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(54) **ELECTRIC BICYCLE**

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(51) **Int. Cl.**
B62M 6/40 (2010.01)
B62M 6/90 (2010.01)

(52) **U.S. Cl.** **180/207.3**; 180/206.1; 180/220; 180/68.5

(58) **Field of Classification Search** 180/220, 180/206.1–206.8, 207.3, 68.5, 65.1, 65.6, 180/65.8; 280/281.1, 288.4
See application file for complete search history.

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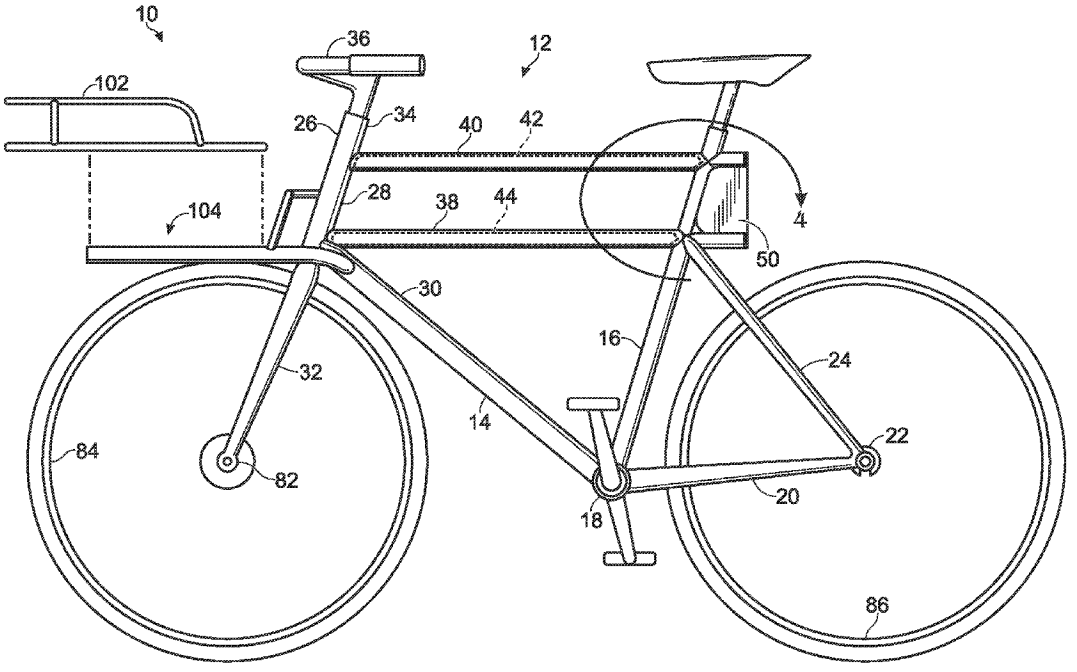
(57) **ABSTRACT**

An electric bicycle and electric bicycle frame including batteries stored in a pair of substantially parallel top tubes. In some cases, the top tubes extend rearward of the bicycle seat tube, and an electronics housing may be disposed between the rearward extending top tube portions.

17 Claims, 4 Drawing Sheets



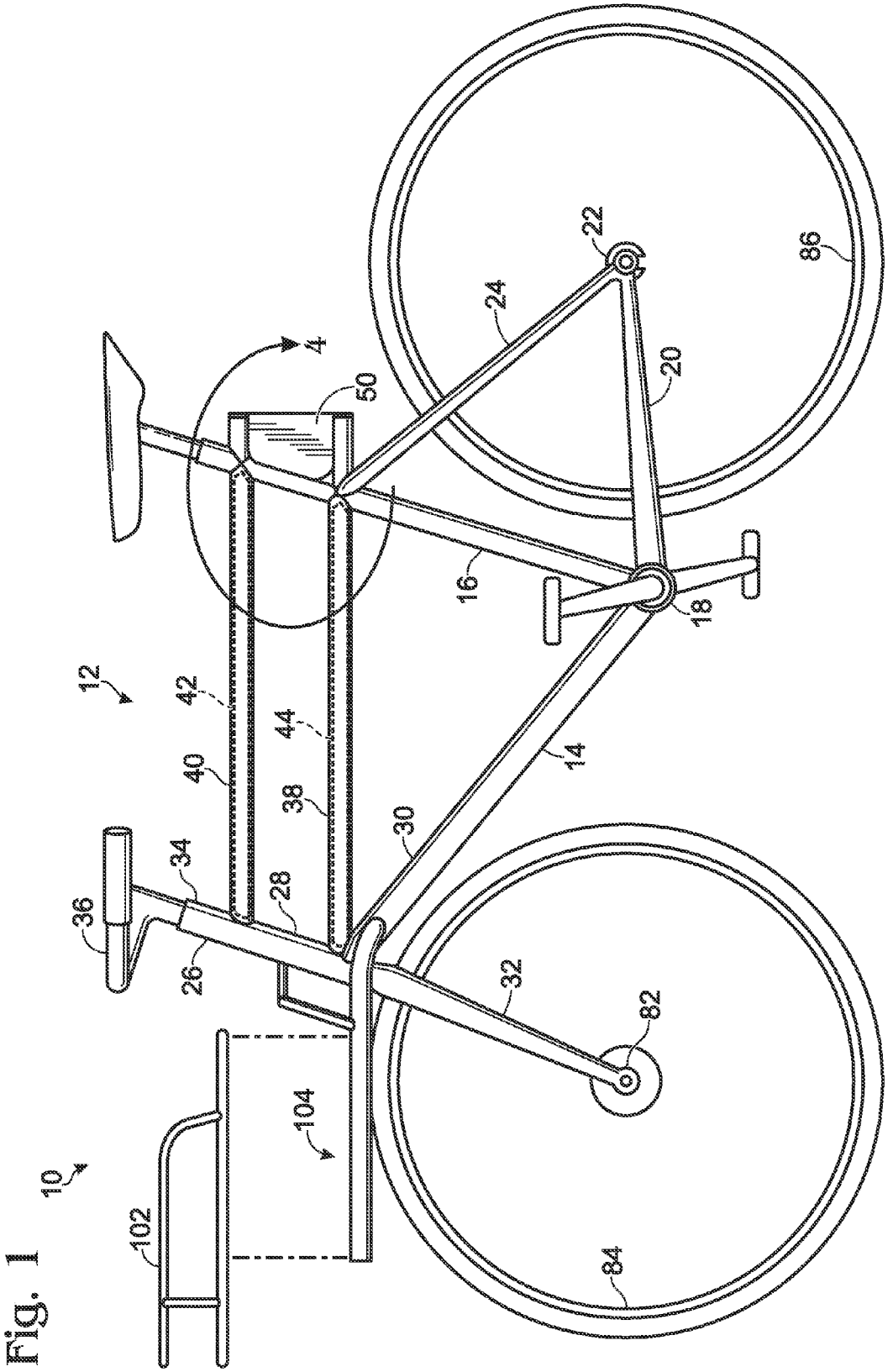

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Fig. 1

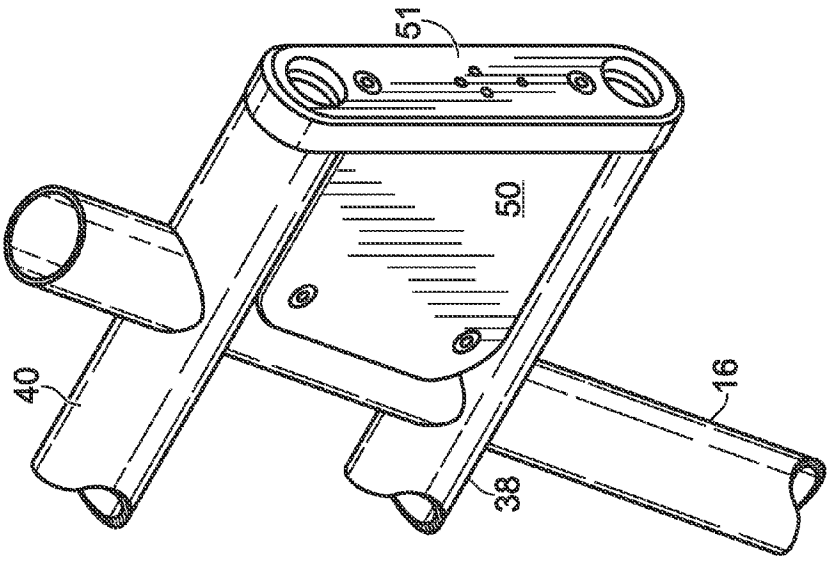

Fig. 3

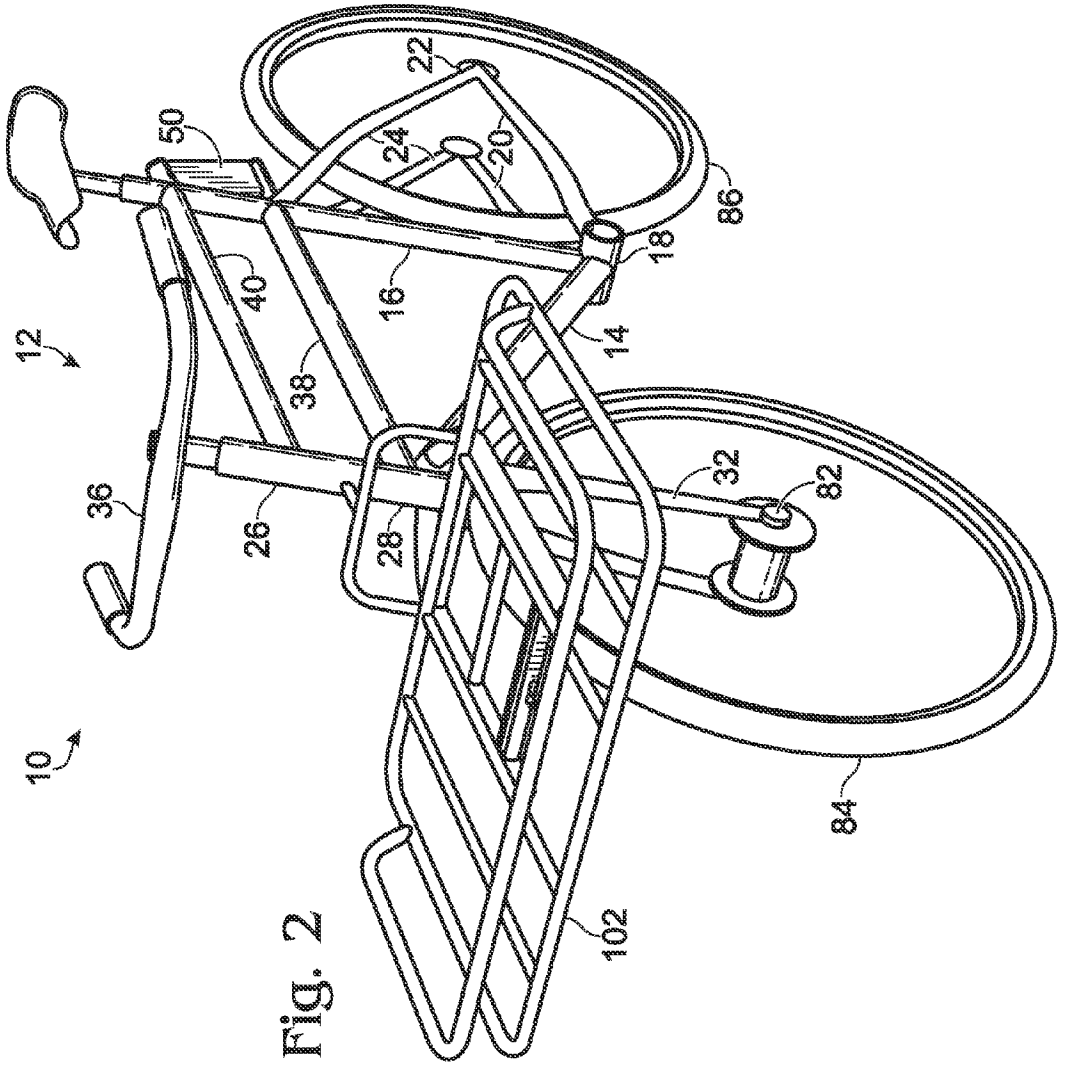

Fig. 2

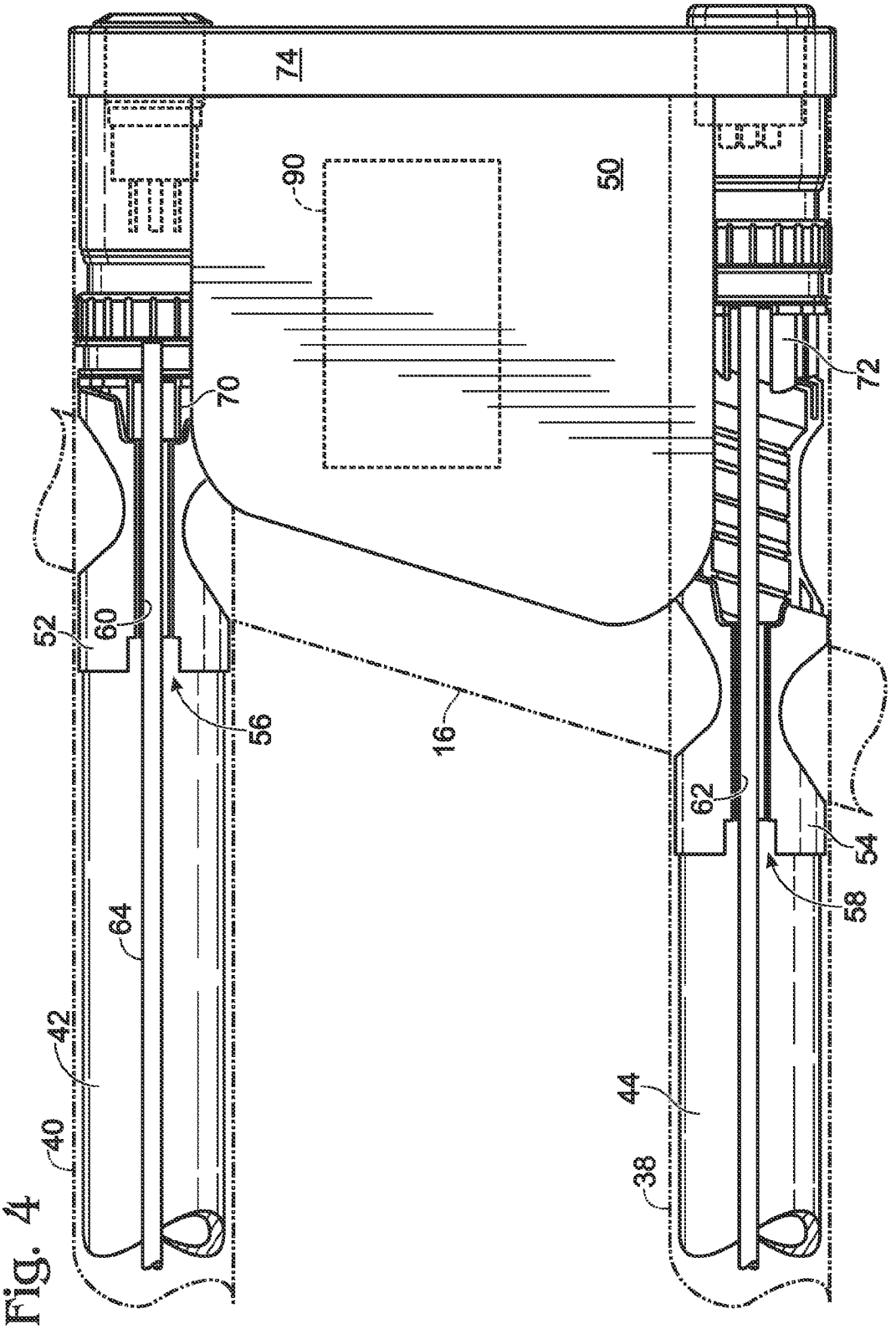

Fig. 4

Fig. 5

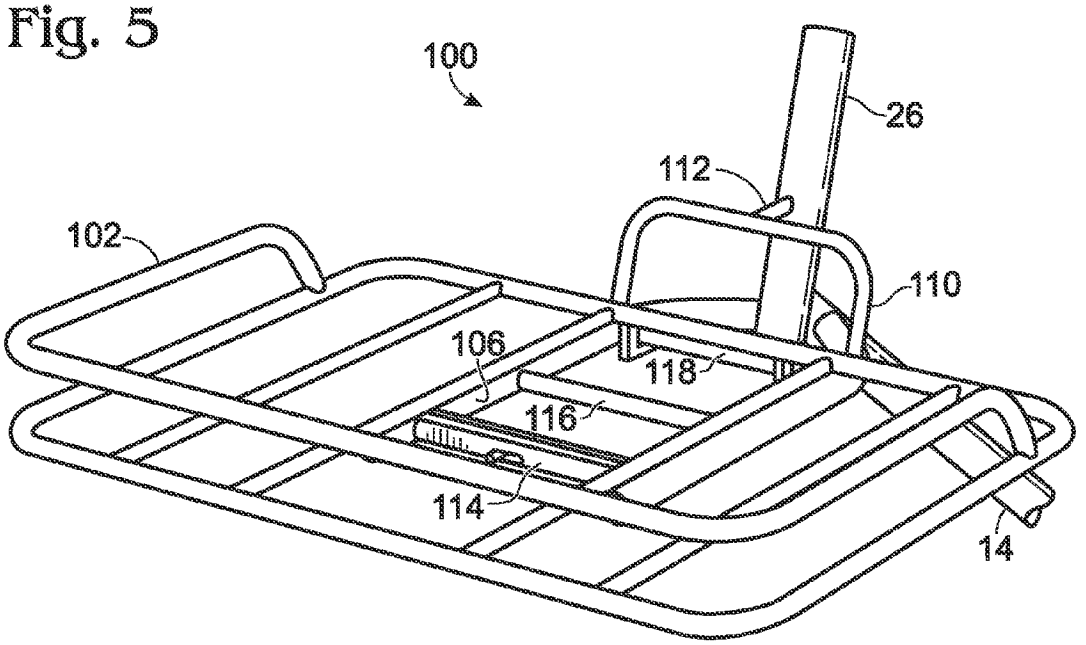
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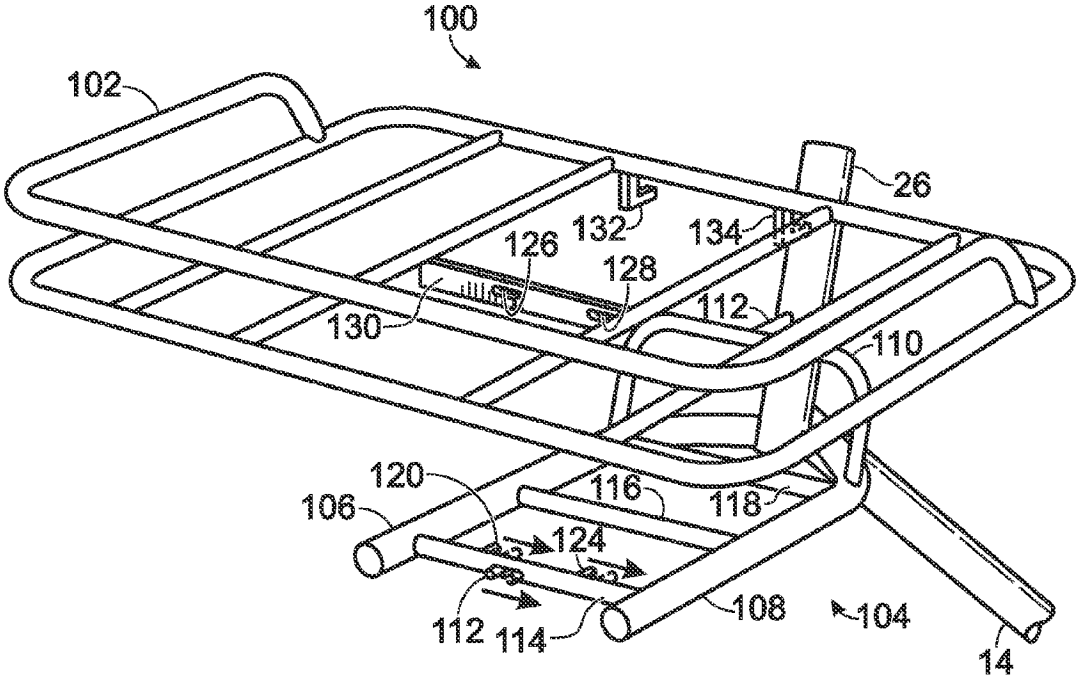
Fig. 6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ELECTRIC BICYCLE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application Ser. No. 61/538,118, filed Sep. 22, 2011, which is hereby incorporated by reference.

BACKGROUND

Conventional electric bicycles typically rely on a battery pack and electronics incorporated into one or more housings that are attached by various means to the outside of the bicycle frame. External batteries and electronics have drawbacks including, but not limited to, adding extra weight, consuming storage space on the bike, negatively affecting the distribution of weight on the bike, and hurting the aesthetics of the bicycle design.

In addition, existing electrical assist algorithms for electrical bicycles typically do not take into account the continuity of the bicycle's speed and acceleration, resulting in bursts of power from the electric motor that may be unexpected and/or excessively forceful and that may compromise the rider's safety or enjoyment when riding the bicycle. Accordingly, improvements to electric bicycles are needed, including improved battery and electronics configurations and improved electrical assist algorithms.

SUMMARY

The present teachings disclose aspects of an electric bicycle and electric bicycle frame including batteries stored in a pair of substantially parallel top tubes. In some cases, the top tubes extend rearward of the bicycle seat tube, and an electronics housing may be disposed between the rearward extending top tube portions.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a side elevational view of an electric bicycle, according to aspects of the present teachings.

FIG. **2** is an isometric view of the electric bicycle of FIG. **1**.

FIG. **3** is an isometric view of a rear portion of the frame of the electric bicycle of FIGS. **1-2**, showing further details of an electronics housing disposed between rearward extending portions of the bicycle top tubes.

FIG. **4** is a semi-transparent side elevational view of the electronics housing of FIG. **3**, showing details of battery end caps disposed within the housing and facilitating electrical connection between the bicycle batteries and the electronics housing.

FIG. **5** is an isometric view of a front portion of the frame of the electric bicycle of FIGS. **1-2**, showing further details of a front rack and a mounting portion of the bicycle frame that facilitates attachment of the front rack.

FIG. **6** is a partially exploded view similar to the view of FIG. **5**, depicting the front rack disengaged from the bicycle frame.

DETAILED DESCRIPTION

The present teachings generally relate to electric bicycles having batteries integrated into a bicycle frame and configured to be electrically connected to an electronics housing in a particular manner. The present teachings also relate to other aspects of an electric bicycle, including a novel front rack and accessory mounting system.

FIGS. **1-2** schematically depict an electric bicycle, generally indicated at **10**, according to aspects of the present teachings. Bicycle **10** includes a frame, generally indicated at **12**, having various tubes that are joined together by any of a number of standard methods known in the art, such as welding, brazing, molding and/or the like. The particular method of joining the tubes depends to a large degree on the chosen frame material. Typical materials used to construct a bicycle frame include steel, aluminum, titanium and carbon fiber, although other materials may be used.

Frame **12** includes a down tube **14**, a seat tube **16** intersecting a lower portion of the down tube at a bottom bracket region **18**, a pair of chain stays **20** each extending backward from the bottom bracket region to a rear wheel dropout **22**, and a pair of seat stays **24** each extending generally upward and forward from a corresponding one of the rear wheel dropouts to intersect the seat tube. The frame further includes a head tube **26** having a lower portion **28** that intersects an upper portion **30** of the down tube and which is configured to receive a steerer tube of a bicycle fork **32**, and an upper portion **34** which is configured to receive a stem of a bicycle handlebar **36**. In other words, down tube **14** extends generally downward and rearward from the lower portion of the head tube.

In addition, frame **12** includes a first or lower top tube **38** extending between either the lower portion of the head tube or an upper portion of the down tube and the seat tube, and a second or upper top tube **40** extending between the upper portion of the head tube and the seat tube. More generally, the upper top tube extends generally rearward from an upper portion of the head tube, and the lower top tube extends rearward from a portion of the frame below the upper top tube. Whether this portion of the frame is the lower portion of the head tube or an upper portion of the down tube is a matter of design choice that typically depends on the overall frame size. As depicted in FIG. **1**, seat tube **16** intersects each of upper top tube **40**, lower top tube **38** and down tube **14**.

As also depicted, for example, in FIG. **1**, top tubes **38** and **40** each may be configured to hold a battery or a battery pack for powering an electric motor of bicycle **10**. For instance, each top tube may contain a plurality of battery cells connected in series to form batteries **42**, **44**, which are inserted into the top tubes.

Also as depicted in FIG. **1**, top tubes **38** and **40** each extend rearward of seat tube **16** to some extent, i.e. beyond its intersection with the seat tube. This allows an electronics housing **50** to be disposed rearward of the seat tube, between the first and second (i.e., upper and lower) top tubes. In other cases, the electronics housing may be disposed in front of the seat tube, but still between the top tubes. In still other cases, the controlling electronics may be disposed elsewhere than in a housing between the top tubes, such as in a bag that may be removably attached to a portion of the bicycle frame or to a rack. When electronics housing **50** is disposed at the rear of the frame as in FIG. **1**, a rearward portion of the housing may include one or more lights, such as integrated safety lights **51** configured to receive power from the batteries stored within the frame.

Electronics housing **50** is configured to be electrically connected to batteries **42**, **44** stored within the top tubes. Specifically, in the embodiment depicted in FIGS. **1-4**, upper and lower battery end caps **52**, **54** are provided and configured to fit around seat tube **16** and each to provide an electrical conduit, generally indicated at **56**, **58** in FIG. **4**, between a

respective one of the batteries and electronics housing **50**. Conduits **56**, **58** each include a pair of detents indicated at **60**, **62** formed in opposing lateral sides of the respective battery end cap and configured to allow passage of wires from the battery to the electronics housing. For example, substantially flat wires **64**, **66** are shown passing through detents **60**, **62** in FIG. **4**. Another similar wire (not shown) passes through a similar detent on the opposing lateral side of each battery end cap and carries the opposite electrical polarity.

In other cases, an electrical conduit between each battery and the electronics housing may be formed in some other manner, such as by passing a wire through or around the seat tube, with or without the use of a battery end cap of the type shown in FIG. **4**. Furthermore, according to the present teachings, conduits provided by battery end caps need not be configured to accommodate flat wires, but instead may have any other shape configured to accommodate electrical connectors of any desired type, such as cylindrical wires.

Electronics housing typically includes upper and lower "male" electrical plugs **70**, **72**, which are configured to form an electrical connection with a respective one of the battery end caps by interfacing with a corresponding "female" connector in each end cap. Other forms of electrical connection between the electronics housing and the battery end caps are possible, including reversing the disposition of the "male" and "female" connectors, or eliminating those connectors entirely and instead using some other form of electrical connection, such as banana plugs, or simply wiring the batteries directly to the electronics housing. However, the plug configuration depicted in FIG. **4** allows convenient installation and removal of the electronics housing from the electric bicycle. Similarly, the electronics housing itself may include a removable rear portion **74**, within which one or more lights such as light **51** may be disposed.

In addition to the various tubes described previously, bicycle **10** also will typically include various other parts of a working electric bicycle, such as a front fork **32** extending generally downward from the lower portion of the head tube and providing a pair of front wheel dropouts **82**, a front wheel **84**, and a rear wheel **86**. Furthermore, the electric bicycle will include an electric motor (not shown) attached to some portion of the bicycle drive train, such as to the front wheel hub, rear wheel hub, or bottom bracket, although other attachments are also possible.

The batteries stored in the top tubes are generally configured to provide locomotive power to the electric bicycle, typically through a power controller, generally indicated at **90**, which is disposed in the electronics housing. Controller **90** is configured to provide power from the batteries to the motor of the bicycle according to a control algorithm. This can be accomplished through an electrical connection between the controller and the motor. This electrical connection may include wires disposed entirely within the bicycle frame, although in some cases one or more segments of wire may be disposed outside the frame.

FIGS. **5-6** depict close-up views of a rack system, generally indicated at **100**, suitable for mounting a rack on the front portion of a bicycle such as electric bicycle **10**. Rack system **100** includes a rack **102** that is configured to connect with an integrated mounting portion **104** of bicycle frame **12**. In FIGS. **5-6**, mounting portion **104** takes the form of a pair of substantially horizontal mounting tubes **106**, **108** connected to down tube **14** on opposing lateral sides of the down tube. An angled bridge portion **110** connects the horizontal mounting tubes to head tube **26** via a connecting tube **112** that passes between a central portion of the head tube and bridge portion **110**. Three transverse tubes **114**, **116**, **118** provide additional structural integrity to mounting portion **104** and provide an attachment mechanism for rack **102**, as described in more detail below.

More specifically, as can be seen in FIG. **6**, transverse tube **114** includes a plurality of movable protrusions **120**, **122**, **124**, all of which are attached to a spring-biased member (not shown) that can slide within transverse tube **114**. As indicated by the arrows in FIG. **6**, these three protrusions may be slid from left to right in order to engage the rear protrusions **120**, **124** with complementary slots **126**, **128** in a connection member **130** of rack **102**. This is typically done by a user by manually moving front protrusion **122**, which causes the spring-biased member and thus the rear protrusions also to move. In addition, rack **102** includes L-shaped brace members **132**, **134** configured to fit under transverse tube **118** of mounting portion **104**.

To engage the rack with the mounting portion, a user angles the rack slightly downward, fits brace members **132**, **134** under transverse tube **118**, lowers the rack toward the horizontal, slides protrusion **122** to the right causing protrusions **120**, **124** also to move toward the right, engages protrusions **120**, **124** with complementary slots **126**, **128** of connection member **130**, lowers the rack to a completely horizontal position, and then releases protrusion **122**, allowing spring-biased protrusions **120**, **124** to slide back toward the left within slots **126**, **128**. At this point, rack **102** will be securely engaged with mounting portion **104** by the combination of brace members **132**, **134** disposed under transverse tube **118**, and protrusions **120**, **124** engaged within slots **126**, **128**.

Although a specific attachment mechanism for mounting rack **102** to mounting portion **104** is shown in FIGS. **5-6** and described above, the present teachings contemplate more general attachment mechanisms. For example, any number of attachment protrusions may be used, rather than exactly two for engaging the rack and one for providing manual input from a user. Furthermore, the size and shape of these protrusions, and of the mechanism that allows a user to move the protrusions, may be varied. In addition, the protrusions themselves may be located on either the mounting portion of the frame (as shown in FIGS. **5-6**) or on the rack itself (not shown), in which case the complementary slots will be disposed on the mounting portion of the frame.

Generally speaking, any number, size or shape of mounting protrusions may be used and disposed either on the rack itself or the mounting portion of the frame, in conjunction with complementary slots or apertures of suitable design. Similarly, different, sizes, shapes and numbers of brace members may be used, and in some cases no brace members at all may be used, in which case another set of mounting protrusions and complementary apertures may be used instead. The mounting protrusions need not be spring biased, but in some cases instead may be biased toward or otherwise securable in a mounting position by some other suitable mechanism.

The present teachings also contemplate that the attachment mechanism used to engage rack **102** with frame mounting portion **104** may be used to attach things other than rack **102** to the bicycle. For example, the attachment mechanism may be used to attach racks of other sizes and/or styles, bags such as panniers, baskets, platforms, child-carrying seats or the like. In other words, frame mounting portion **104** may be configured with a universal interface that allows the secure attachment of a plethora of interchangeable accessories to the bicycle frame.

What is claimed is:

1. An electric bicycle, comprising:

a frame, including:

a head tube;

an upper top tube extending generally rearward from an upper portion of the head tube and containing a first battery;

a lower top tube extending generally rearward from a portion of the frame beneath the upper portion of the head tube, oriented substantially parallel to the first top tube and containing a second battery;

a down tube extending generally downward and rearward from the lower portion of the head tube;

a seat tube that intersects the upper top tube, the lower top tube and the down tube;

a fork extending generally downward from the lower portion of the head tube and providing a pair of front wheel dropouts;

a pair of seat stays extending generally downward and rearward from an upper portion of the seat tube; and

a pair of chain stays extending generally rearward from a lower portion of the seat tube to form a pair of rear wheel dropouts in conjunction with the seat stays;

a front wheel;

a rear wheel; and

an electronics housing disposed between the upper top tube and the lower top tube and rearward of the seat tube;

wherein the batteries are configured to provide locomotive power to the electric bicycle; and

wherein each top tube extends rearward beyond its intersection with the seat tube.

2. The electric bicycle of claim **1**, further comprising a controller configured to provide locomotive power from the batteries to the bicycle according to a control algorithm.

3. The electric bicycle of claim **2**, wherein the controller is configured to provide locomotive power from the batteries to the bicycle through an electrical connection disposed entirely within the frame.

4. The bicycle of claim **1**, wherein the upper top tube and the lower top tube are each substantially horizontal.

5. An electric bicycle, comprising:

a down tube;

a seat tube intersecting a lower portion of the down tube at a bottom bracket region;

a pair of chain stays each extending backward from the bottom bracket region to a rear wheel dropout;

a pair of seat stays each extending generally upward and forward from a corresponding one of the rear wheel dropouts to intersect the seat tube;

a head tube having a lower portion that intersects an upper portion of the down tube and which is configured to receive a bicycle fork steerer tube, and an upper portion which is configured to receive a bicycle handlebar stem;

a first top tube extending between either the lower portion of the head tube or an upper portion of the down tube and the seat tube;

a second top tube extending between the upper portion of the head tube and the seat tube; and

an electronics housing disposed between the first and second top tubes and configured to be electrically connected to batteries stored within the top tubes;

wherein the first and second top tubes are each configured to hold a battery for powering an electric motor of the bicycle.

6. The electric bicycle of claim **5**, wherein the electronics housing is disposed rearward of the seat tube, and further comprising at least one battery end cap configured to fit around the seat tube and to provide an electrical conduit between one of the batteries and the electronics housing.

7. The electric bicycle of claim **6**, wherein the at least one battery end cap includes a pair of battery end caps each configured to provide an electrical conduit between a respective one of the batteries and the electronics housing.

8. The electric bicycle of claim **6**, wherein the electrical conduit includes a pair of detents formed in opposing lateral sides of the battery end cap and configured to allow passage of wires from the battery to the electronics housing.

9. The electric bicycle of claim **8**, wherein the wires are substantially flat.

10. The electric bicycle of claim **6**, wherein a rearward portion of the electronics housing includes at least one integrated safety light configured to receive power from the batteries.

11. The bicycle of claim **5**, wherein the first top tube and the second top tube are each substantially horizontal.

12. A bicycle frame for an electric bicycle, comprising:

a head tube;

an upper top tube extending generally rearward from an upper portion of the head tube;

a lower top tube extending generally rearward from a portion of the frame below the upper top tube and oriented substantially parallel to the upper top tube;

a down tube extending generally downward and rearward from the lower portion of the head tube;

a seat tube that intersects the upper top tube, the lower top tube and the down tube; and

an electronics housing disposed between the upper top tube and the lower top tube and rearward of the seat tube;

wherein each top tube is configured to contain a battery for powering the bicycle; and

wherein each top tube extends rearward beyond its intersection with the seat tube.

13. The bicycle frame of claim **12**, further comprising upper and lower battery end caps each configured to fit around the seat tube and to provide an electrical conduit between a respective one of the batteries and the electronics housing.

14. The bicycle frame of claim **13**, wherein the electronics housing includes upper and lower electrical plugs configured to form an electrical connection with a respective one of the battery end caps.

15. The bicycle frame of claim **13**, wherein the battery end caps each include a pair of detents disposed on opposite sides of the seat tube and forming the electrical conduit.

16. The bicycle frame of claim **15**, wherein the detents are configured to provide a passage for a pair of substantially flat wires connecting the respective one of the batteries to the electronics housing.

17. The bicycle frame of claim **12**, wherein the upper top tube and the lower top tube are each substantially horizontal.

* * * * *