ABSTRACT

A chainless electric bicycle design that allows a rider/user to pedal a pedal generator to create an electric transmission energy source that either charges the battery or partially powers a hub motor, discharges the battery to the hub motor contained within one of the wheels, allows the user to set a desired level of resistance from the pedal generator using controls oriented about the handlebars, allows the user to activate the hub motor using a speed controlling device oriented about the handlebars, and allows the user to charge the battery by connecting to a standard 110V/220V AC power supply. A chainless cycle is a cycle where the input power from a rider is not converted into output power by the rear wheel through a gear and chain system connecting the pedals to the rear wheel.
PEDAL GENERATOR ELECTRIC BICYCLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to provisional application 61/440,000 filed on Feb. 7, 2011 entitled Concept Electric Bicycle and hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention is in the technical field of transportation. More particularly, the present invention is in the technical field of electric bicycle transportation.

[0003] Existing electric bicycles typically fall into one of two categories. The first category includes electric bicycles that require the user to pedal before electric assistance is provided. These bicycles typically measure the amount of force the user is providing, through a conventional gear-and-chain system connecting the user’s pedaling force with the rear wheel of the bicycle, and produce a multiple of that amount of force from an electric motor. The second category includes electric bicycles that do not require the user to pedal at all. These bicycles typically allow the user to activate an electric motor using a speed controlling device oriented around the bicycle’s handlebars. These bicycles typically allow the user to provide input pedaling power through a conventional gear-and-chain system connecting the user’s pedaling force with the rear wheel of the bicycle.

[0004] Both of these categories of electric bicycles allow the user to power the bicycle solely by human power, although the weight of additional components typically makes this an undesirable condition. Additionally, both of these categories of electric bicycles typically do not permit charging of the battery by means of pedaling. Additionally, both of these categories of electric bicycles typically include a conventional gear-and-chain system to connect the user’s pedaling force with the rear wheel of the bicycle.

[0005] An important exception to the second category of bicycles described above is the Bike 2.0 electric bicycle design developed by Ioads+Sveje in Italy. This is a design company that developed a concept electric bicycle that does not contain a conventional gear-and-chain system to connect the user’s pedaling force with the rear wheel of the bicycle. Instead, this design allows the user to pedal a step less gear box at a user-selected cadence level, and this step less gearbox generates power to power a rear hub motor. A battery is optional for this bike but can be used to help provide power to the hub motor. This bike contains a supercapacitor to provide power during high power demands such as hill climbing. It is also important to note that this bike exists as an artistic design only; the components required to build the bike in its given embodiment do not exist, and no attempts to make a working version of the bike have been made.

[0006] There is a need for an electric bicycle that: allows the user to pedal a pedal generator to charge an onboard battery or provide power directly to an electric motor; discharges the on board battery to a motor contained within one of the wheels; allows the user to set the desired level of resistance from the pedal generator using controls oriented about the handlebars; allows the user to activate the electric motor using a speed controlling device oriented about the handlebars; and allows the user to charge the battery by connecting to standard 110V and/or 220V AC power supply.

SUMMARY

[0007] The present invention is a chainless electric bicycle design that allows the user to pedal a pedal generator to create an electric transmission energy source that either charges the battery or partially powers a hub motor, discharges the battery to the hub motor contained within one of the wheels, allows the user to set a desired level of resistance from the pedal generator using controls oriented about the handlebars, allows the user to activate the hub motor using a speed controlling device oriented about the handlebars, and allows the user to charge the battery by connecting to a standard 110V/220V AC power supply. A chainless cycle is a cycle where the input power from a rider is not converted into output power by the rear wheel through a gear and chain system connecting the pedals to the rear wheel. Further, a chainless cycle is a cycle that does not utilize a mechanical system to convert rider/user human input power into propulsive output power on the driven wheel, where the mechanical system is typically comprised of a gear driven by turning the pedals, a gear that drives the rear wheel of the cycle, and a chain that connects the two gears.

[0008] While an exemplary embodiment is a single rider/user electric bicycle, the elements of the cycle are applicable to a two (dual) rider/user bicycle electric bicycle or a tricycle.

[0009] The elements of an electric drive system an electric cycle include: one or more pedal driven generator(s) mounted on a pedal system coupled to a charge controller; one or more batteries coupled to said charge controller and to one or more motors mounted on one or more wheel hubs; a user controlled resistance device to adjust a rate of perceived exertion for said user in conjunction with said pedal generator; a user controlled throttle mounted on a handlebar system, and a charge controller. The rider/user provides pedal power to the pedal generator combination producing a DC power to the charge controller.

[0010] The charge controller allocates power distribution between the batteries and the motor. A user controlled throttle coupled to the motor determines a speed of the motor and thus the speed of said cycle. The electric drive system is a chainless drive system for said cycle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings wherein.

[0012] FIG. 1 is a side view of a pedal generator electric bicycle embodiment of the present invention;

[0013] FIG. 2 is a perspective view of a pedal generator electric bicycle embodiment of the present invention; and

[0014] FIG. 3 is a block diagram of the electrical system within a chainless electric bicycle.

DETAILED DESCRIPTION

[0015] While the detailed description herein discloses a bicycle embodiment, the elements of the bicycle embodiment are relevant to other cycle embodiments disclosed further below. FIG. 1 and FIG. 2 illustrate a bicycle 10 having a front wheel 12 with a hub motor 14, a rear wheel 16, a seat 18, a set
of handlebars 20, front wheel frame supports 22 and 24, rear wheel frame supports to a main triangular frame 26 and 28, a rear wheel frame that supports the pedal assembly 30 and 32, and a main triangular frame comprised of a top bar 34, a rear bar 36, and a front bar 38. The pedal assembly is comprised of pedal bars 40 and 42 and pedals 44 and 46. The front main bar 48 connects the front wheel frame supports, the main triangular frame, and the extension bar 50 to the handlebars 20. The rear top bar 52 connects the seat 18 to the main triangular frame. In addition to these common components of an electric bicycle, there are one or more (an exemplary value of three batteries 54, 56, and 58) attached to the front bar 38, a charge controller 60 attached to the rear bar 36, and a generator 62 attached in the center of the pedal assembly. The throttle 64 is on the right side of the handlebars 20, and the resistance selector 66 is on the left side of the handlebars 20. The position of some of these elements is exemplary and are not limited to the precise location indicated above or illustrated within the drawings.

In more detail, still referring to the embodiment of the invention of FIG. 1 and FIG. 2, the pedal generator 62 is coupled to the pedals 44 and 46 such that when a user bends and stretches his legs in such a way as to move the pedals 44 and 46, the pedal generator 62 generates electricity. The pedal generator 62 may be a DC generator or a combination of an AC generator with an AC/DC Rectifier to produce DC electricity for the bicycle. The electricity is coupled to the charge controller 60 which regulates the flow of electricity to the one or more batteries 54, 56, and 58 and to the hub motor 14. The charge controller may be a pulse width modulation device (PWM) or a maximum power point tracking device (MPPT). The hub motor may be a DC motor or a combination of a DC to AC converter and an AC motor. The purpose of the charge controller 60 is to permit the batteries 54, 56, and 58 to be charged according to a proper charging algorithm from a variable input power source, or route electricity directly from the pedal generator 62 to the hub motor 14. In the present embodiment of the invention, the variable input power source is the user bending and stretching his legs in such a way as to move the pedals 44 and 46. The one or more batteries 54, 56, and 58 output electrical energy to the hub motor 14. The electrical demand of the hub motor 14 is controlled by the user by twisting the throttle 64, and this controls the speed of the electric bicycle 10. The resistive force of the pedal generator 62 is controlled by the resistance selector 66, which allows the user to select the desired resistive force of the pedal generator 62 by twisting the resistance selector 66. The resistance device may be a selectable set of resistors on the output of the pedal generator to create a rate of perceived exertion for the user. The resistance device may also be an electromagnetic device that acts as an electromagnetic brake on the generator.

In further detail, still referring to the embodiment of the invention illustrated in FIG. 1 and FIG. 2, the selected pedal generator 62 is sufficiently powerful to capture all of the energy generated by the user to send to the charge controller 60, about 500 to about 700 Watts maximum power generated by a typical human user. The charge controller 60 is sufficiently efficient to charge the one or more batteries 54, 56, and 58 without major electrical losses, an exemplary value of at least 97% efficient. The one or more batteries 54, 56, and 58 have sufficient capacity to provide enough energy to allow the user to travel an exemplary value of about 15 to about 20 miles on a full charge. The hub motor 14 is selected to be sufficiently powerful to maintain exemplary values of constant speeds of about 15 to about 20 miles per hour, which requires about 500 to about 1000 Watts maximum output power. The resistance selector 66 has a sufficient number of settings to allow a typical user to select a most comfortable resistive force, exemplary values from typically about 8 to about 24 settings. The bicycle size must be sufficiently large to accommodate the additional features of the electric bicycle, including the hub motor 14, the pedal generator 62, the one or more batteries 54, 56, and 58, the charge controller 60, throttle 64, and resistance selector 66 of the present embodiment of the invention, requiring a bicycle with wheels to be at least about 20 inches in diameter.

The advantages of the present embodiment of the invention include, without limitation, the ability to use a pedal generator to supply human power to the electric bicycle transmission system. When the charge current from the pedal generator is greater than the discharge current demand by the hub motor, excess current will charge the one or more onboard batteries. When the charge current from the pedal generator is less than the discharge current demand from the hub motor, the hub motor will accept all of the charge current directly and draw the remainder of power demand from the battery, thereby discharging the one or more batteries at a lower rate. Thus, the user may extend the range of the batteries on a full charge by pedaling and turning the pedal generator during use. The present embodiment of the invention allows the user to plug in the batteries to charge through a standard 110V/220V AC power supply when not in use. The user may also select the desired resistive force of the pedal generator, separating the perceived level of exertion by the user and the conditions of the environment, including rough terrain, hills, and wind resistance. The user could place the bicycle in a stationary fixture and pedal the pedal generator to charge the batteries. Other electric bicycles do not display this ability because the pedals are connected to a gear-and-chain system that mechanically powers the rear wheel. A chainless cycle is a cycle where the input power from a rider is not converted into output power by the rear wheel through a gear and chain system connecting the pedals to the rear wheel. Further, a chainless cycle is a cycle that does not utilize a mechanical system to convert rider/user human input power into propulsive output power on the driven wheel, where the mechanical system is typically comprised of a gear driven by turning the pedals, a gear that drives the rear wheel of the cycle, and a chain that connects the two gears.

The effect of this chainless system is to have full propulsive power delivered by a hub motor driven by a battery and/or a pedal driven pedal generator thus eliminating any need for a chain drive. As a byproduct of the separation of the conditions of the environment and perceived level of exertion by the user, the present embodiment of the invention being chainless, this system prevents users from rubbing a chain with their clothes or skin and causing discomfort and grease stains.

FIG. 3 illustrates an electrical block diagram of the electrical system embodiment 70 used with the chainless bicycle. A rider/user 72 provides three inputs to electrical system 70: the rider/user 72 provides the pedal power 74 to turn the pedal generator; the rider/user adjusts the throttle 76 to provide the speed control 78 of the motor 80; and the rider/user adjusts the resistance selection 82 to provide control of resistance that controls a rate of perceived exertion (RPE) 84.
As discussed above, the rider/user's pedal power 74 turns the pedal generator 86 to generate electricity. As discussed above, the pedal generator may be a DC generator or an AC generator coupled to a rectifier 88 to create a DC voltage 90 accepted by the charge controller 92 and needed for the battery 94 and the motor 80.

The output of the pedal generator 86 or a pedal generator 86 rectifier combination 88 is a DC voltage 90 coupled to the charge controller 92 that regulates the flow of electricity to the one or more batteries 94. The purpose of the charge controller 92 is to permit the one or more batteries 94 to be charged according to a proper charging algorithm from a variable input power source and control electricity flow to the motor 80. In the present embodiment of the invention, the variable input power source is the rider/user bending and stretching his/her legs in such a way as to provide pedal power 74 to the pedal generator 86. The one or more batteries 94 output electrical energy to the motor 80. The electrical demand of the hub motor 80 is controlled by the rider/user 72 by twisting the throttle 76, and this controls the speed of the electric bicycle. The resistive force of the pedal generator 86 is controlled by the resistance selector 82, and this allows the user to select the desired resistive force of the pedal generator 86 by twisting the resistance selector 82. As described herein and above, the electrical system 70 provides the traction and operation of an electrical bicycle without a gear and chain system.

The embodiments discussed above are directed to a bicycle with a single hub motor mounted on a front wheel and a single pedal AC generator. Another embodiment may include a single cyclist with a hub motor on a rear wheel or on both wheels. Another embodiment includes a provision for a pair of cyclists each with a pedal generator and a single hub motor on the front wheel or the rear wheel or a pair of hub motors.

Another embodiment may include a three wheeled vehicle with a hub motor on one wheel hub or up to all three wheel hubs. The basic embodiment herein is a chainless electric bicycle having: a frame supporting two or more wheels, an electric drive system, a seat and a handlebar system. The electric drive system includes: one or more pedal driven generator(s) mounted on a pedal system; one or more hub motors mounted on one or more wheel hubs; one or more batteries; a resistance selection system; a throttle mounted on the handle system, and a charge controller with this electric drive system providing a chainless drive system for the cycle.

Three embodiments of the basic embodiment include a bicycle having the chainless electric drive system; a two cyclist bicycle having the chainless electric drive system; and a tricycle having the chainless electric drive system.

The chainless electric drive system for a single rider/user bicycle includes: one or more hub motors mounted on one or more wheel hubs, a single pedal driven generator mounted on a pedal system; one or more batteries are mounted on the frame; a charge controller mounted on the frame; a resistance selection mounted on the handle bar; and a throttle mounted on the handle bar. The electric drive system includes: receipt of pedal power from a rider/user to the pedal driven generator; the resistance selection is coupled to the generator output to provide resistance control that controls rate of perceived exertion; the charge controller is also coupled to the generator output to determine the amount of energy supplied to the one or more batteries and to the hub motor; and the throttle is coupled to the hub motor to control a speed of the hub motor. The resistance selection includes an exemplary value of 8-24 levels of resistance.

The generator in each embodiment may be a DC generator or an AC generator coupled to a rectifier to produce DC power. The hub motor may be a DC motor or a DC/AC converter combined with an AC motor such the motor system operates on DC power. The hub motor may be mounted on a front wheel hub or a rear wheel hub.

A chainless electric drive system for a two cyclist bicycle includes: one or two hub motors mounted on one or both wheel hubs; one or two pedal driven generators mounted on one or both the pedal systems; one or more batteries are mounted on the frame; one or two charge controllers mounted on the frame; the one or two resistance selectors mounted on one or both handlebars; and one or two throttles mounted on one or both the handle bars.

The electric drive system for a two cyclist bicycle includes: receipt of pedal power from one or both users to a pedal driven generator; a resistance selection is coupled to one or both pedal generator outputs to provide control of resistance that controls rate of perceived exertion; one or both charge controllers are also coupled to the one or both pedal generator outputs to determine the amount energy supplied to the one or more batteries and to each hub motor; and a throttle is coupled to each hub motor to control a speed of the hub motors. The resistance selection includes an exemplary value of 8-24 values of resistance. The one or more pedal generators may be a DC generator or an AC generator coupled to a rectifier to produce DC power and one or more hub motors are a DC motor or AC/DC converter DC motor combinations. The hub motors for this embodiment may have one of the hub motors mounted on a front wheel hub or on a rear wheel hub or have two hub motors each mounted on each wheel hub.

A chainless electric drive system for a tricycle includes: one or more hub motors mounted on one or more wheel hubs; one or more pedal driven generator is mounted on one or more of the pedal systems; one or more batteries are mounted on the frame; one or more charge controllers mounted on the frame; resistance selection mounted on the handlebar; and throttle mounted on the handle bar. The chainless electric drive system for a tricycle further includes: receipt of pedal power from one or more users to one or more pedal driven generators; a resistance selection is coupled to each of the pedal generator output to provide control of resistance that controls rate of perceived exertion; each charge controller is also coupled to each pedal generator output to determine the amount of energy supplied to the one or more batteries and to the one or more hub motors; and a throttle is coupled to each hub motor to control the speed of the hub motors. The resistance selection comprises an exemplary value of 8-24 values of resistance. The generators may be a DC generator or an AC generator coupled to a rectifier to produce DC power. The one or more hub motors are a DC motor or AC/DC converter AC motor combinations. The tricycle may have a hub motor mounted on a front wheel hub or a rear wheel hub.

While the foregoing written description of the invention enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific embodiment, method, and examples herein. The invention should therefore not be limited by the above described
embodiment, method, and examples, but by all embodiments and methods within the scope and spirit of the invention.

SUMMARY OF THE DRAWING IDENTIFIERS

10 Bicycle
12 Front Wheel
14 Hub Motor
16 Rear Wheel
18 Seat
20 Handlebar
22 Left Front Wheel Frame Support
24 Right Front Wheel Frame Support
26 Left Side Main Triangular Frame
28 Right Side Main Triangular Frame
30 Left Side Support for Pedal Assembly
32 Right Side Support for Pedal Assembly
34 Top Bar
36 Rear Bar
38 Front Bars
40 Left Pedal Bar
42 Right Pedal Bar
44 Left Pedal
46 Right Pedal
48 Front Main Bar
50 Extension Bar
52 Rear Top Bar
54 First Battery
56 Second Battery
58 Third Battery
60 Charge Controller
62 Permanent Magnet Pedal DC Generator
64 Throttle
66 Resistive Selector
68 Not used
70 Electrical System
72 Rider/user
74 Pedal Power
76 Throttle
78 Speed Control
80 Motor
82 Resistance Selection
84 Rate of Perceived Exertion
86 Generator
88 Rectifier
90 DC Voltage
92 Charge Controller
94 Battery

1. A bicycle comprising:
   a user controlled throttle coupled to said motor determines a speed of said motor and thus the speed of said cycle wherein said electric drive system is a chainless drive system for said cycle.

2. The bicycle of claim 1 comprising a single user bicycle.

3. The bicycle of claim 2 comprising:
a main triangular frame system having a top bar, a rear bar and a front bar providing a basic structure for said bicycle;
a first end of said front bar is coupled to a first end of a pair of front wheel frame supports, the main triangular frame, and an extension bar coupled to a pair of handlebars;
a second end of each front wheel frame supports are coupled to a motor mounted to the axis of said front wheel;
a second end of said front bar and first end of said rear bar are coupled to said pedal generator;
a first end of a rear top bar is coupled to said top bar and said rear bar and said second end of said rear top bar is coupled to and supports a seat;
a first end of a pair of rear triangular frames are coupled to said rear bar and a second of each rear triangular frames are coupled to each axis of a rear wheel;
the first end of each support for said pedal assembly is coupled to each side of said pedal assembly and said second end support for said assembly is coupled to each side of said wheel axis;
said pedal assembly includes a pair of pedal bars coupled to a pair of pedals and said pedal generator;
said one or more batteries is coupled to said front bars;
said resistance selection is coupled to a first side of said handlebars;
said throttle is coupled to a second side of said handlebars; said charge controller is coupled to said rear bar.

4. The bicycle of claim 3 wherein said pedal generator is a DC generator.

5. The bicycle of claim 3 wherein said pedal generator is an AC generator/rectifier combination to produce a DC voltage.

6. The bicycle of claim 3 wherein said motor is a hub motor.

7. The bicycle of claim 3 wherein said motor is a DC motor.

8. The bicycle of claim 3 wherein said motor is an AC motor driven by a DC to AC converter.

9. The bicycle of claim 3 wherein resistance selection comprises multiple selections of resistors in parallel with an output of said pedal generator and provides control of a rate of perceived exertion for said user.

10. The bicycle of claim 9 wherein said resistance selection comprises 8-24 settings.

11. The bicycle of claim 3 wherein said resistance selection comprises multiple selections of resistance to said pedal generator with an electromagnetic brake coupled to said pedal generator and provides a rate of perceived exertion for said user.

12. The bicycle of claim 11 wherein said electromagnetic brake comprises 8-24 settings of resistance.

13. The bicycle of claim 3 wherein said charge controller regulates a flow of electricity to said one or more batteries and/or said hub motor.

14. The bicycle of claim 13 wherein said charge controller may be a pulse width modulation device (PWM) or a maximum power point tracking device (MPPT).

15. The bicycle of claim 13 wherein said charge controller allocates said electricity from said pedal generator between
16. The bicycle of claim 15 wherein said variable power source is the user bending and stretching his legs in such a way as to move said pedals and said one or more batteries output electrical energy to said hub motor.

17. The bicycle of claim 3 wherein an electrical demand of said hub motor is controlled by said user by twisting said throttle and thus providing a speed control of said electric bicycle.

18. The bicycle of claim 1 comprising a dual user bicycle.

19. The dual user bicycle of claim 18 comprising:
   one or two hub motors mounted on one or both wheel hubs;
   one or two pedal driven generators mounted on one or two pedal systems;
   one or more batteries are mounted on a frame;
   one or two charge controllers mounted on said frame;
   one or two resistance selectors mounted on one or two handlebars; and
   one or two throttles mounted on one or both the handlebars.

20. The dual user bicycle of claim 19 comprising an electric drive system further comprising:
   receipt of pedal power from one or both users to said pedal driven generator;
   a resistance selection coupled to one or both generator outputs to provide control of resistance that controls rate of perceived exertion;
   one or both charge controllers coupled to said one or both generator outputs to determine an amount energy supplied to said one or more batteries and to each hub motor; and
   said throttle(s) coupled to each hub motor to control a speed of the hub motors. The resistance selection includes an exemplary value of 8-24 values of resistance. The one or more generators are a DC generator or an AC generator/rectifier combination to produce a DC voltage and the one or more hub motors are a DC motor or AC/DC converter AC motor combinations. The hub motors for this embodiment may have one of the hub motors mounted on a front wheel hub or a rear wheel hub or have two hub motors each mounted on each wheel hub.

21. The bicycle of claim 1 comprising a tricycle.

22. The tricycle of claim 1 comprising:
   one or more hub motor(s) mounted on one or more wheel hubs;
   one or more pedal driven generator(s) is mounted on one or more of the pedal systems;
   one or more batteries are mounted on a frame;
   one or more charge controllers mounted on said frame;
   a resistance selector mounted on a handlebar;
   a throttle mounted on said handlebar.

23. The tricycle of claim 22 comprising:
   receipt of pedal power from one or more users to one or more pedal driven generators;
   a resistance selection is coupled to each of said generator output to provide control of resistance that controls a rate of perceived exertion;
   each charge controller is also coupled to each pedal generator output to determine the amount of energy supplied to the one or more batteries and to the one or more hub motors; and
   a throttle is coupled to each hub motor to control the speed of the hub motors.