act as a castor wheel.

The down tube 9, and the chainstay 7 form the joint 18 to complete the frame. Fixed to the chainstay are the front wheel axle 19, the wheel 20 and the pedal and drive mechanism 21. Traditional pedals & crank assemblies 34 and 36 are mounted on their separate axles running on a common axis 35.

The bicycle saddle 37 and a seatpost 38 of conventional design may be fitted to the seat post tube 5. The length of the seatpost 38 may be adjusted to suit.

FIG.2 is a partial plan view for the bicycle in FIG.1. Some elements are omitted for clarity and those shown match the corresponding elements of FIG.1.

FIG. 3 is a Penny Farthing bike with a triangulated frame. All the elements are labelled to match those in FIG.1.

FIG.4 is a partial plan view of the bicycle in FIG.3. Some elements are omitted for clarity and those shown labelled to match the elements in FIG.3. Examples of tubes 6a, 6b, 7a, 7b that straddle

the wheels as two elements are shown. Tube 4 is shown as a single element but may be double element construction. A freewheel 39 has been added in this embodiment.

FIG.5 is a schematic elevation of a current art bicycle. All the elements are labelled to match the embodiment of FIG.3.

FIG.6 shows the pedal drive using sprockets and chains. For example pedal and crank assembly 36 drives sprocket 40a of drive mechanism 21. The driven sprocket 40b is mounted on a shaft 41 that is positioned outside the periphery of the wheel. Shaft 41 also has a sprocket 42 that drives a traditional chain cassette 44 fixed to the front wheel axle 19b.

FIG.7 shows typical construction of the down tubes 9, the pedal drive mechanism 21 and the front wheel axle 19b in the frame 2. The mechanism 21 is supported in a construction consisting of two element chainstays 7 and downtubes 9 and single elements of top tube 4 and the front headtube 3. Other details are not shown.

FIG.8 shows a block diagram of the pedals and drive mechanism 21. It has right side elements 50 and left side elements 51 shown in dotted line boxes.

Within the right side element 50 is the mechanism 52 that includes the pedal and crank assembly 34 (not shown) , an independant pedal axle 58b with its driver means (not shown) on a common axis 35. It also includes the drive train 54 and driven mechanism 56 that transmits power to the front wheel.

Within the left side element 51 is the mechanism 53 that includes the pedal and crank assembly 36 (not shown) , an independant pedal axle 58a with its driver means (not shown) on a common axis 35. It also includes the drive train 55 and driven mechanism 57 that transmits power to the front wheel.

The elements 56 and 57 share a common axle 19.

The driving means of 52 and 53, drive trains 54 and 55 and driven mechanisms 56 and 57 may be gears, belts, chains or electrical in construction. No details are shown here. People practicing the art can design these. For example a gear train is shown schematically in FIG.4 or a chain drive is shown schematically in FIG.6. Driven mechanisms may have a fixed speed or have a free wheel with single or multiple speed capability (not shown).

There are various ways to provide steering means that turn the bicycle in the same direction as the handle bars. Some types of mechanical means are shown in FIGs. 9, 10, 11. The same function may be achieved using electrical and electronic means.

FIG.9 shows steer means 14 has a universal joint 14a fitted at the end of the front steerer tube 10. A rod 45 connects with another universal joint 14b and a spur gear 46 that engages with another spur gear 47 that is fixed to the rear head tube 31 thus reversing the steering motion.

FIG.10 uses spur gears, chain sprockets and a chain. Front steerer tube 10 drives spur gear 46 that engages with spur gear 47 thus reversing the motion. Spur gear 47 is rigidly fixed to sprocket 48a. This drives another similar sprocket 48b fixed to the rear steerer tube 31. A chain 49 may be tensioned with a tensioner 50. The chain system can easily be replaced with belts.

FIG.11 has a ball joint 55a fixed to a block 56a that is fixed to the front steerer tube 10. A similar ball joint 55b is fixed to block 56b that is fixed to the rear steerer tube 31 but orientated through 180° as shown. The ball joints are connected with a rod 57. This arrangement makes the steerer tubes 10 and 31 to rotate in opposite directions.

FIG.12 shows the drive mechanism 21. It has two gear boxes made of four bearing housing plates 60a, 60b, 60c, 60d and four end caps 61a, 61b, 61c, 61d. One gearbox is fixed to each of the chainstay tubes 7a and 7b. On the common axis 35 two independent pedal axles 58a and 58b are mounted in their respective bearings. On the left hand side, the pedal axle 58a has a driver gear 63a that engages with idler gear 64a, to ensure wheel 20 rotates in the same direction as the power stroke of the pedals, that engages with the driven gear 65 transmitting power to the wheel axle 19. On the right hand side, the independent axle 58b has the driver gear 63b that engages with idler 64b and the driven gear 66 to transmit power to the wheel axle 19 via a free wheel 39 that is fixed to the wheel on one side and the driven gear 66 on the other. Gears are keyed to the shafts at positions marked X.

FIG.13 shows the cargo carrying means 70 that may be fixed or detachable. Attachment means are not shown being something that a person practicing the art can design. Wheels 71 are integrated into the cargo means. In the detachable option a retractable pulling handle, commonly used on suitcases, may be incorporated.

When the cargo means 70 is on the bicycle, the wheels 71 may be set just off the ground when riding normally and may be brought into contact with the ground only when there is a tendency to topple.

FIG.14 is self explanatory. The variables used for the calculations in the table are shown in the diagram below it. The table is a tool used to determine the sizes of the prototypes built. The table shows values as examples only. Labels for vertical variables have a prefix y and the horizontal prefix x.

Single speed prototypes were built and tested satisfactorily according to the parameters described above. Proprietary off the shelf items were either used directly or modified to fit. Such items were: pedals, cranks, ball bearings, thrust bearings, sprockets, chains, single speed freewheels, headsets, forks, universal joints, some of the spur gears, ball joints bolts, nuts and washers. The gearboxes were made from aluminium. The frames were fabricated from wood, sheet steel and metal tubes. The proportions of the bicycles were determined by using the table shown in FIG.14.

Prototype one was approximately half scale made mostly from wood. The independent drive means 21 from the pedals used chains and sprockets without a freewheel. Front wheel was 4 spoked wooden about 24 inch (592mm) diameter and the rear 5.1 inch (130mm) diameter. Wheelbase about 575mm and a total length of about 911 mm. The cargo trolley was fixed and built with 2 inch castor wheels. The seat height of about 840 mm and handlebar height about 960 mm above the ground. Both heights were selected to suit an adult rider. The steering correction was by using spur gears and universal joints of FIG. 9.

Prototype two was also approximately half scale as prototype 1 using a traditional 26 inch (660mm) mountain bike wheel at the front and a baby stroller wheel about 5 inch (130mm) diameter at the rear. The drive means 21 was made using proprietary 1 module spur gears and a freewheel.

Wheelbase about 600 mm with total length of about 995 mm. Seat height at about 850 mm and handlebar height at about 950mm above the ground. The steering correction was by using spur gears and universal joints of FIG. 9. The proprietary spur gears were large in diameter ranging from 80mm to 150mm set at gearbox centres of about 120mm and were found to be too heavy.

Prototype three was similar to prototype two except special spur gears were cut for use in the drive means 21 to enable pedals to drive over an arc less than 180° and return over an arc of greater than 180° . This gearbox was set at 34mm centres. The seat was made adjustable about 75mm horizontally and 75mm vertically. The handlebar height could be adjusted vertically by about 50mm. The steering correction was by using ball joints of FIG.11.

Prototype four used a 48 inch 6 spoked wooden wheel at the front and a 16 inch wheel, from a child's bicycle, at the rear. The gear boxes used proprietary 1 module 50 tooth spur gears set at a gearbox centre of 56mm with a freewheel to allow space for idler direction reversing gears. The seat height of about 1250 mm and the handlebar height at about 1350 mm above the ground. The steering correction was by using ball joints of FIG.11.

Claims

1. A pedal powered vehicle with front wheel drive and rear wheel steering where in it has a frame to support:
 - different size front and rear wheels that are propelled by
 - a driver means consisting of two separate pedal drive axles that share a common axis,
 - separate transmission means coupled to each driver means ensuring the front wheel turns forward when the pedal drives forward,
 - a driven means mounted on the driven wheel axis using a freewheel,
 - a compact wheel base suited to take it in public transport,
 - a cargo carrying means and
 - a steering means where in the head tubes are vertical and incorporate elements to turn the vehicle in the same direction as its handlebar.
2. A pedal powered vehicle as claimed in claim 1 is a bicycle.
3. A bicycle as claimed in claim 2 that has a compact wheelbase suitable for taking on public transport without the need to fold the main frame that carries the wheels.
4. A bicycle as claimed in claim 2 that has a cargo carrying means with its independent wheels.
5. A bicycle, as claimed in claim 2, has the same size front and rear wheels.
6. A bicycle as claimed in claim 2 that has its driven means split between a remote axis and the driven wheel axis.
7. A bicycle as claimed in claim 2 where in the final driven means may have a combination of a fixed speed, single speed, multiple speed and the associated speed changing means.
8. A bicycle as claimed in claim 2 where in the head tubes may be set in combination of vertical and inclined axes.
9. A pedal powered vehicle as claimed in claim 1 where in the driver means are on a common axis and axles fixed to the front wheel.
10. A pedal powered vehicle as claimed in claim 1 where in the rider seat and the braking means are configured to suit the chosen wheel sizes.
11. A method of forming a pedal powered vehicle with front wheel drive and rear wheel steering where in it has a frame to support:
 - different size front and rear wheels that are propelled by
 - a driver means consisting of two separate pedal drive axles that share a common axis,
 - separate transmission means coupled to each driver means ensuring the front wheel turns forward when the pedal drives forward,
 - a driven means mounted on the driven wheel axis using a freewheel,
 - a compact wheel base suited to take it in public transport,
 - a cargo carrying means and
 - a steering means where in the head tubes are vertical and incorporate elements to turn the vehicle in the same direction as its handlebar.