



ПАТЕНТНО ВЕДОМСТВО НА РЕПУБЛИКА БЪЛГАРИЯ

София,
Ж.к. Южен парк, бл.1р вх.Д, ап.1
invertortonchev@gmail.com
Георги Тончев

Наш знак:	СПИС-71	29.01.2025
Ваш знак:		

Искане за предварително проучване за новост на
изобретение с наименование
„Леко надлъжно сгъваемо двойно моторизирано превозно средство
с предно кормилно управление“

Патентното ведомство Ви уведомява, че във връзка с Ваше искане № СПИС-71 от 20.01.2025г. е извършено проучване въз основа на:

- ☒ описанието, претенциите
- ☒ приложените фигури

Класове по МПК: B62K3/00; B62K15/00; B62K21/16; B62M1/10
Класове по КПК: B62K21/16; B62K15/006

Бази-данни: IPAS; Esp@cenet,

При проучването са намерени следните документи, посочени в приложения доклад:

Патентни документи:

WO2017029641 (A1), US2021197919 (A1), WO2024246806 (A1)

И. Стефанова
Главен експерт ДЕЗИПМПД

СТАНОВИЩЕ

ОТНОСНО: предварително проучване за новост на
изобретение с наименование

„Леко надлъжно сгъваемо двойно моторизирано превозно средство
с предно кормилно управление“
вх. № СпИС-71/22.01.2025 г.

Проучването е направено въз основа на представените 24 патентни претенции описание и приложените към него фигури.

Обектът на настоящето проучване е леко надлъжно сгъваемо двойно моторизирано превозно средство с предно кормилно управление.

Съгласно независима патентна претенция 1, лекото надлъжно сгъваемо двойно моторизирано превозно средство с предно кормилно управление, включва задвижващи колела, спирачни колесни системи, монтирани на колелата и основен акумулатор, като поне една спирачна колесна система е безжично свързана, през ръчен механичен спирачен превключвател със съответен спирачен сигнален вход на програмируем управляем контролер; в главините на задвижващите колела са фиксирани електромотор- алтернатори, а поне две от задвижващите колела са монтирани в перифериите на напречен носещ мост, който е подвижно механично свързан, през ексцентрична реверсивна ротационна електрическа задвижка, към задната част на надлъжна рама, в чиято горна предна част е монтирано предното кормило с поне едно управляващо колело с педали, в подкормилната част на надлъжната рама е монтиран фрикционен електродвигател с вграден в него акумулатор и собствено управление, безжично свързано с управляващ извод от програмируемия управляем контролер; фрикционният електродвигател е фрикционно куплиран с управляващото колело, при което на горната страна на надлъжната рама е монтирана поне една седалка, основният акумулатор е двумодулен и е подвижно монтиран към напречния носещ мост, а негов електрически изход, през програмируемия управляем контролер, е свързан с електрически вход на поне един електромотор-алтернатор, извод от бутонен електропревключващ механизъм е безжично свързан с изпълнителен вход на програмируемия управляем контролер, чиито съответен изпълнителен извод е свързан с електрически вход на ексцентричната реверсивна реверсивна ротационна електрическа задвижка, електрически извод от ръчен масур за електрическо управление на движението е свързан към двигателен вход на програмируемия управляем контролер, чиито изпълнителни спирачни изводи са свързани със спирачните входове на съответните спирачни колесни системи, като програмируемият управляем контролер е конфигуриран за програмиране със самообучаващ се изкуствен интелект.

Съгласно зависима претенция 2, електромотор-алтернаторите са безчеткови обратими електросилови машини.

Съгласно зависима претенция 3, ексцентричната реверсивна ротационна електрическа задвижка включва реверсивен стъпков електромотор с ротор от постоянни магнити.

Съгласно зависима претенция 4, педалите са монтирани на свободен ход в перифериите на вала на управляващото колело .

Съгласно зависима претенция 5, напречният носещ мост и надлъжна рама са изработени от олекотени многократно рециклируеми материали.

Съгласно зависима претенция 6, поне една седалка е монтирана към надлъжна рама , чрез амортисьор .

Съгласно зависима претенция 7, основният акумулатор е многократно зареждаем.

Съгласно зависима претенция 8, педалите са сгъваеми.

Съгласно зависима претенция 9, в задната част на поне една седалка е монтирана регулируема по наклон облегалка с предпазни колани.

Съгласно зависима претенция 10, седалките са еднакви.

Съгласно зависима претенция 11, на горната задна страна върху надлъжната рама е монтиран багажник.

Съгласно зависима претенция 12, задвижващите колела и управляващите колела са с еднакви външни диаметри.

Съгласно зависима претенция 13, електромотор-алтернаторите са с еднакви външни диаметри.

Съгласно зависима претенция 14, валът на управляващото колело е монтиран на L-образна вилка с хидро- пневматични амортисьори.

Съгласно зависима претенция 15, L-образната вилка е свързана с предното кормило (9), чрез телескопична тръба.

Съгласно зависима претенция 16, задвижващите колела са монтирани в перифериите на напречния носещ мост, чрез еластомерни торсионни амортисьори.

Съгласно зависима претенция 17, на напречния носещ мост е монтиран сваляем фотоволтаичен сенник.

Съгласно зависима претенция 18, ексцентричната реверсивна ротационна електрическа задвижка е регулируема по височина и по наклон.

Съгласно зависима претенция 19, основният акумулатор е преносим.

Съгласно зависима претенция 20, фрикционният електродвигател с вградения в него акумулатор са преносими.

Съгласно зависима претенция 21, вграденият във фрикционното задвижване акумулатор и основният акумулатор са литиево-йонни.

Съгласно зависима претенция 22, акумулатор и основният акумулатор са оловно-киселинни.

Съгласно зависима претенция 23, вграденият във фрикционното задвижване акумулатор и основният акумулатор са натриево-йонни.

Съгласно зависима претенция 24, програмируемият управляем контролер включва оперативна и архивна цифрова памет.

Обект на настоящето проучване е леко надлъжно сгъваемо двойно моторизирано превозно средство с предно кормилно управление, което е с две независими електрически двигателни системи и с олекотено компактно безверижно педално задвижване, с повече от едно места бързоелектрическо автоматично надлъжно сгъване и разгъване, като собствения контролер е програмиран със самообучаващ се изкуствен интелект.

В патентен документ WO2017029641 (A1) е разкрита съгваема триколка с връзка към трите колела, позволяваща по-малък радиус на завиване, когато и трите колела са наклонени по време на завой. Триколката се съгва през задната рамка, имаща шарнирна задна ос с връзка към шарнирни дръжки, монтирани към задната рамка, които, когато се завъртят от позицията им за съхранение в тяхната работна позиция, също завъртат задната ос, чрез споменатата връзка от нейната позиция под задната рамка в работно положение. Задната ос е сегментирана така, че когато се премести в съхранена позиция под задната рамка, всяко от задните колела може да се свие шарнирно към рамката.

Съгваемо превозно средство с три колела, включва също: криволинейна рамка на предното колело, образуваща релса, имаща преден край и заден край, имащ шпиндел, допирателно стърчащ от него. Споменатият преден край има плъзгащ се педал, монтиран върху него и неподвижно позициониран към него; споменатият педален възел, е неподвижно прикрепен към съответния амортизатор, като крайният край на амортизаторите е неподвижно прикрепен към оста на предното колело; рамка на задните колела; комплект седалка; споменатата рамка на задните колела с въртяща се стойка на кормилната връзка, имаща канал през нея.

В патентен документ US2021197919 (A1) са разкрити съгваем велосипед и метод за съгване на велосипеда. Съгваемият велосипед включва: рамка, имаща първи край и втори край; първо колело, свързано с втория край на рамката. Към рамката е свързана седалка и вилка, на която вторият край е свързан шарнирно към първия край на рамката. Велосипедът включва също и двигател, задвижващ механизъм и акумулаторна батерия. Акумулаторната батерия се намира под седалката, при което акумулаторната батерия захранва задвижващия механизъм. Към рамката допълнително е включена опора за крака.

В патентен документ WO2024246806 (A1) е разкрито е компактно електрическо превозно средство, включващо един комплект задни колела, конфигурирани да се въртят от един или повече електрически мотора, първи комплект предни колела и втори комплект предни колела; кормилна колона с кормилен механизъм с единична връзка за маневриране на компактното електрическо превозно средство, при което кормилната колона може да се движи, за да превключва превозното средство между първи режим на работа и втори режим на работа; рамка, конфигурирана да свързва задните колела и един или повече електрически мотори с първия комплект предни колела и втория комплект от предни колела и единичен кормилен механизъм с връзка; при което кормилната колона е конфигурирана да може да се накланя спрямо рамката, за да контролира, когато се използва, посоката на движение на компактното електрическо превозно средство; и включващ освен това шарнирен механизъм, конфигуриран да зацепва първия комплект предни колела в първия режим на работа и да зацепва втория комплект предни колела в втори режим на работа.

Анализът на обекта на проучването и известните решения показва следното:

Новост

При извършен сравнителен анализ между обекта, предмет на настоящето проучване и намерените при проучването документи, се установи, че в нито един от намерените документи не е разкрит леко надлъжно съгваемо двойно моторизирано превозно средство с предно кормилно управление, което да включва всички технически признаци на обекта на проучването.



Следователно, обектът на настоящето проучване, съгласно така формулираните претенции е нов по смисъла на чл. 8 от Закона за патентите и регистрацията на полезните модели (ЗПРПМ).

И. Стефанова
Главен експерт ДЕЗИПМПД

ДОКЛАД ОТ ПРОУЧВАНЕ ПРОУЧВАНЕ ВХ. № СпИС-71/22.01.2025г. .		
I. Уточнен класификационен индекс по МПК/КПК		
МПК: B62K3/00; B62K15/00; B62K21/16; B62M1/10 КПК: B62K21/16; B62K15/006		
II. ОБЛАСТ НА ПРОУЧВАНЕ:		
Минимален обхват на проучване		
Вид класификация:	Класификационен индекс:	
МПК/КПК	МПК: B62K3/00; B62K15/00; B62K21/16; B62M1/10 КПК: B62K21/16; B62K15/006	
Бази данни, в които е извършено проучването		
Esp@cenet; IPAS; Internet		
III. Релевантни документи		
Категория	Цитиране на документите с посочване на релевантните части	Релевантни претенции
A	US2021197919 (A1), [CASABLANCAS JULIAN [US] ±], публ.на 01.07.21г.	1-24
A	WO2017029641 (A1), [BERESNITZKY BERNARDO [US] ±], 23.02.17г.	1-24
A	WO2024246806 (A1), [MOOV ELECTRIC VEHICLES [DE] ±], публ.на 05.12.24г.	1-24
Категория на документа X – документът е от особено значение; претендираното изобретение няма новост или изобретателска стъпка, когато документът се разглежда самостоятелно Y – документът е от особено значение; претендираното изобретение няма изобретателска стъпка, когато документът се комбинира с един или повече други документи и тази комбинация е очевидна за специалист в областта A – документ, отразяващ нивото на техниката, който не е от особено значение D – документ, цитиран в описанието O – неписмено разкриване, използване, прилагане, докладване или демонстриране P - документ, публикуван преди датата на подаване в България, но след приоритетната дата E – по-рано подадена българска заявка, но публикувана на или след датата на подаване L – документ, който може да предизвика съмнение относно приоритета на претенциите или който е цитиран с цел установяване датата на публикация на друг документ или друга специална причина (както е посочено) & - документ от една патентна фамилия		
Дата: 29.01.2025	Име: И. Стефанова И. Стефанова Главен експерт ДЕЗИПМПД	



US 20250368289A1

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(12) **Patent Application Publication**
Bayne

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(43) **Pub. Date: Dec. 4, 2025**

(54) **FOLDING E-TRIKE**

(71) Applicant: **ROTA Mobility Inc.**, Los Gatos, CA
(US)

(72) Inventor: **Christopher John Bayne**, Los Gatos,
CA (US)

(21) Appl. No.: **19/220,758**

(22) Filed: **May 28, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/652,378, filed on May
28, 2024.

Publication Classification

(51) **Int. Cl.**
B62K 15/00 (2006.01)
B62J 43/13 (2020.01)

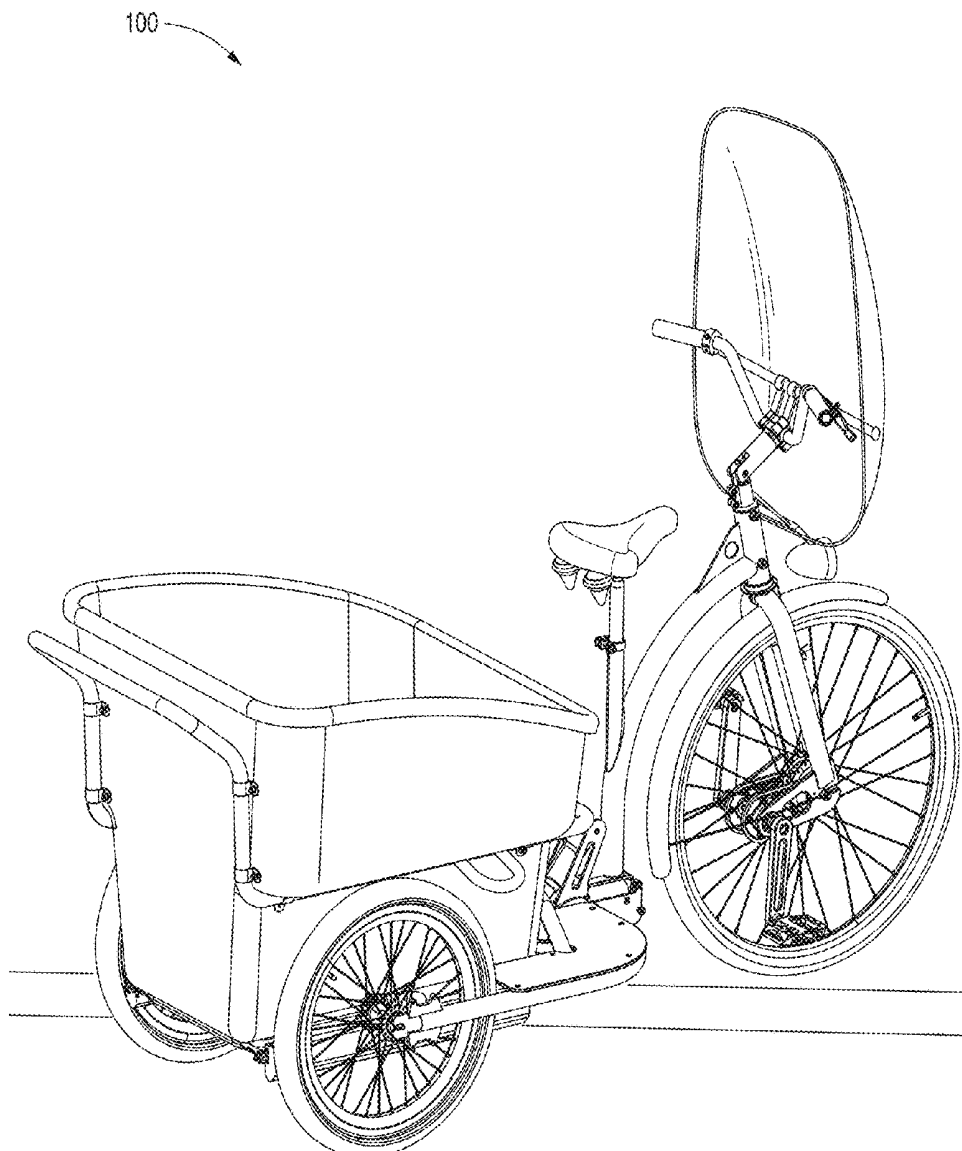
B62K 5/06 (2006.01)

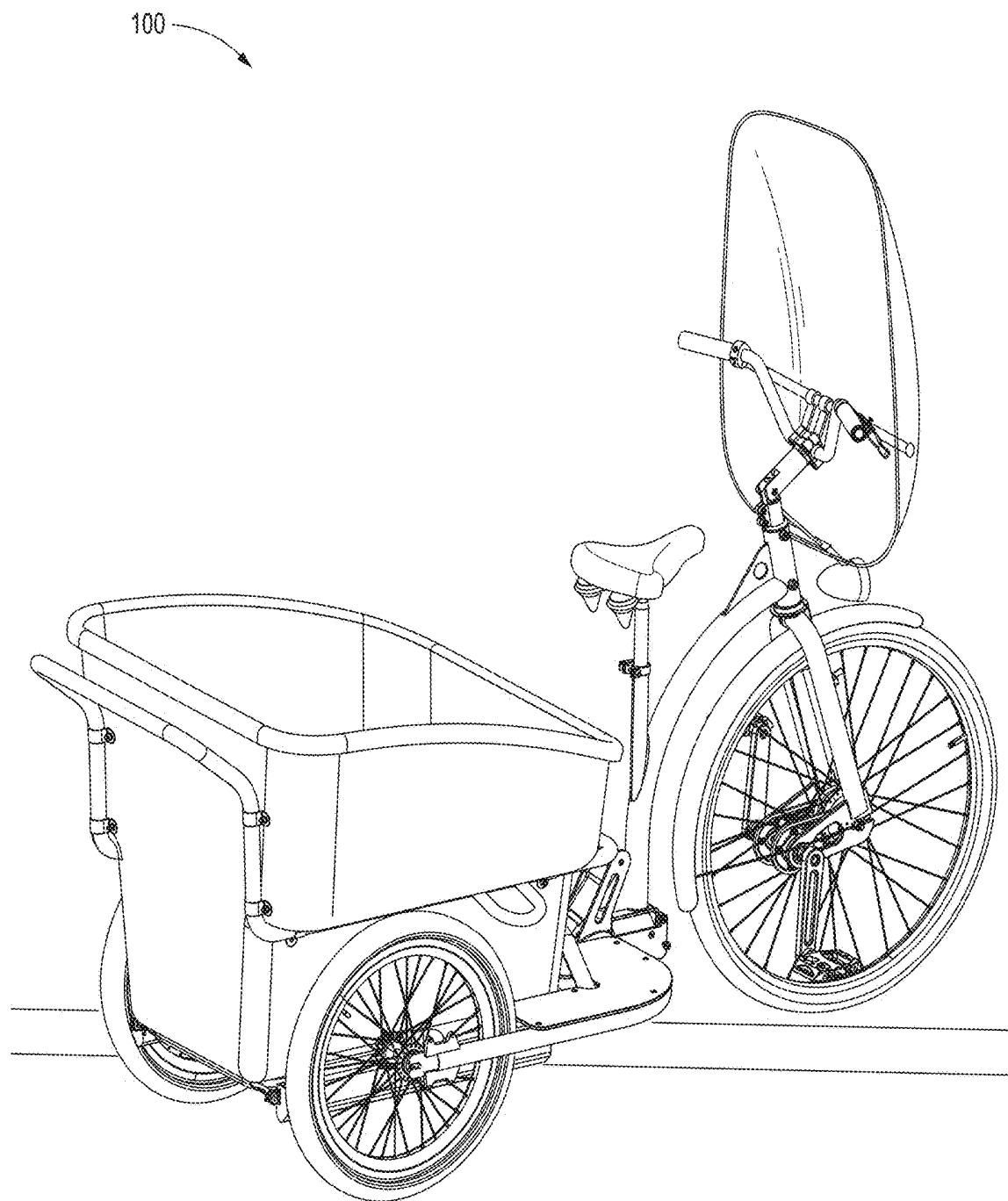
B62M 6/90 (2010.01)

(52) **U.S. Cl.**
CPC **B62K 15/006** (2013.01); **B62J 43/13**
(2020.02); **B62K 5/06** (2013.01); **B62M 6/90**
(2013.01)

(57) **ABSTRACT**

A transportation device is disclosed. One aspect includes a rear assembly that further includes a rear frame, and a first rear wheel and a second rear wheel mounted to the rear frame. The rear assembly may also include a first electric motor and a second electric motor mechanically connected to the first rear wheel and the second rear wheel respectively, and an electrical power source comprising a battery, configured to power the first electric motor and the second electric motor. The transportation device may also include a front assembly that includes a saddle and a front wheel connected to the saddle via a wheel hub and a fork. An aspect includes an elastomeric torsional element connecting the front assembly and the rear assembly.



**FIG. 1**

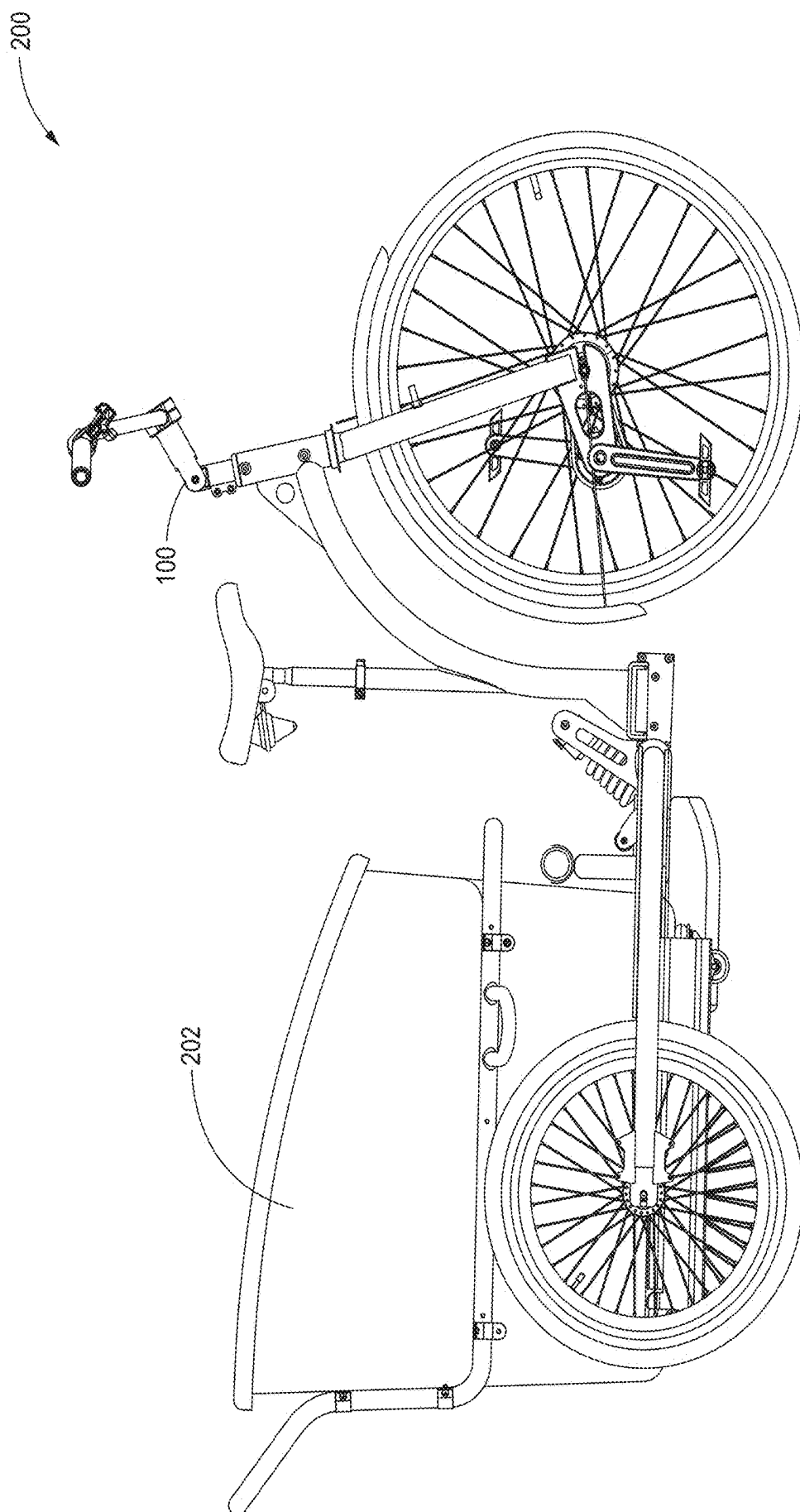


FIG. 2

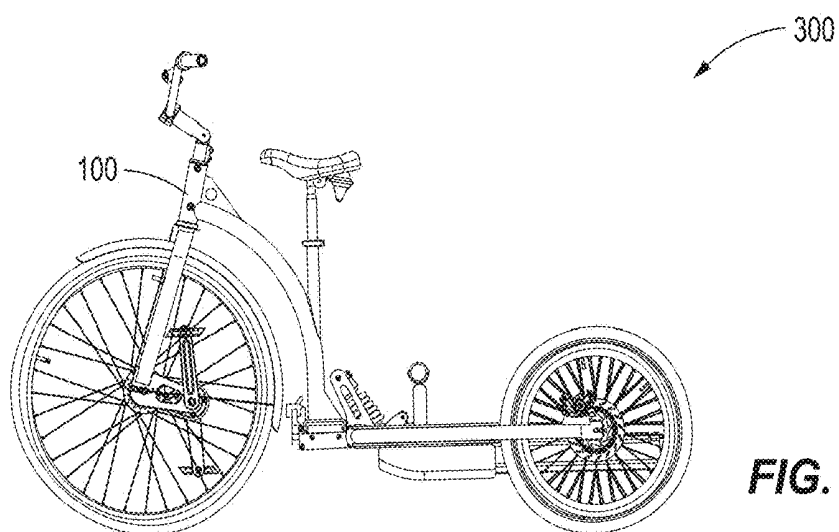


FIG. 3A

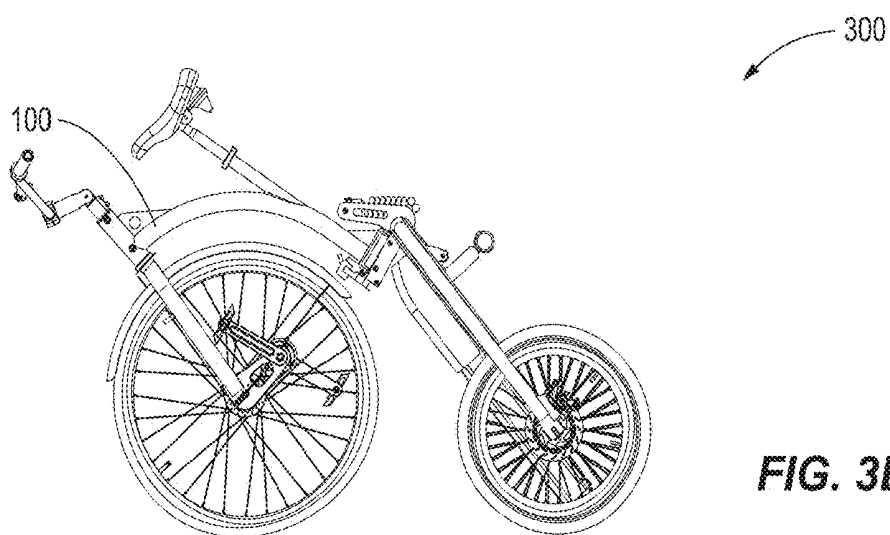


FIG. 3B

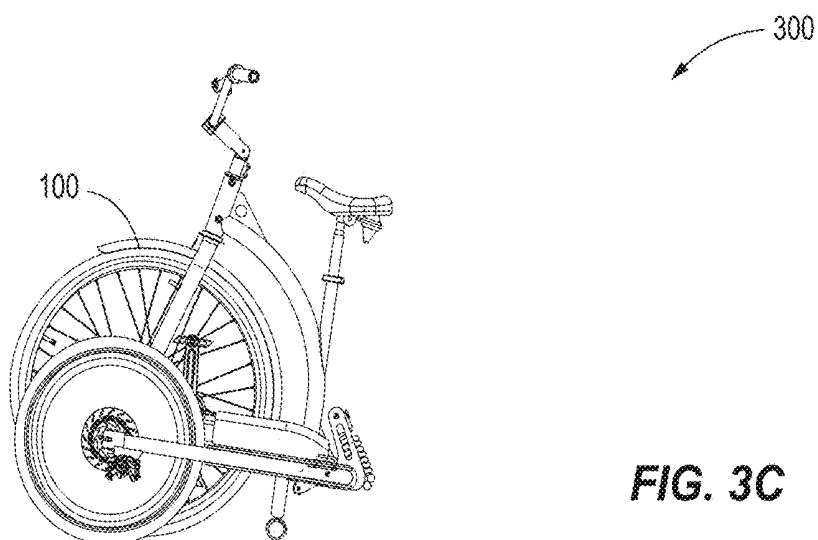


FIG. 3C

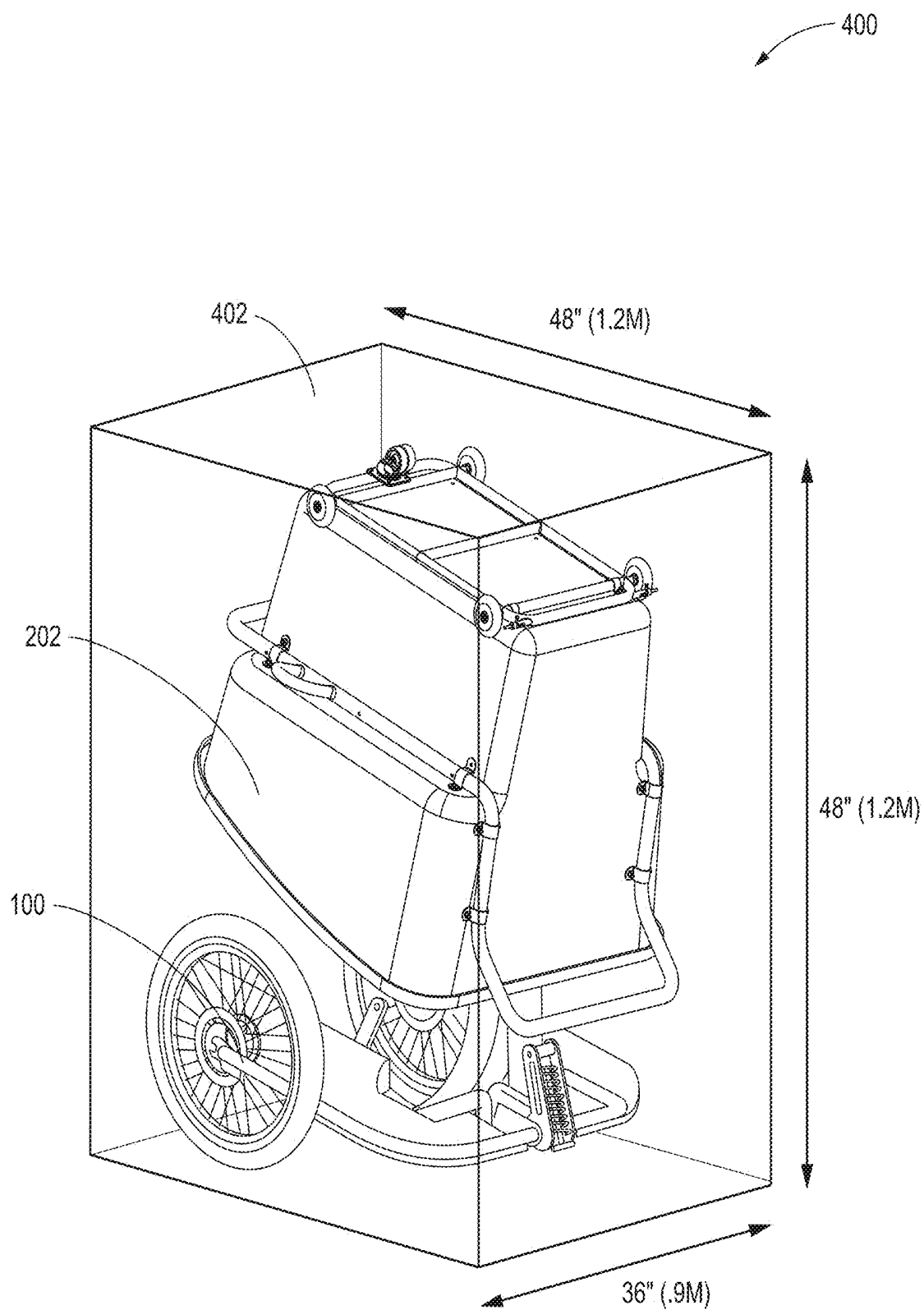


FIG. 4

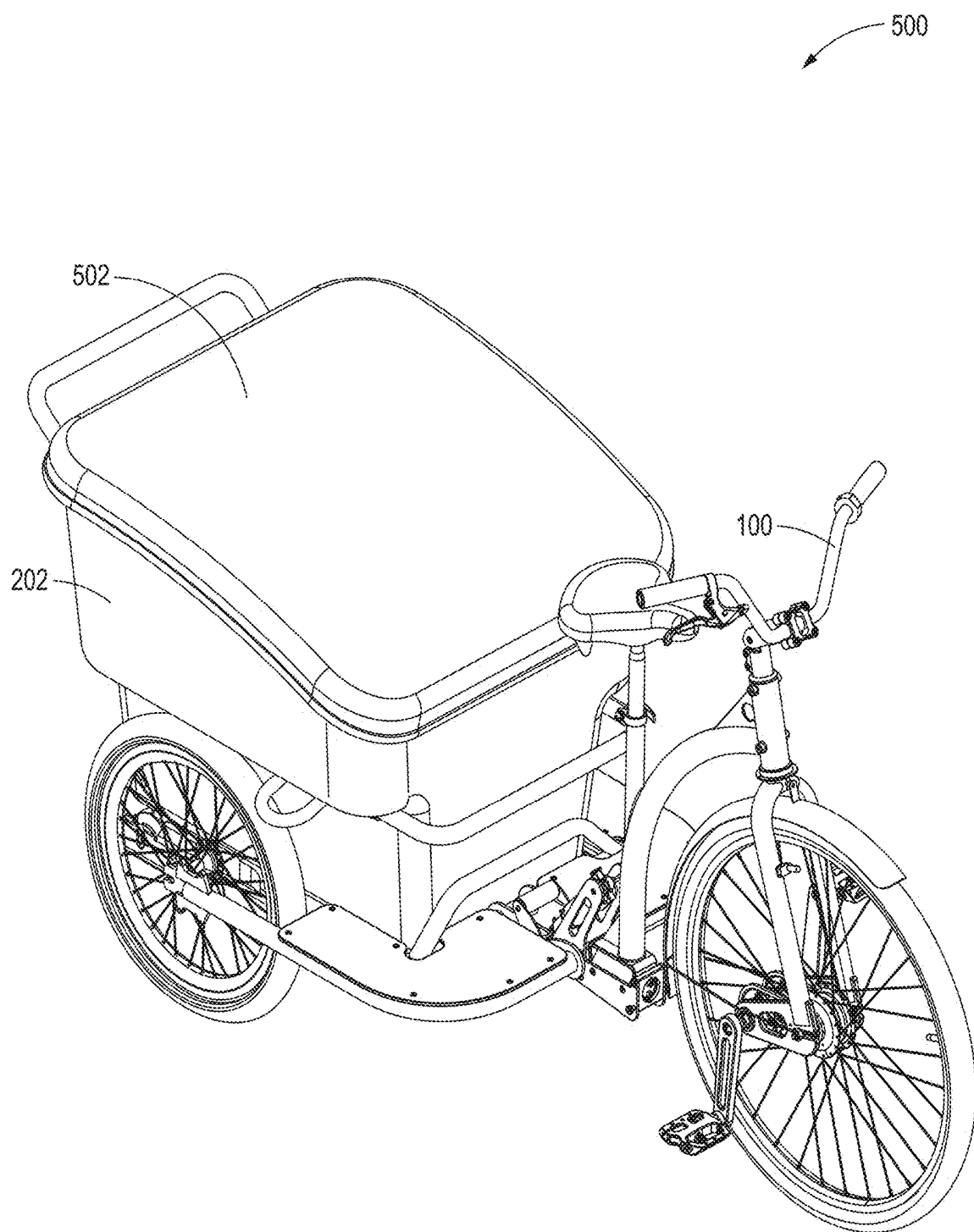


FIG. 5

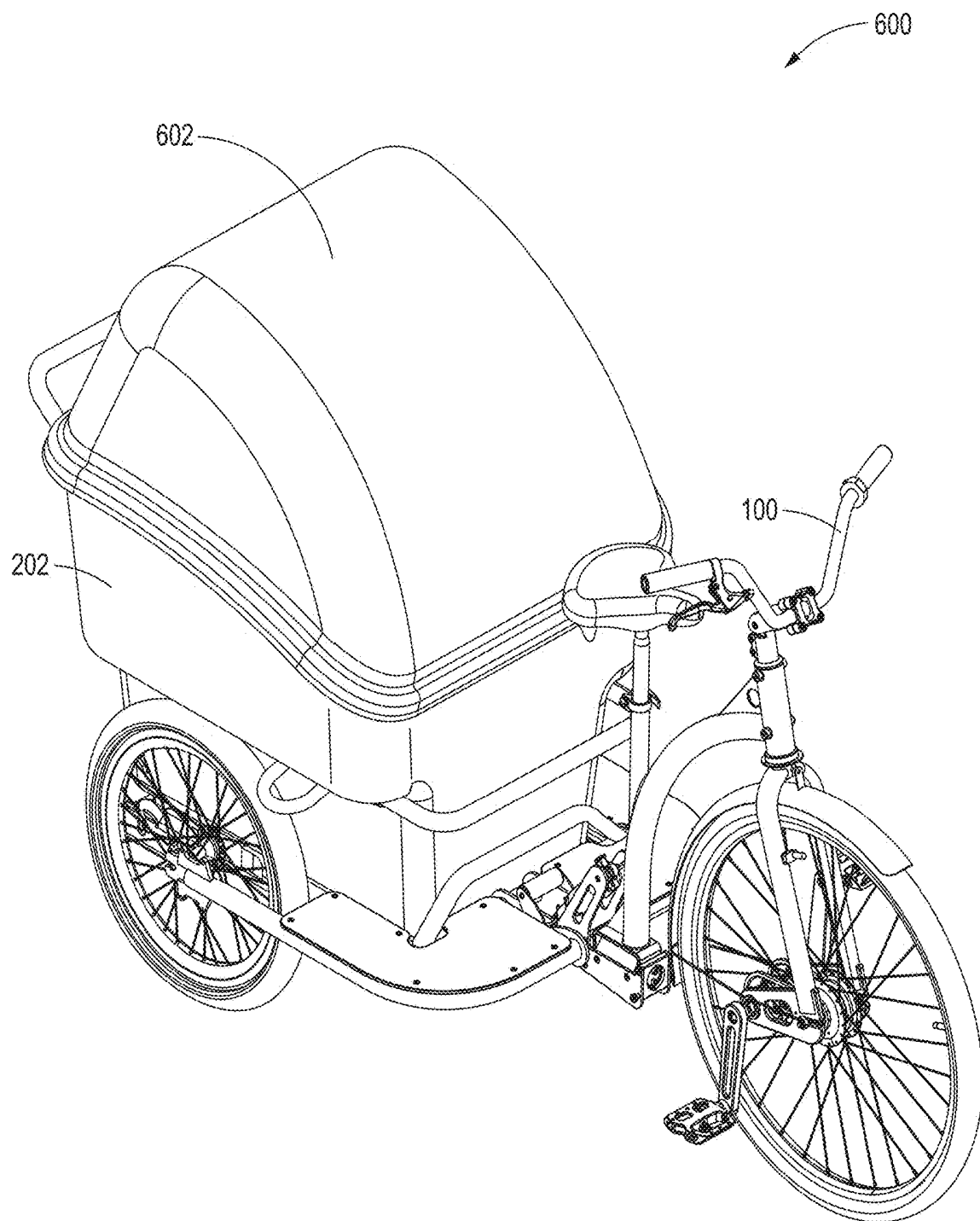


FIG. 6

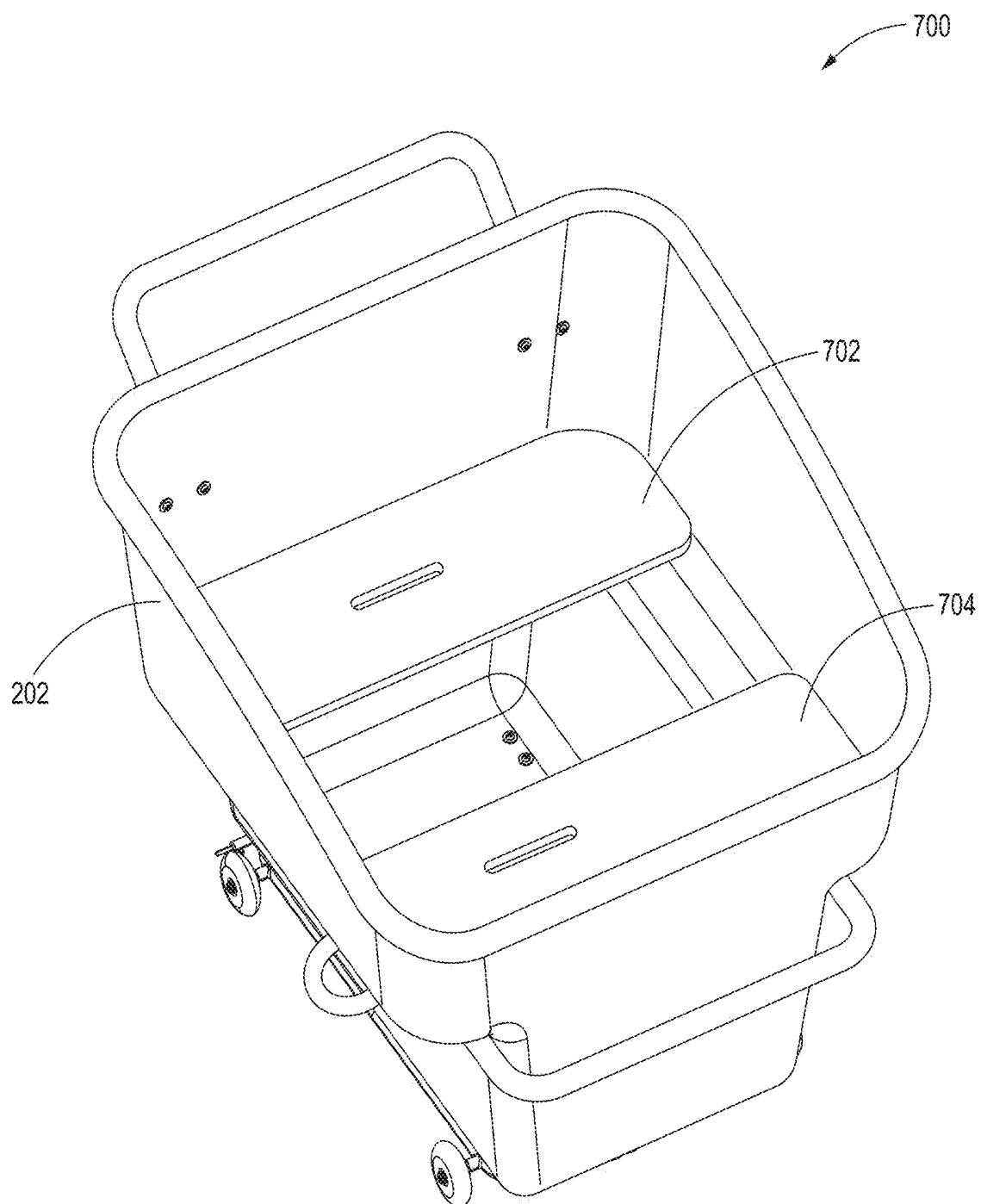


FIG. 7

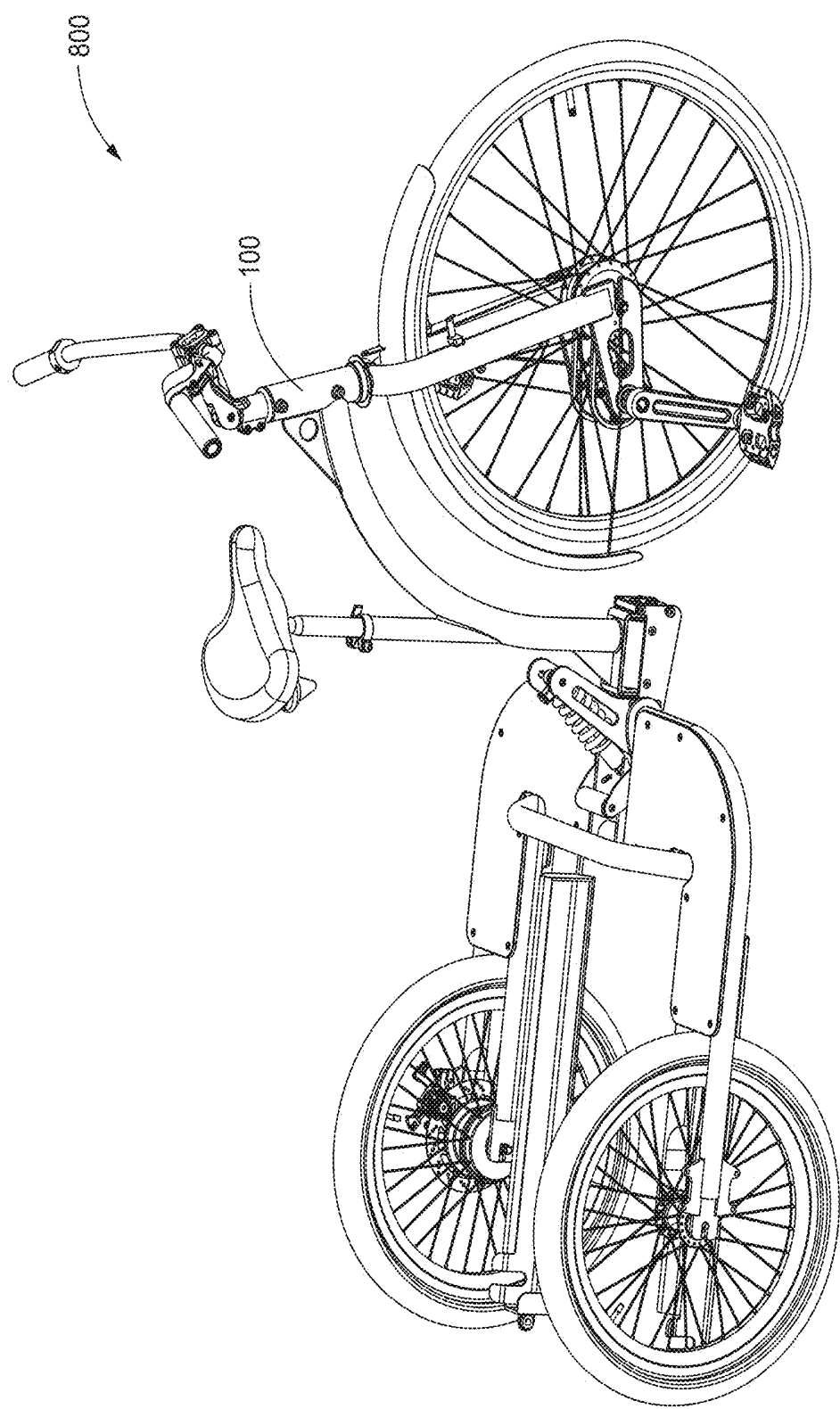


FIG. 8

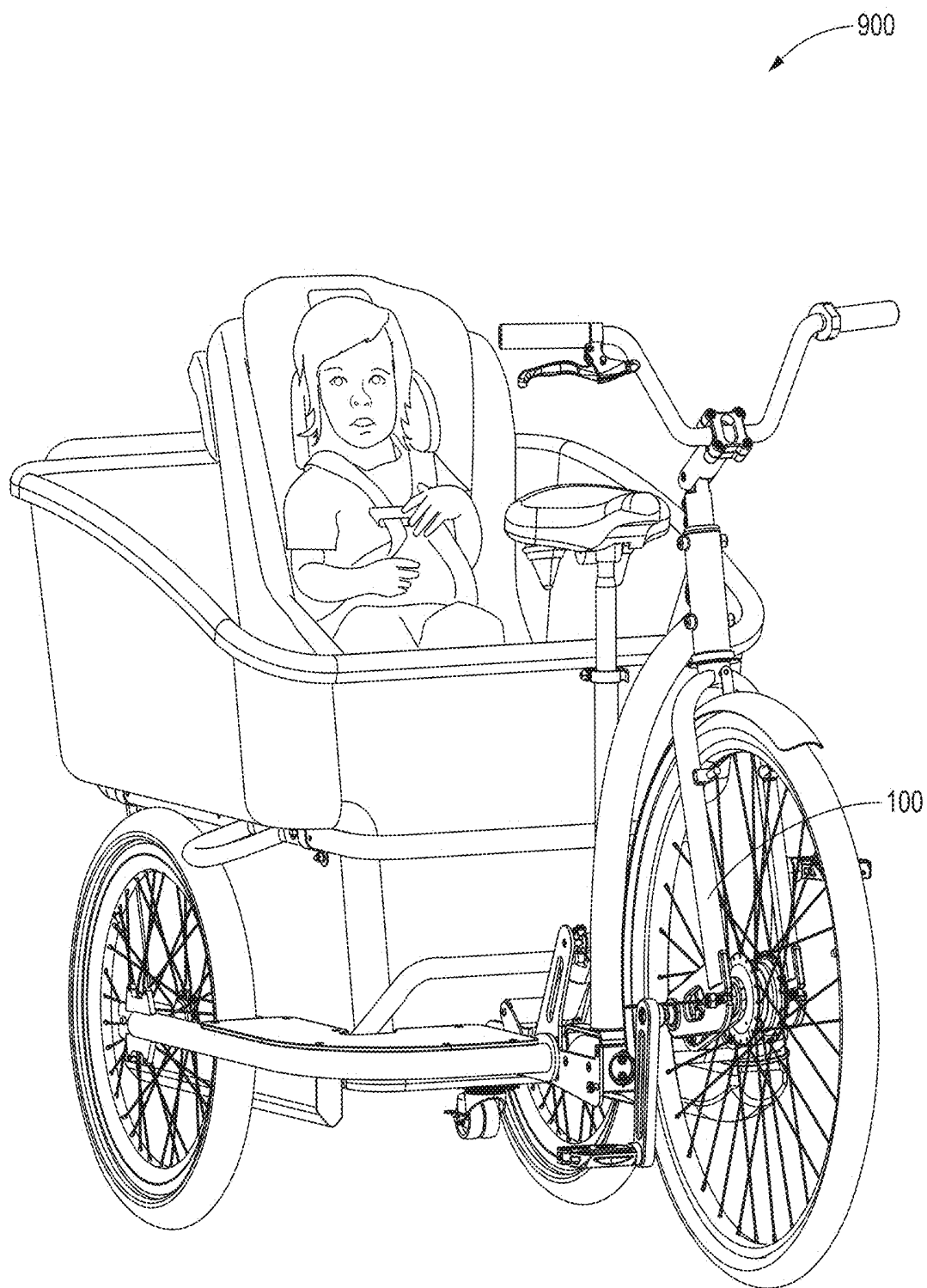


FIG. 9

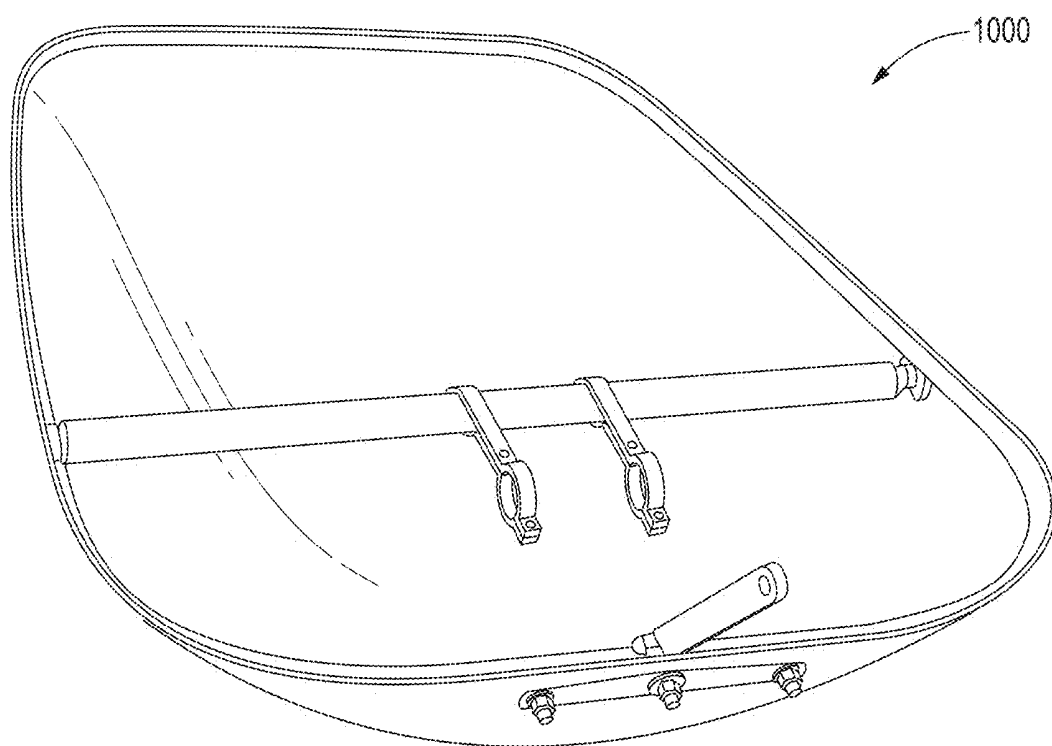


FIG. 10

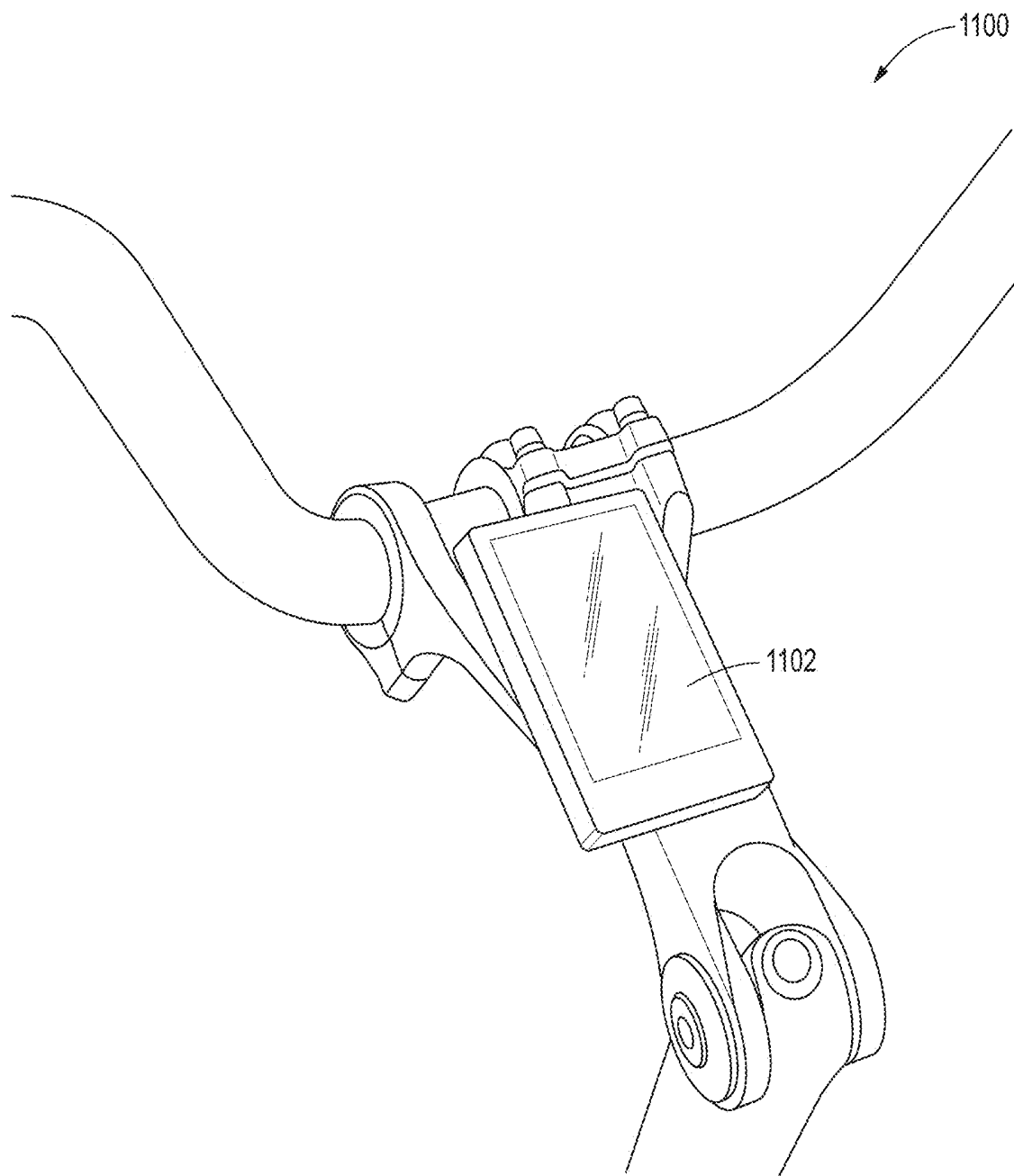


FIG. 11

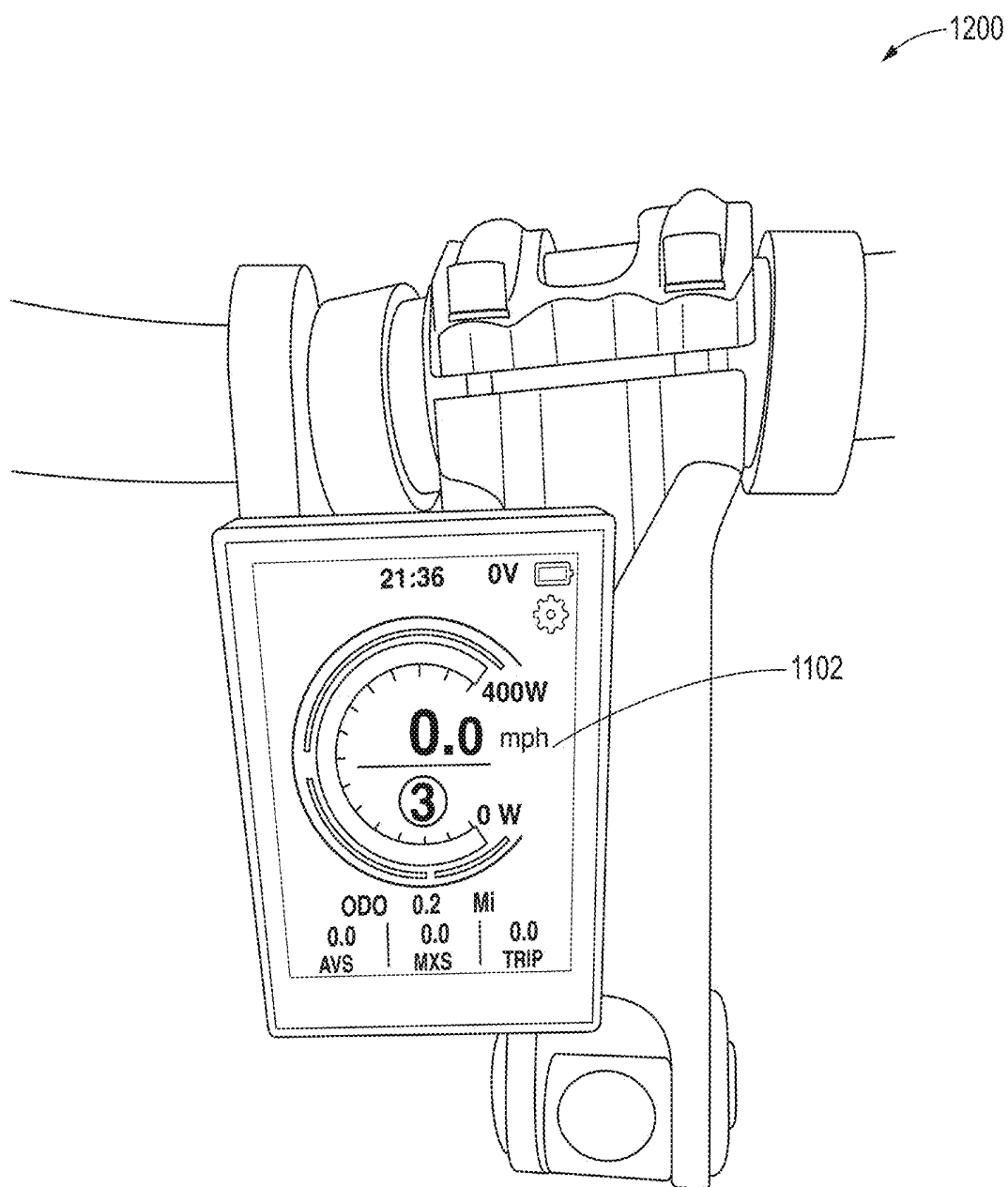


FIG. 12

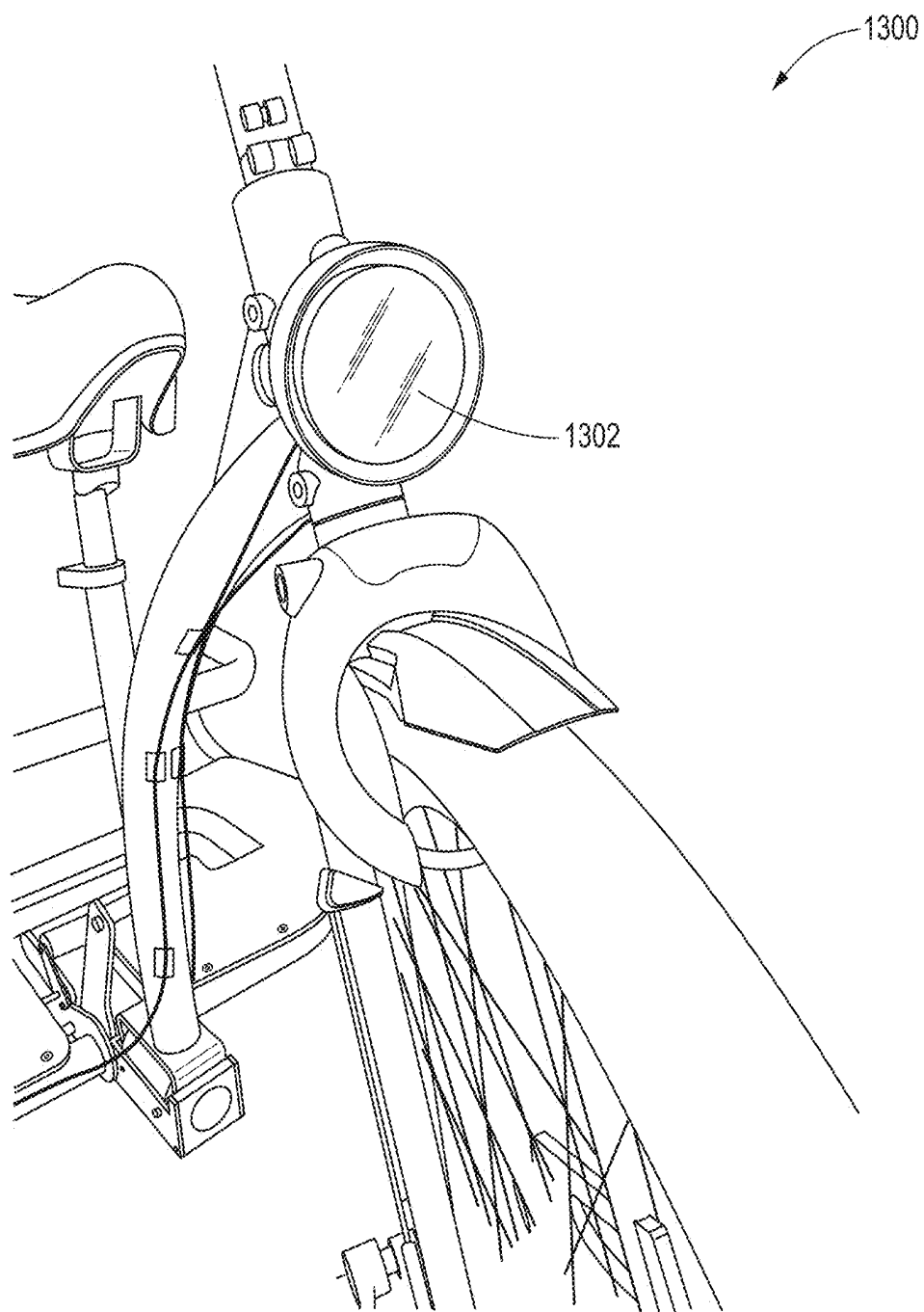


FIG. 13

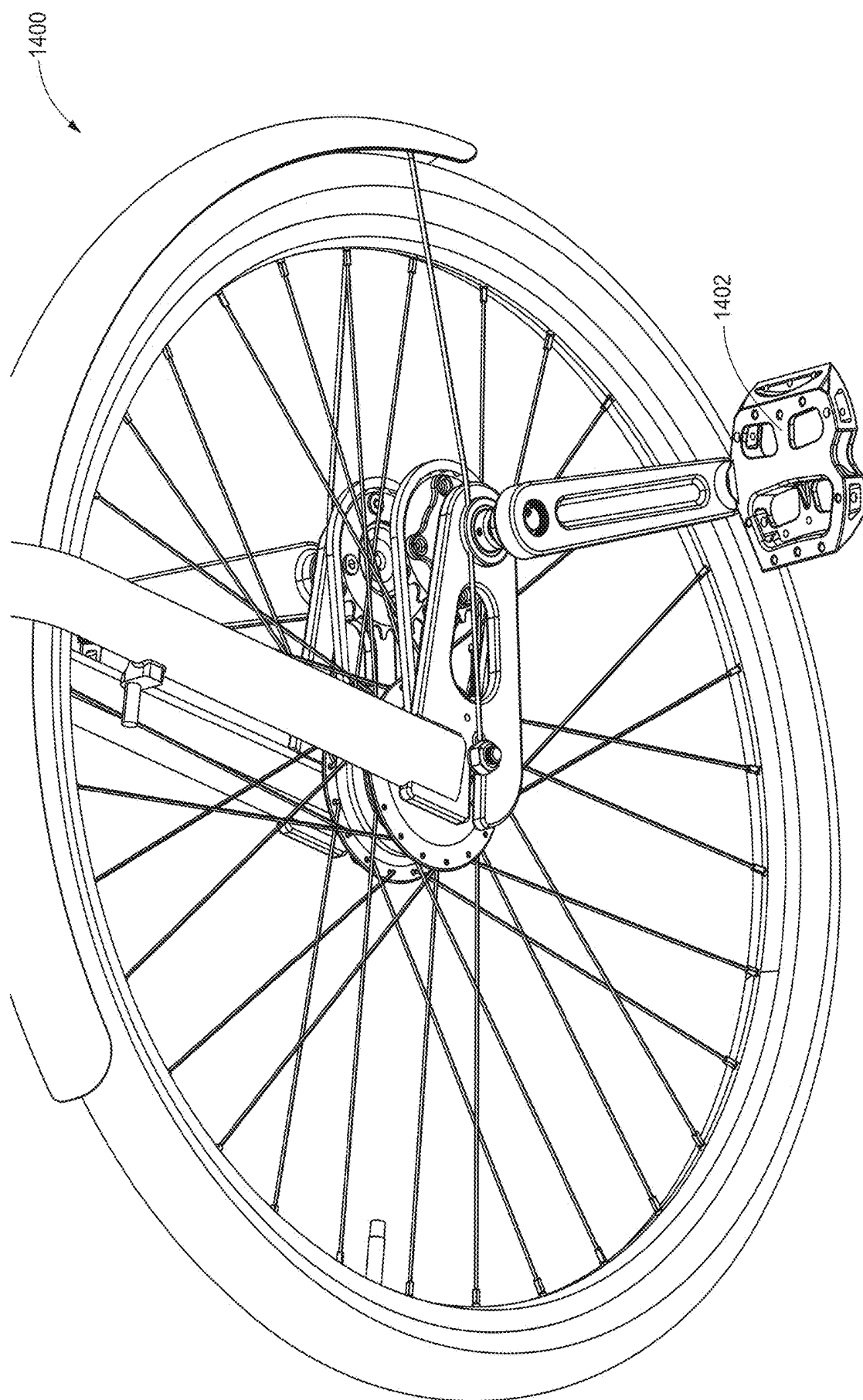


FIG. 14

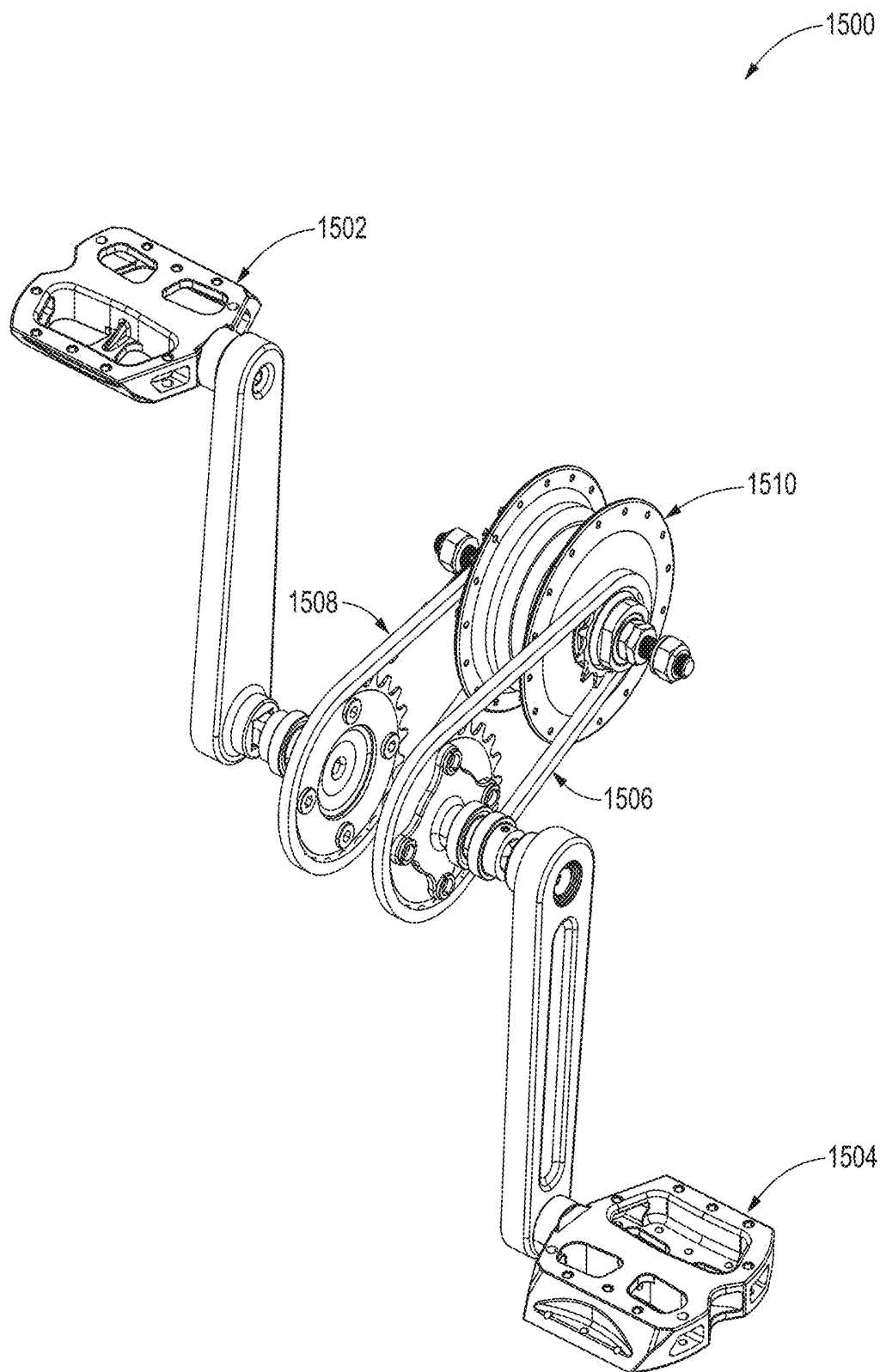


FIG. 15A

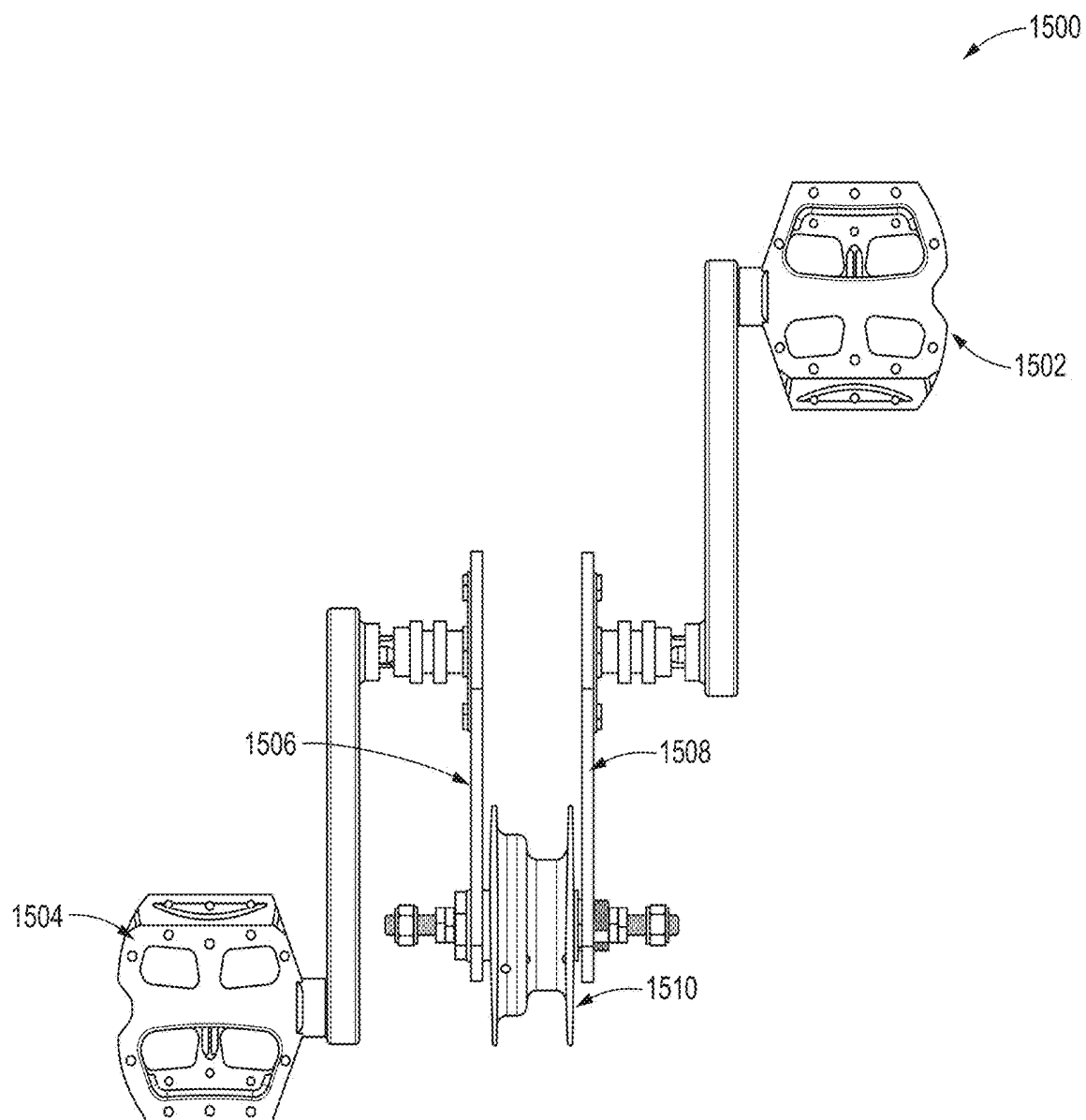


FIG. 15B

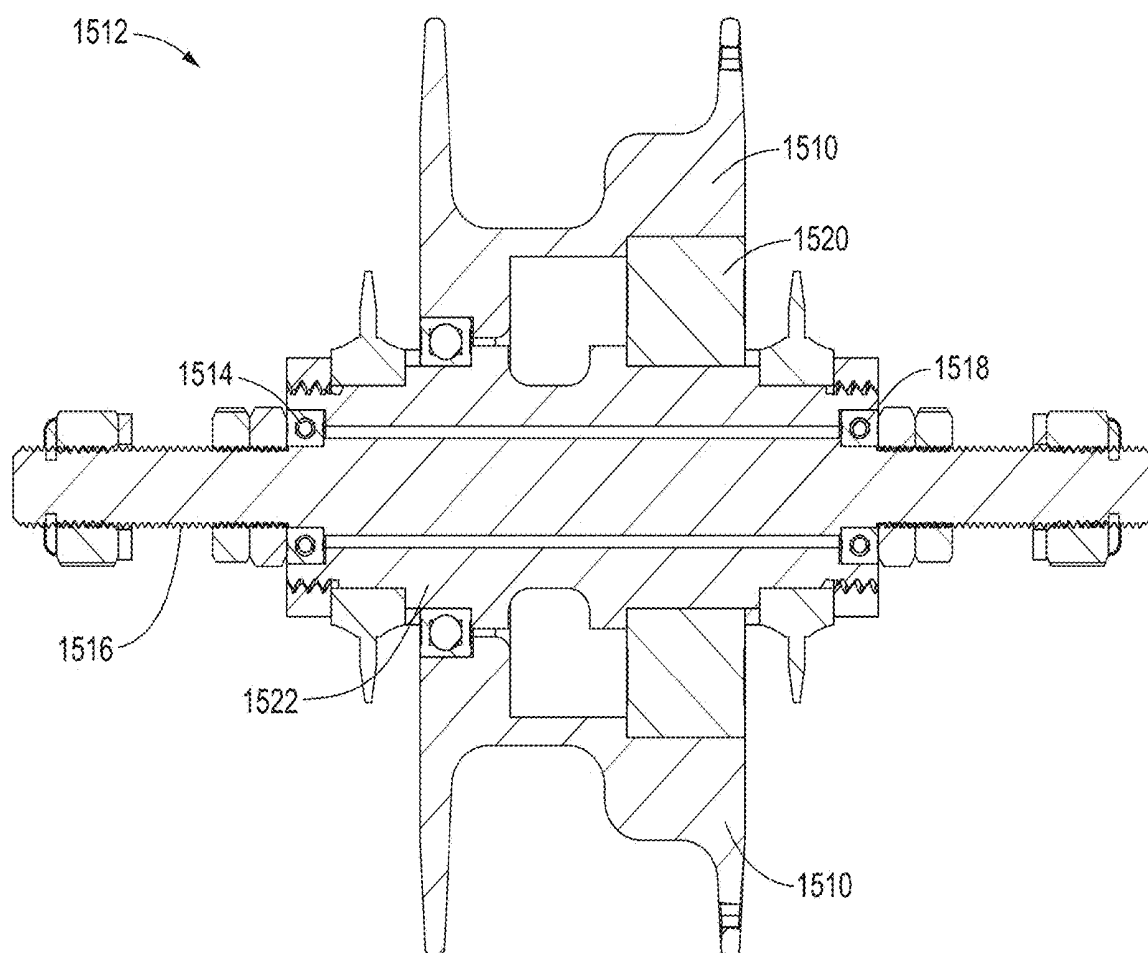
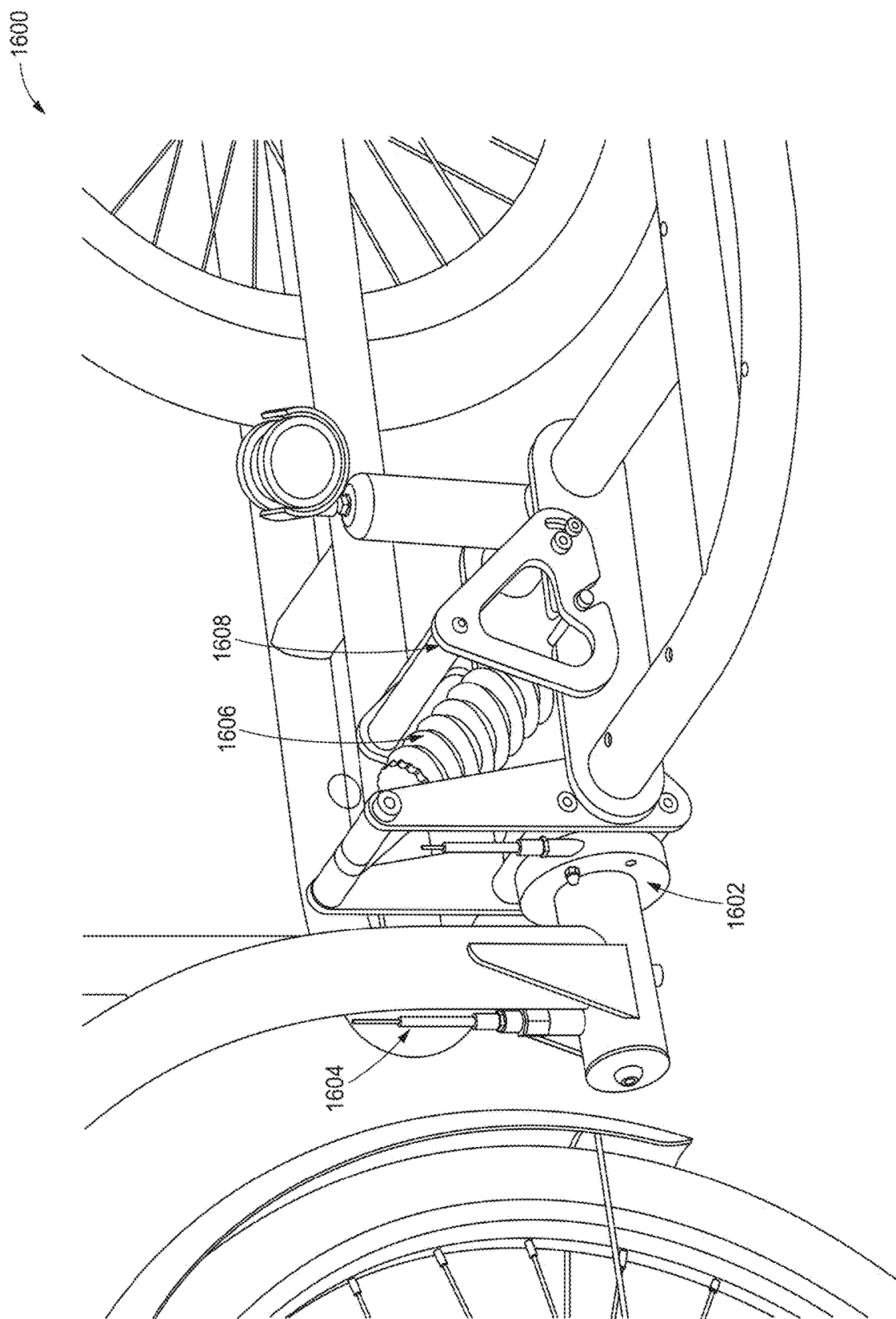
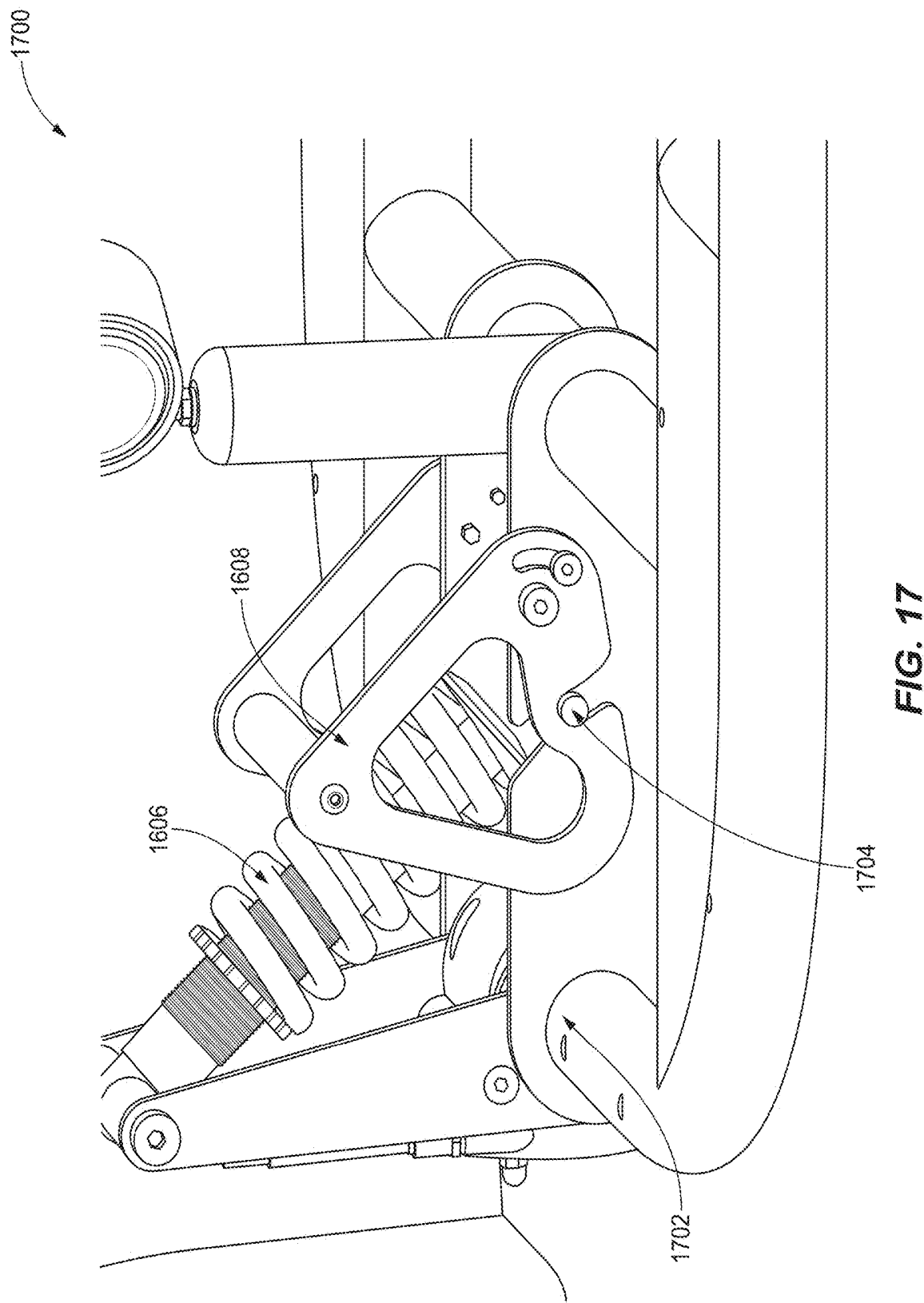


FIG. 15C





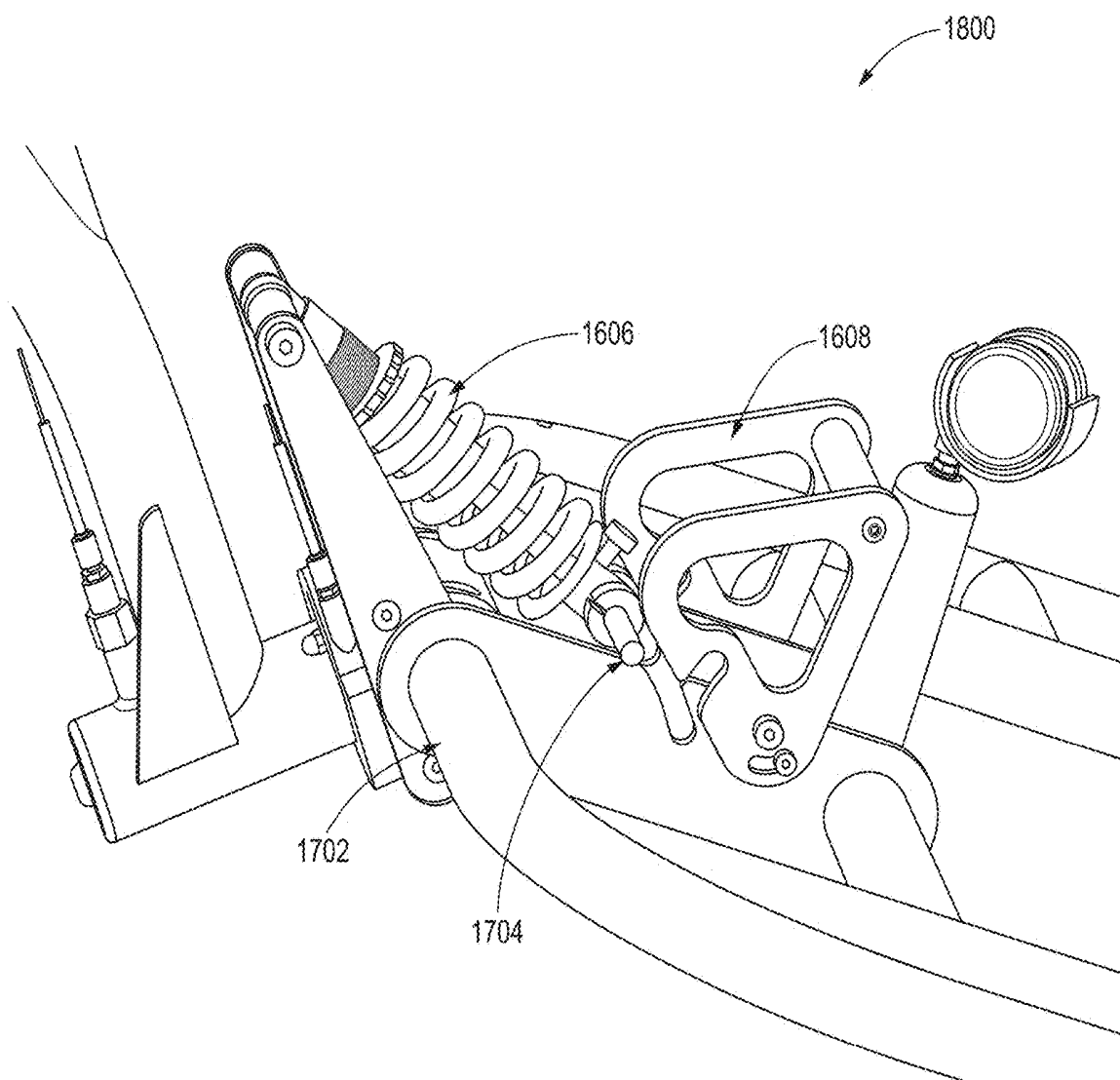


FIG. 18

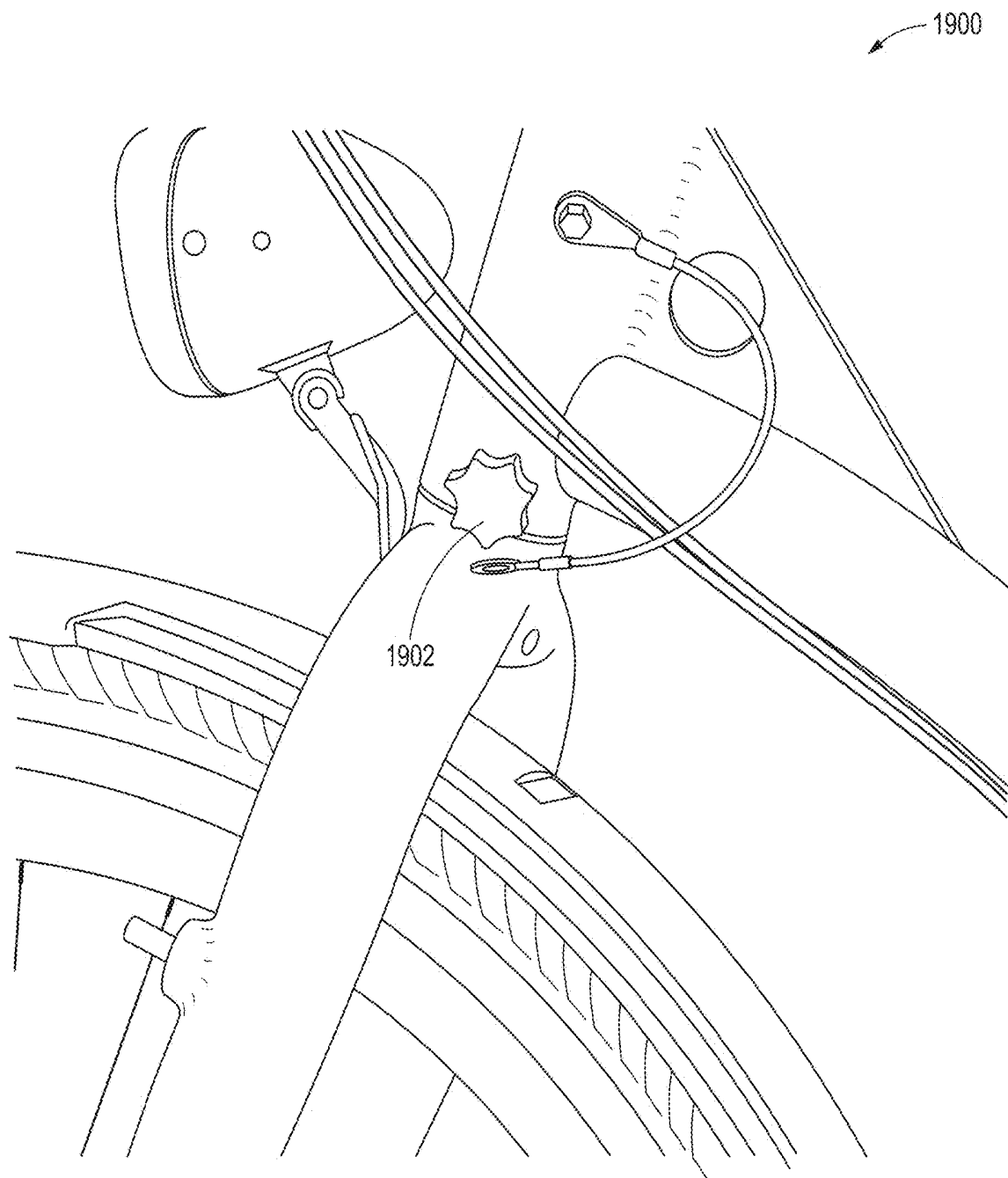


FIG. 19

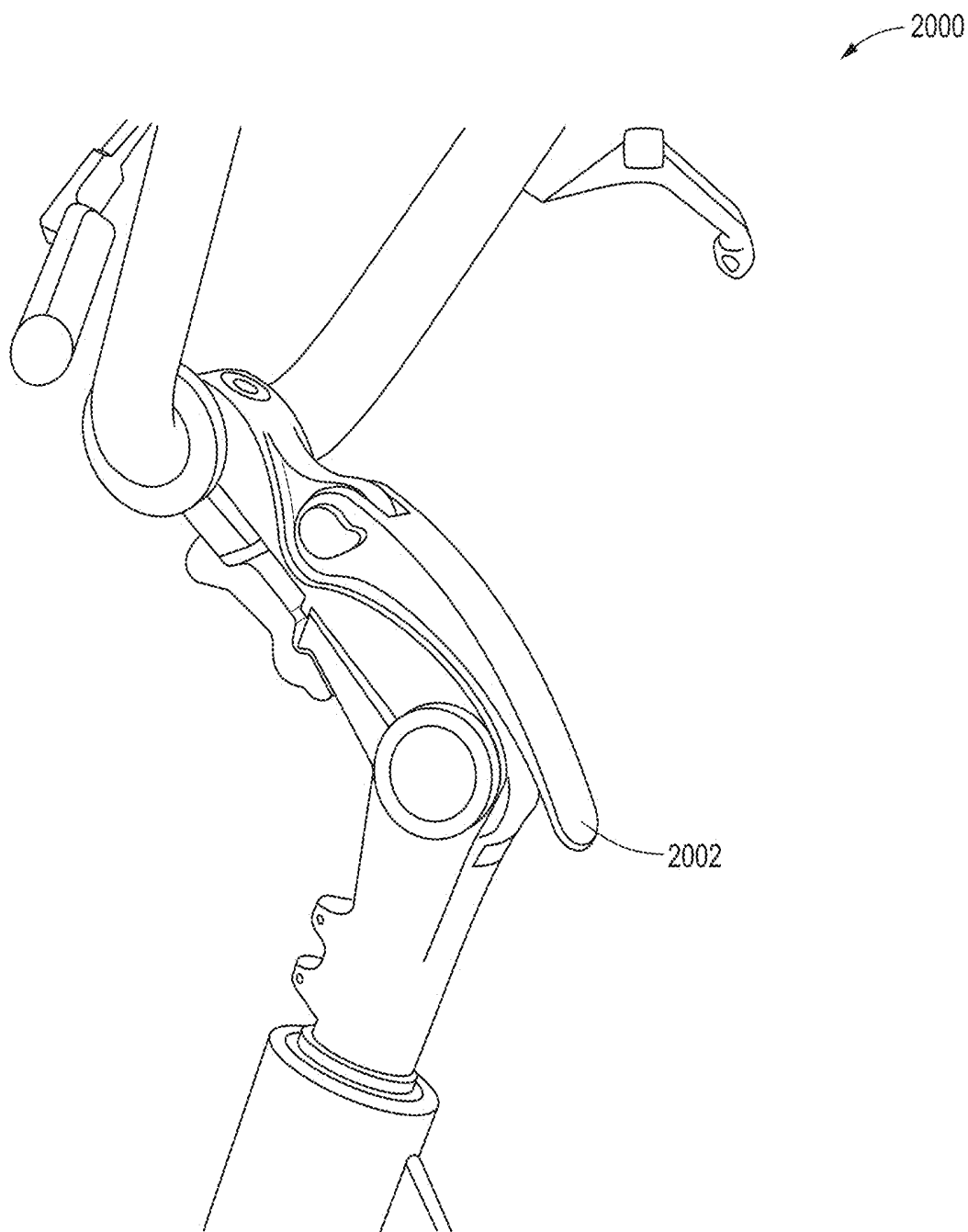


FIG. 20

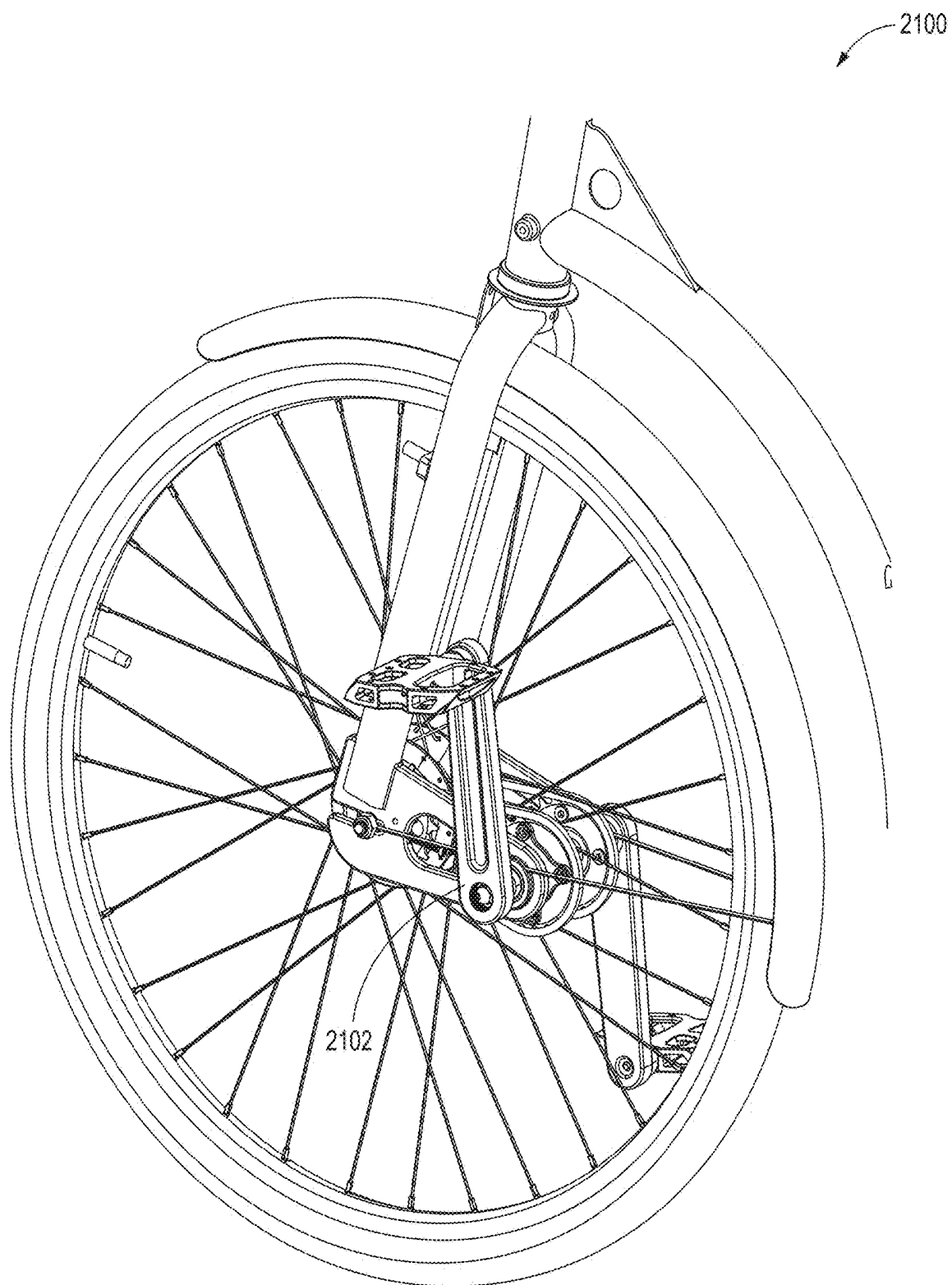


FIG. 21

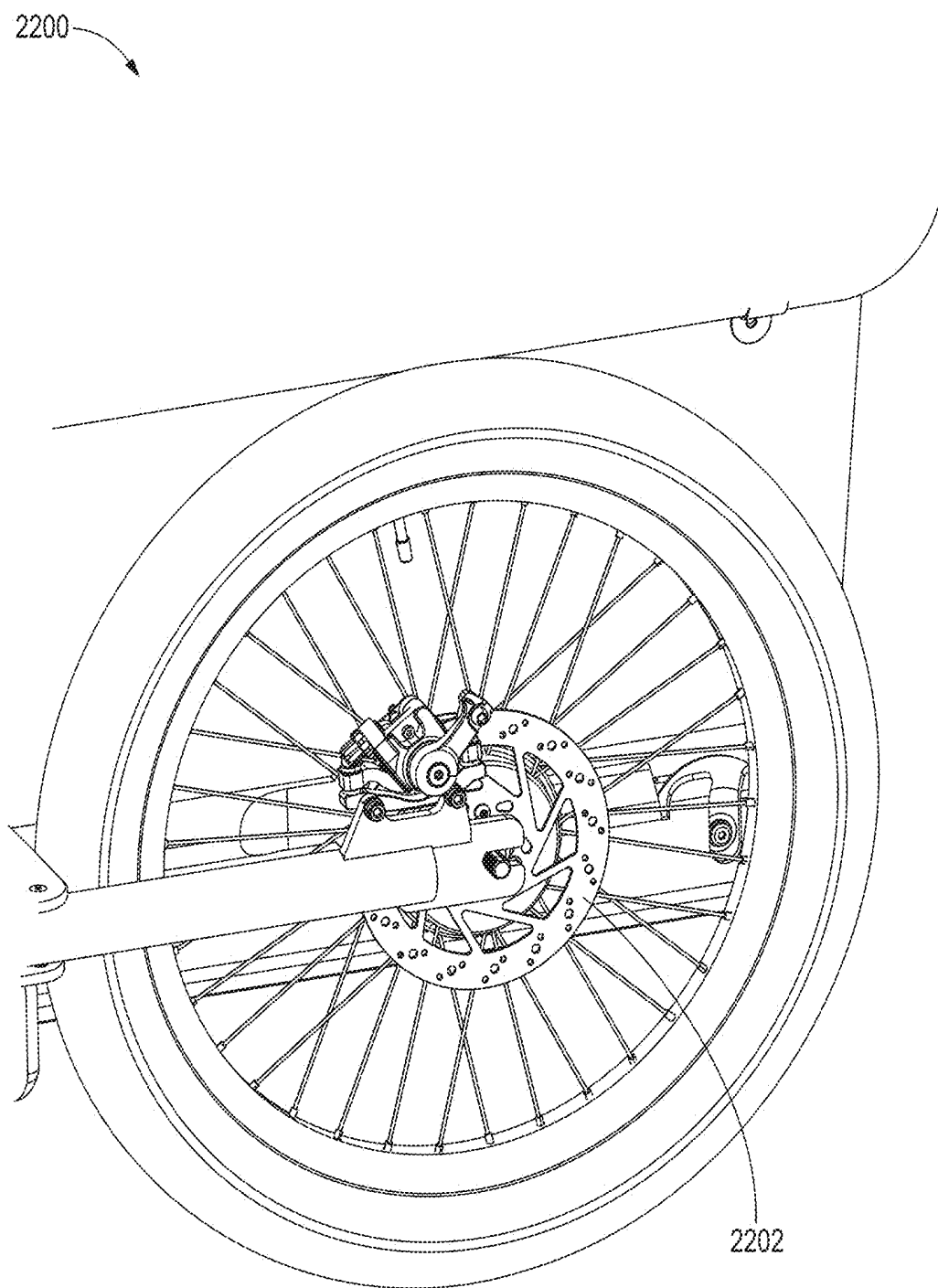


FIG. 22

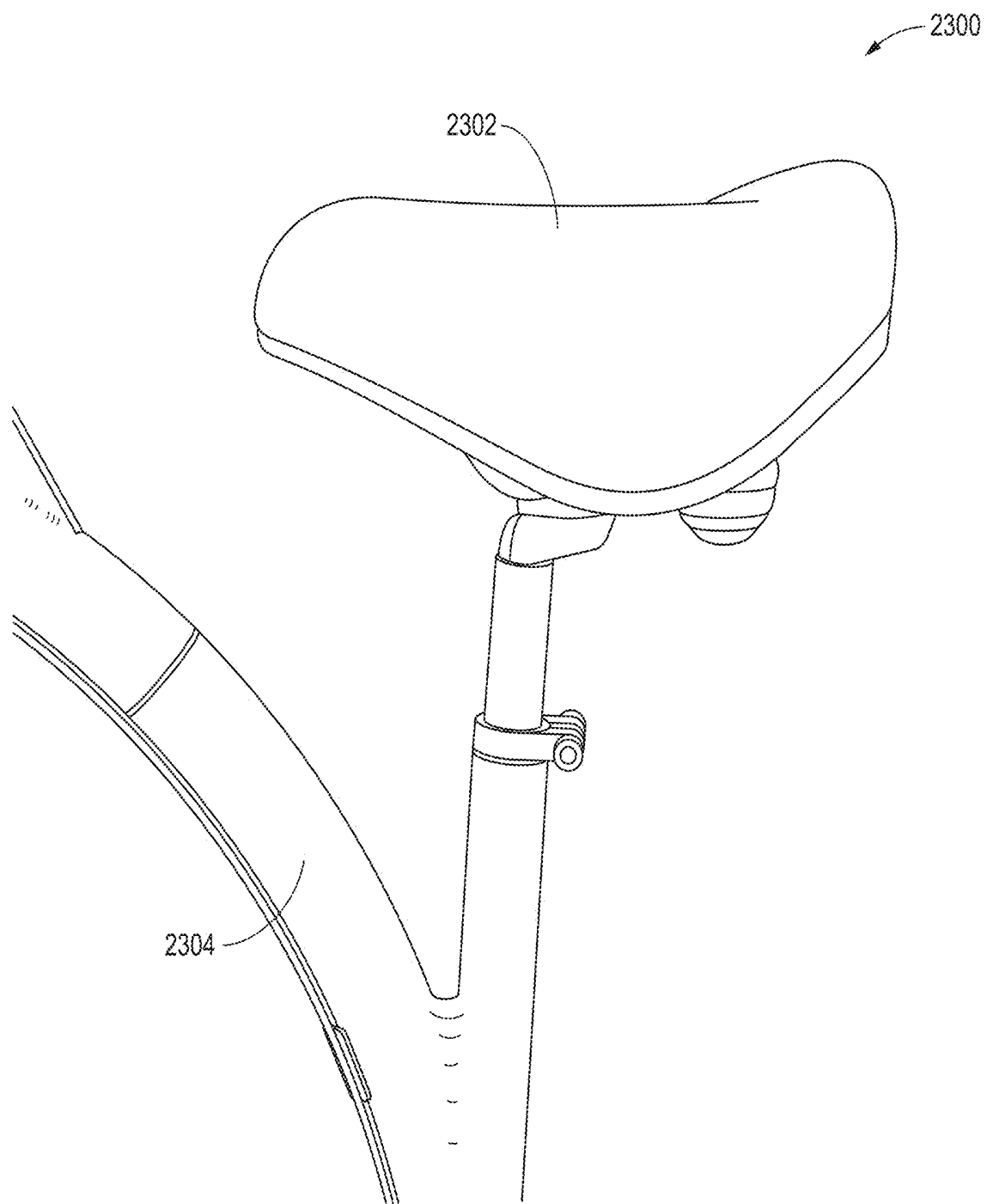


FIG. 23

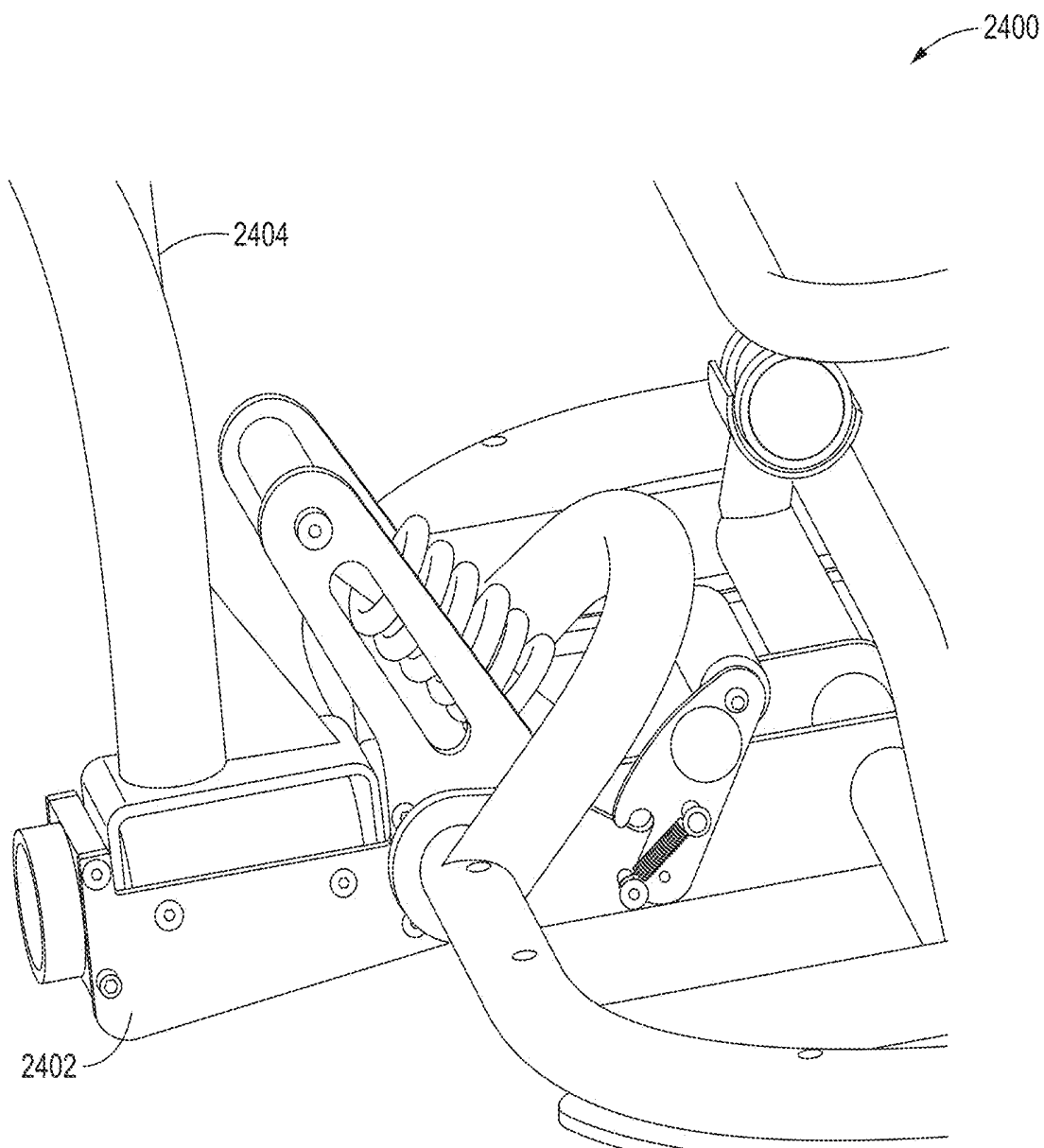


FIG. 24

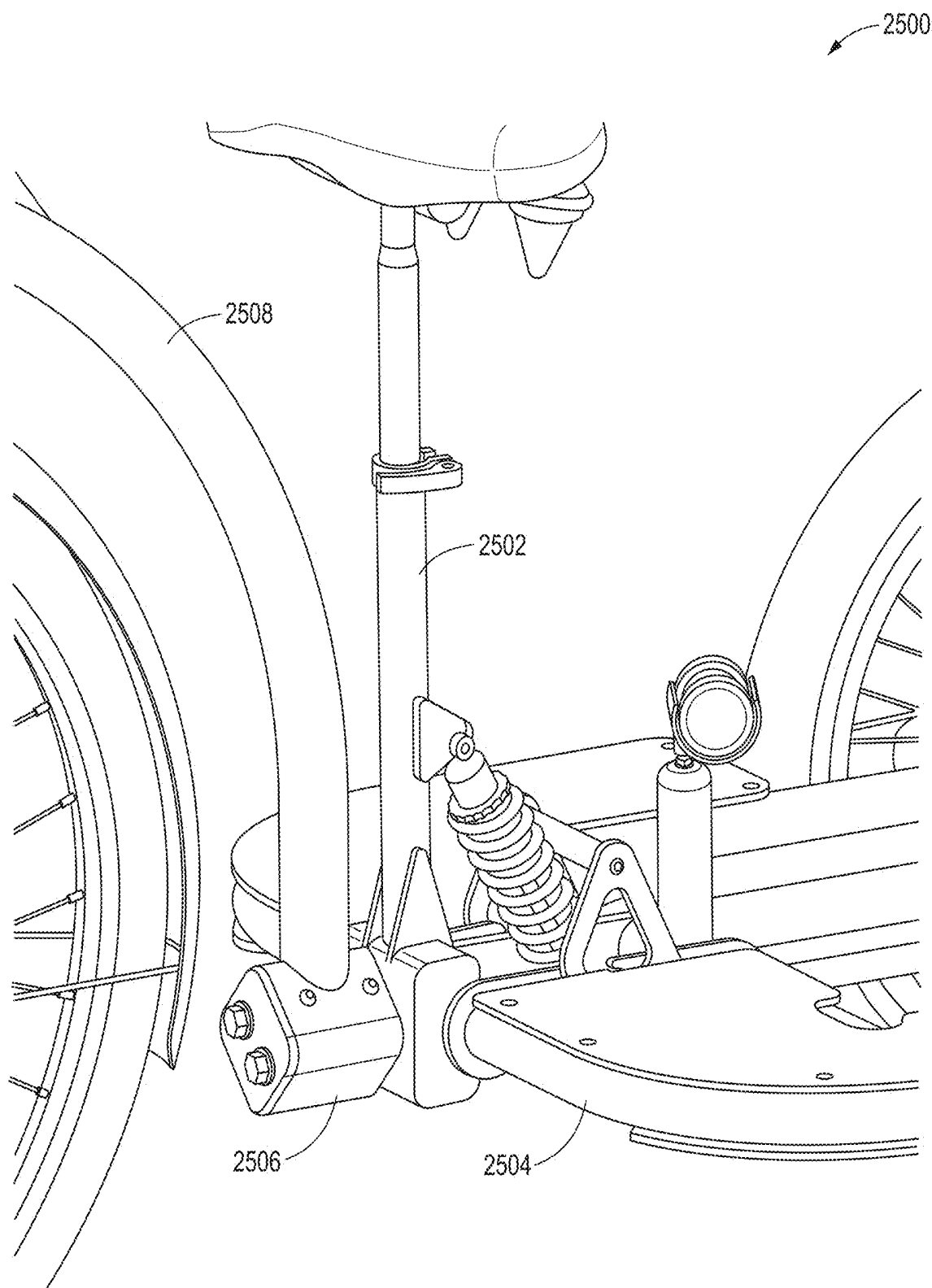


FIG. 25

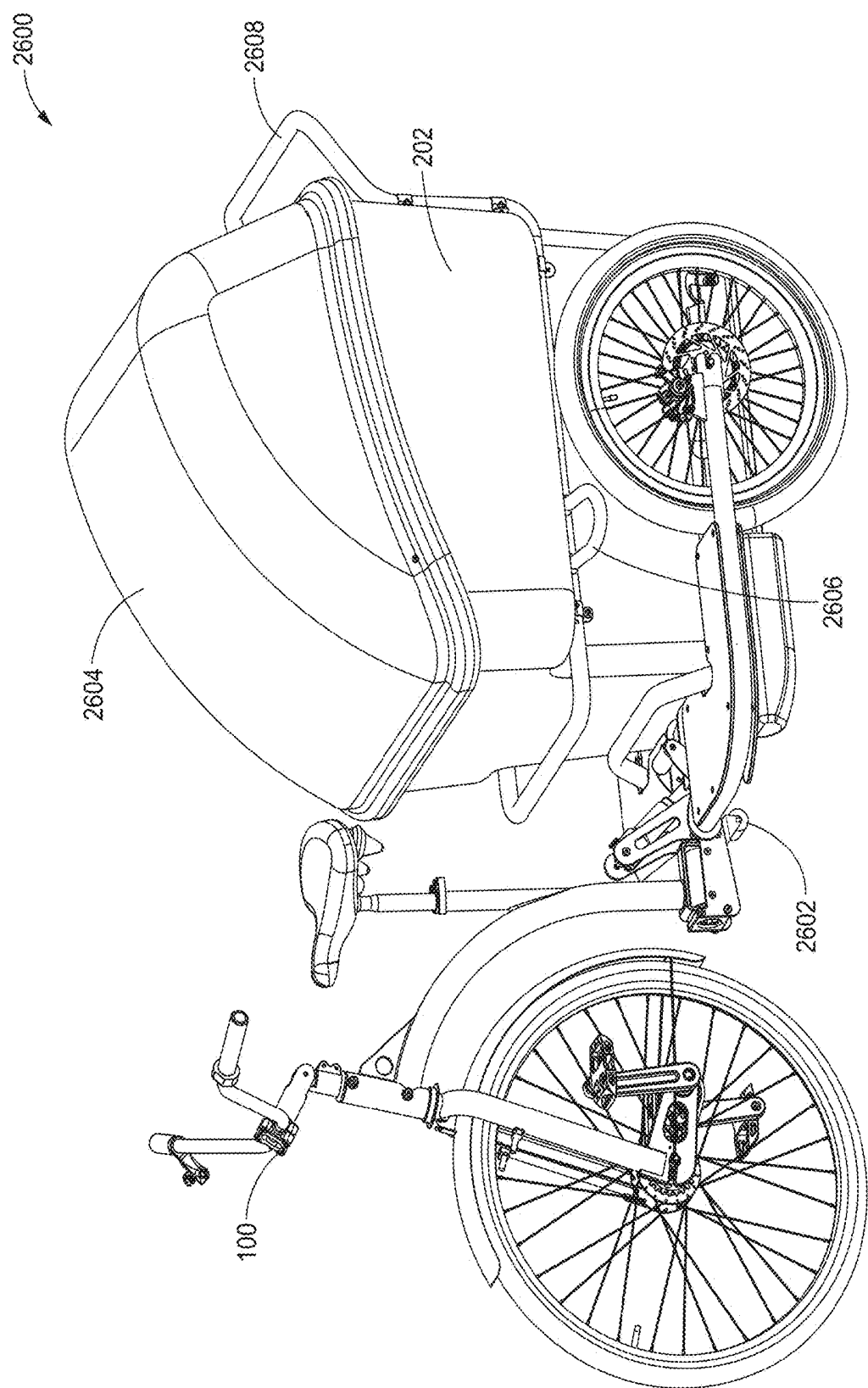


FIG. 26

2700

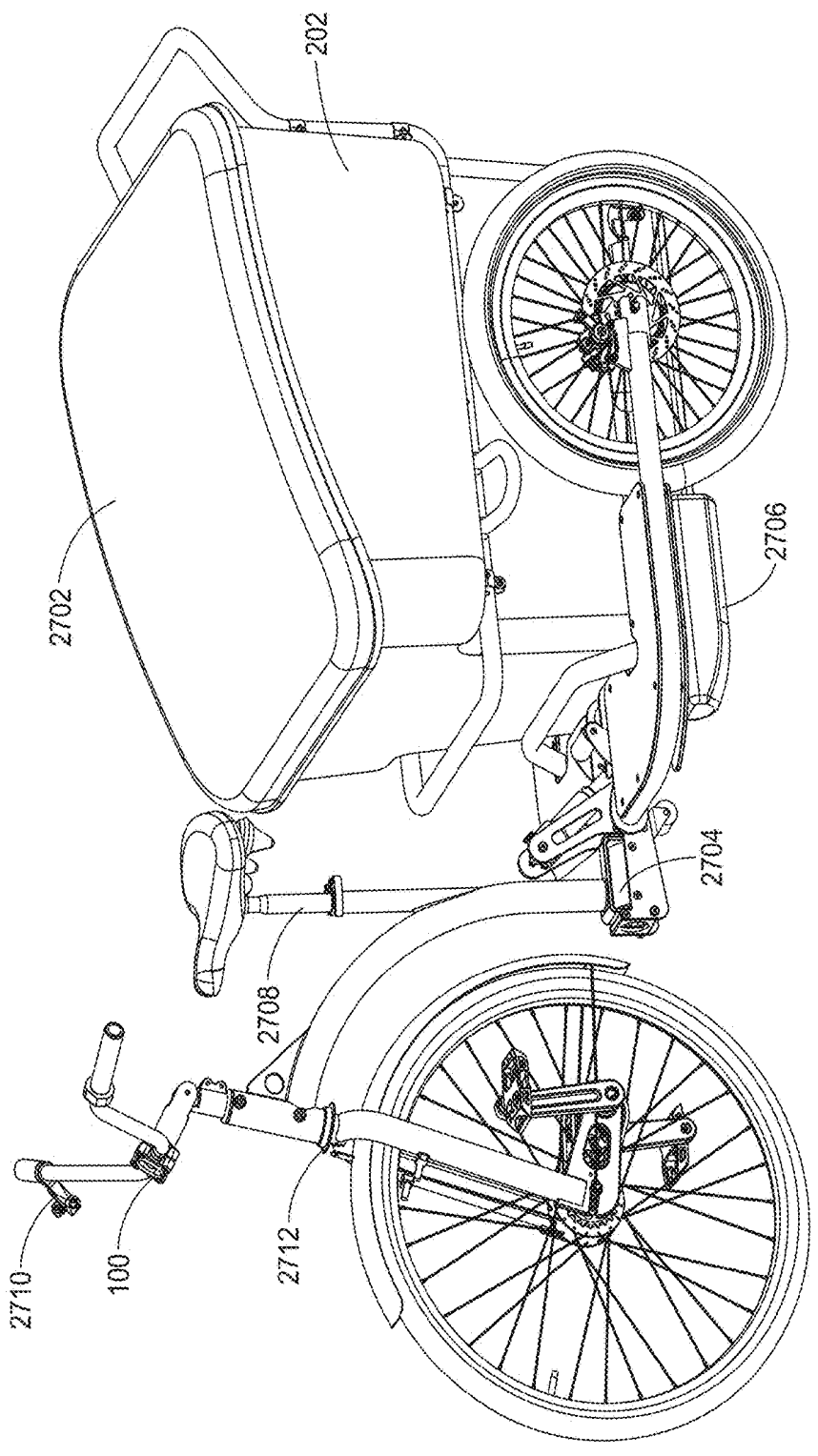
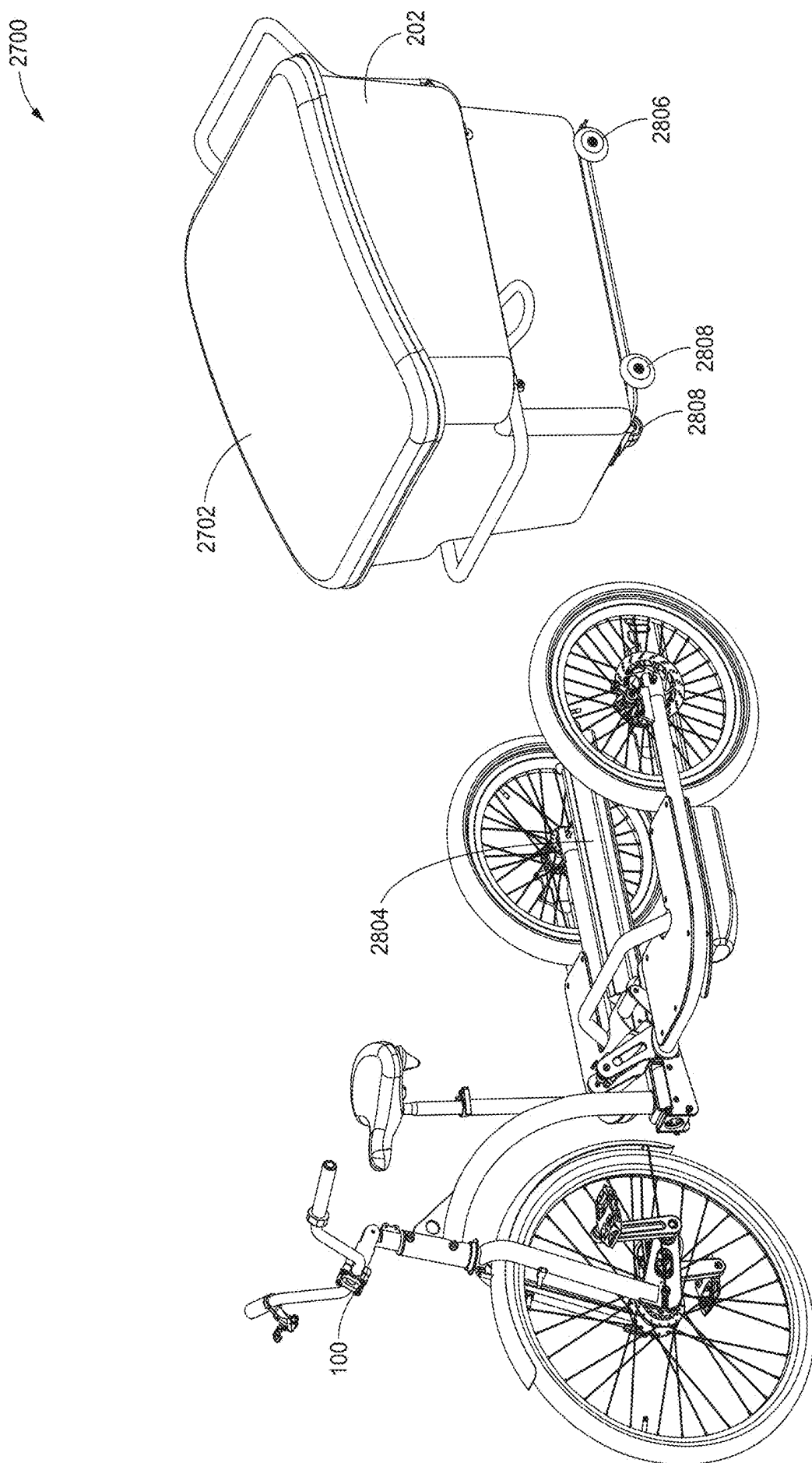


FIG. 27



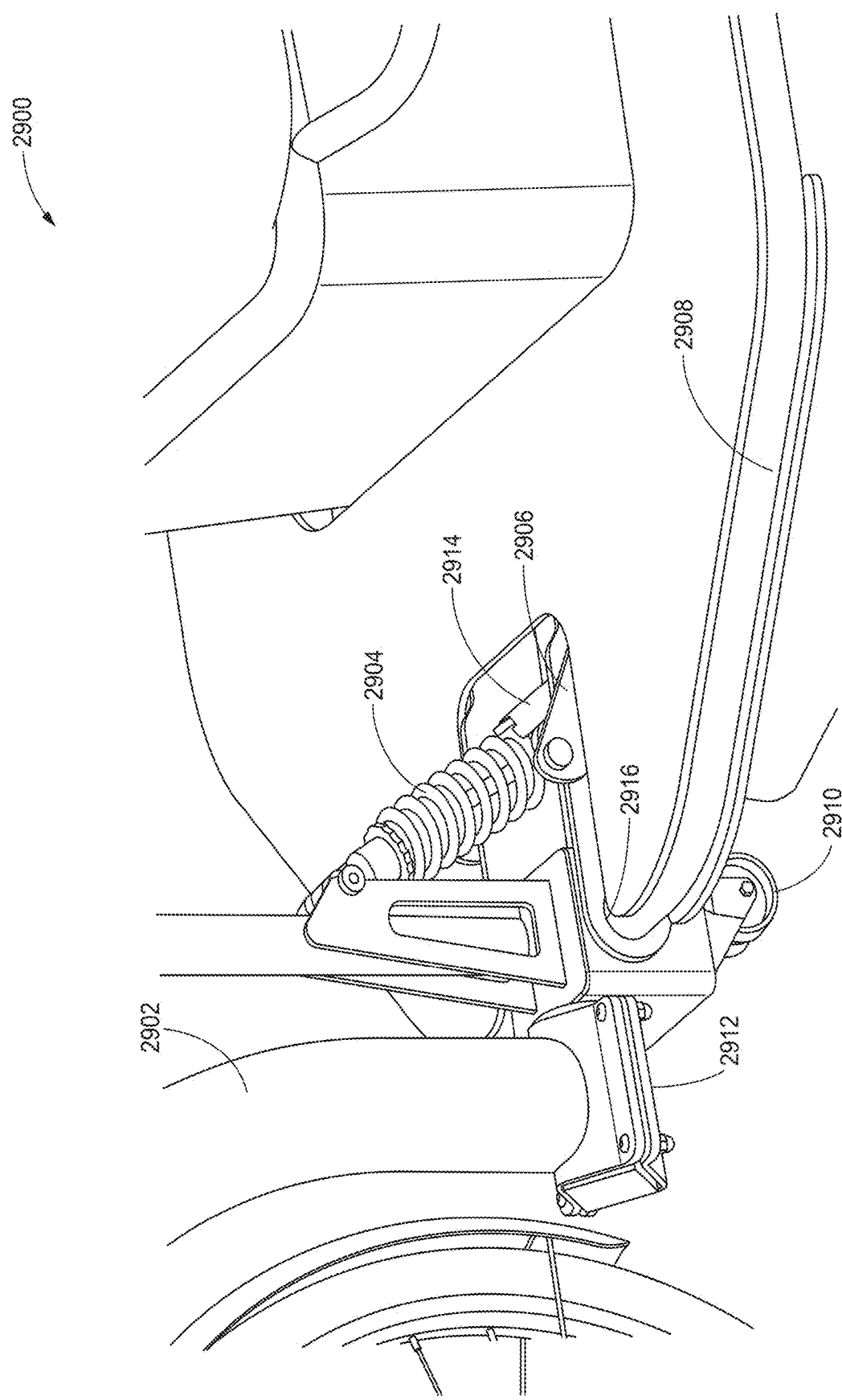


FIG. 29

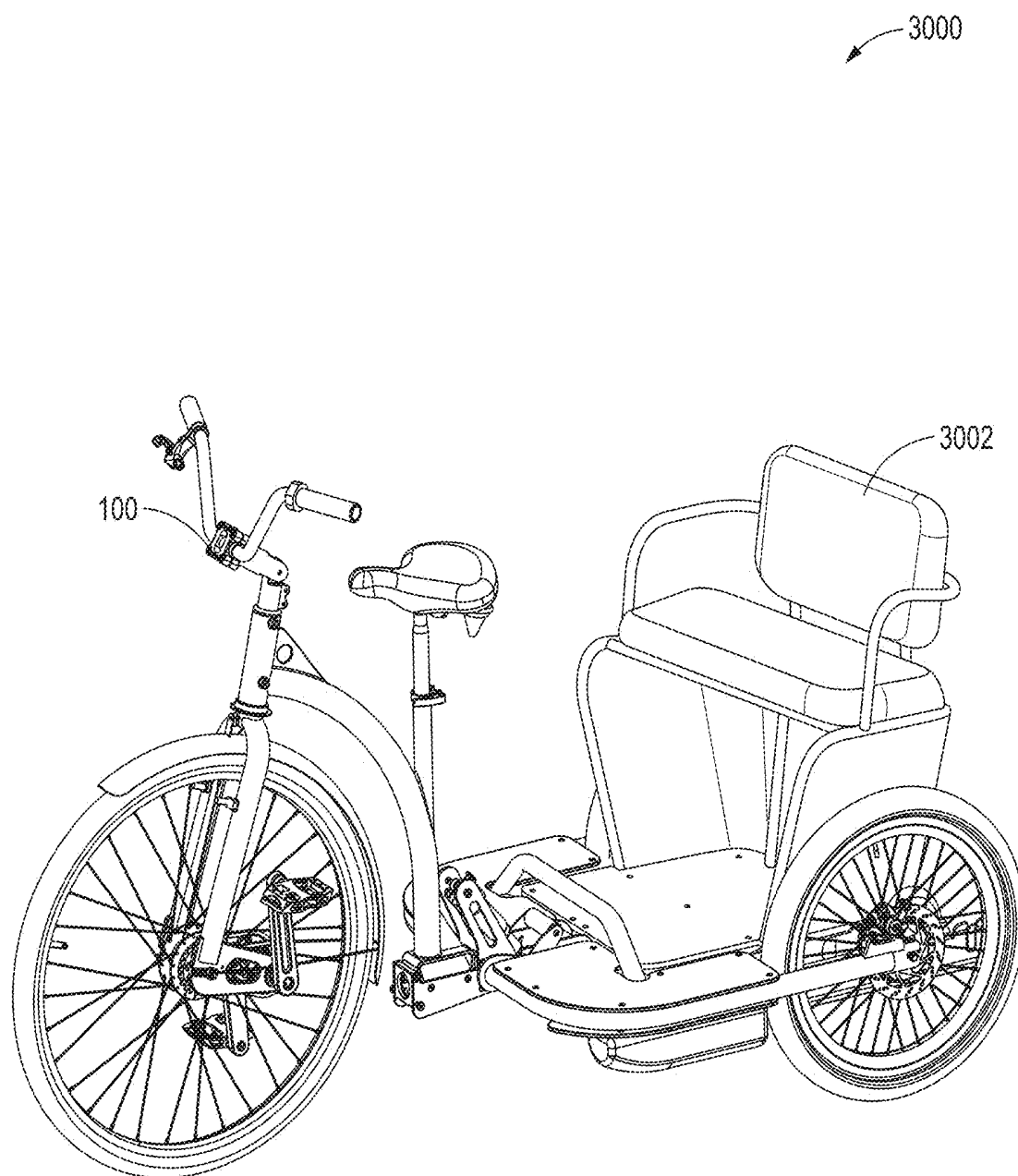


FIG. 30A

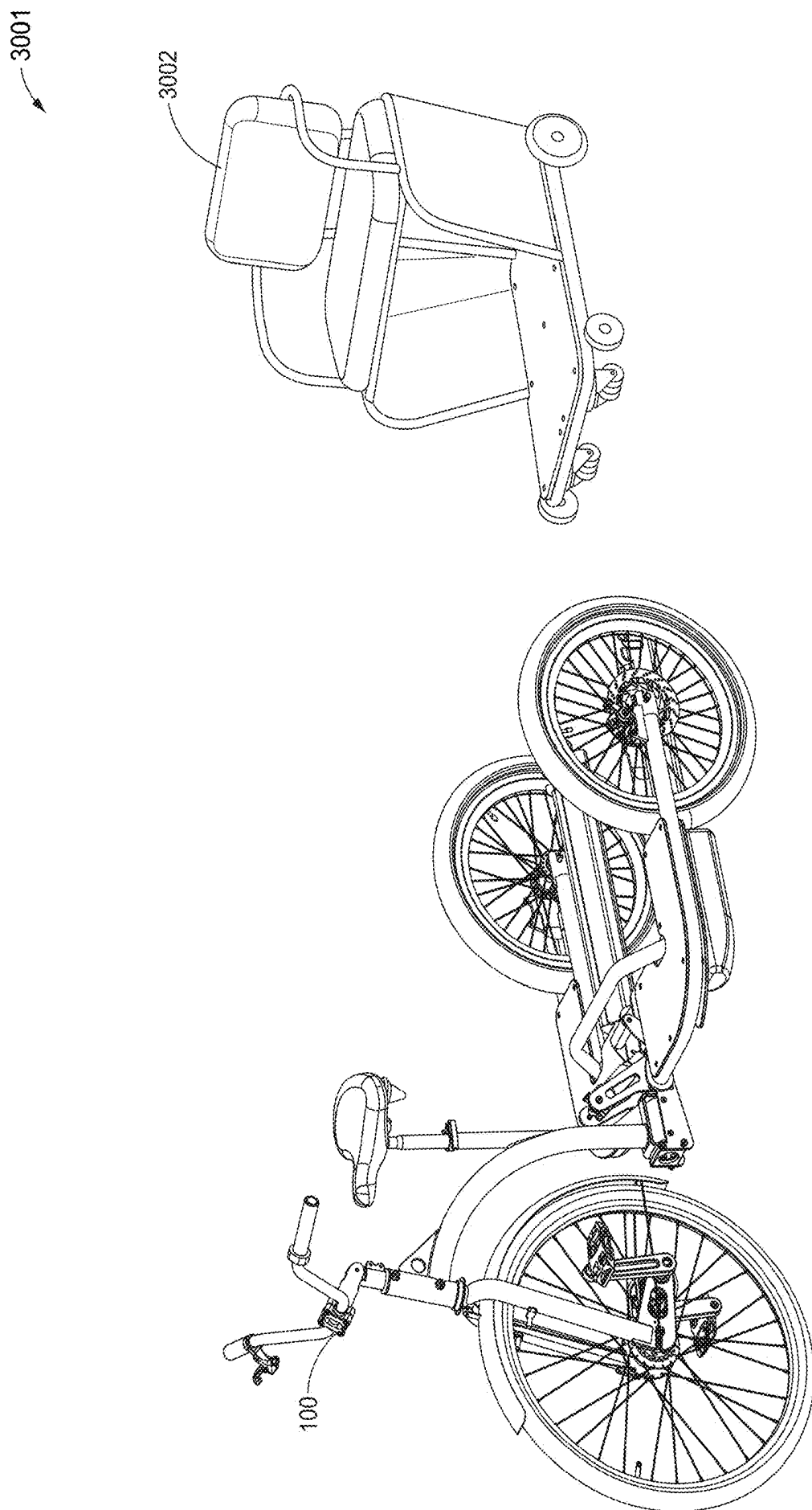


FIG. 30B

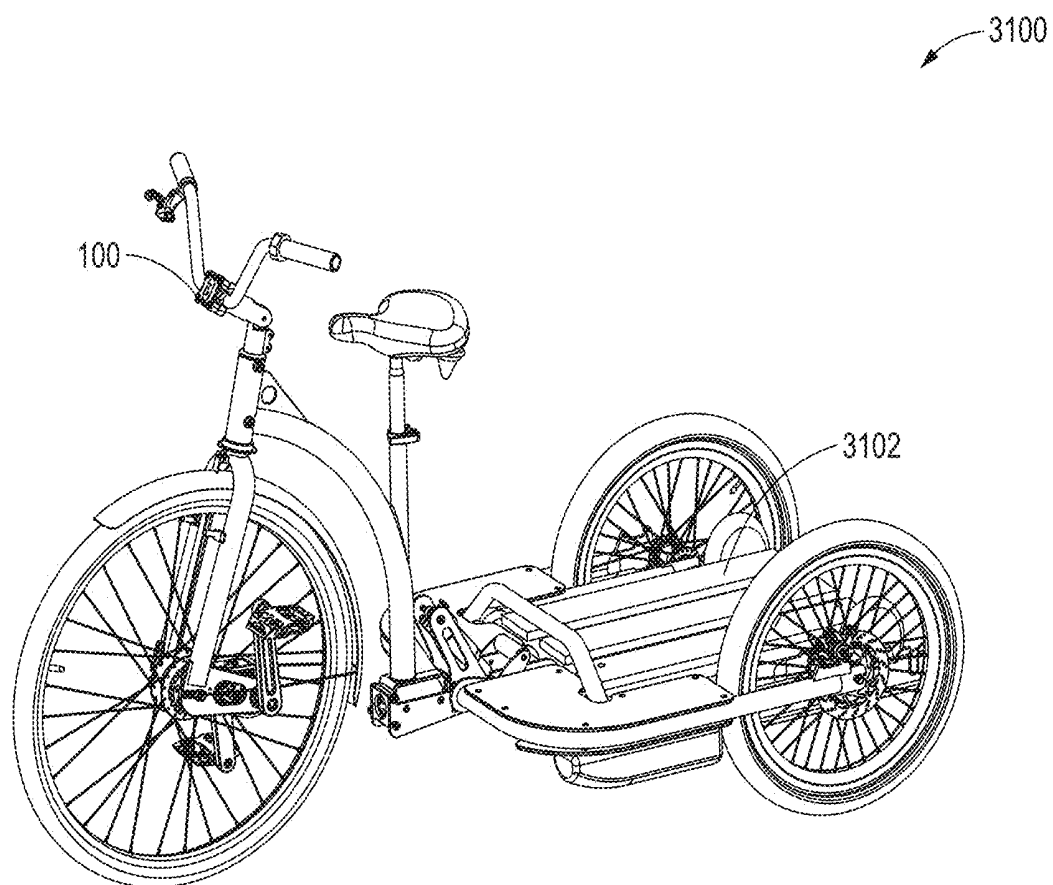


FIG. 31A

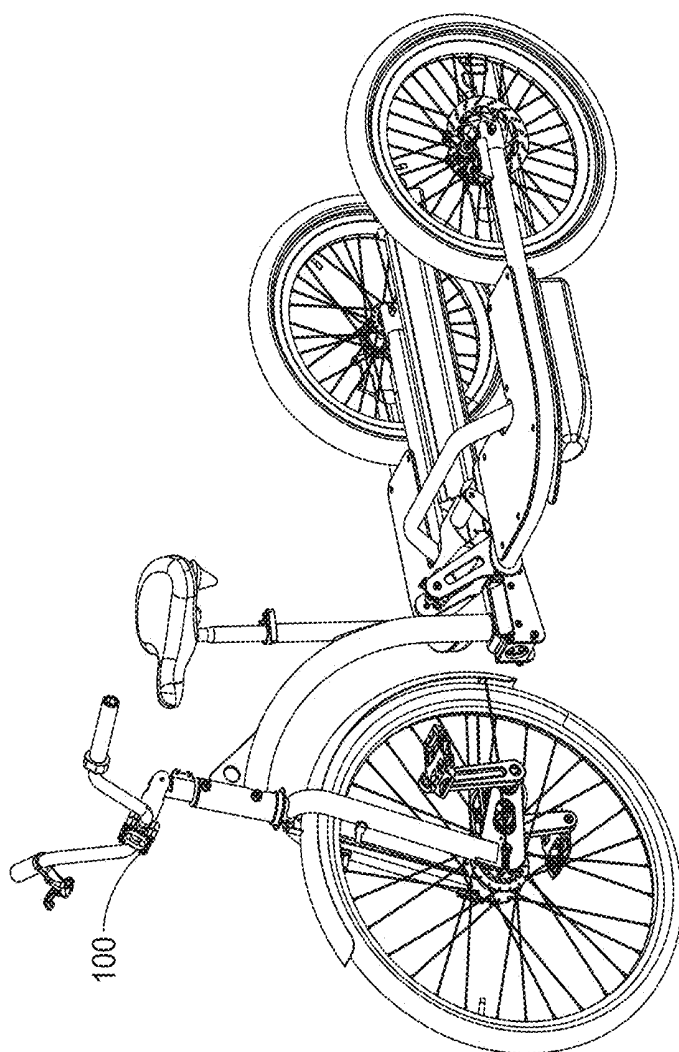
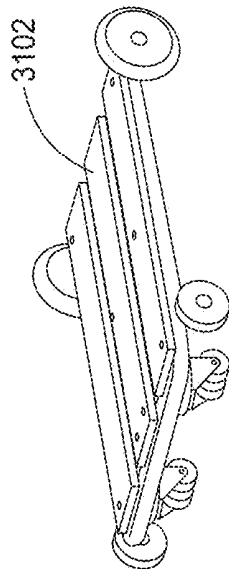


FIG. 31B

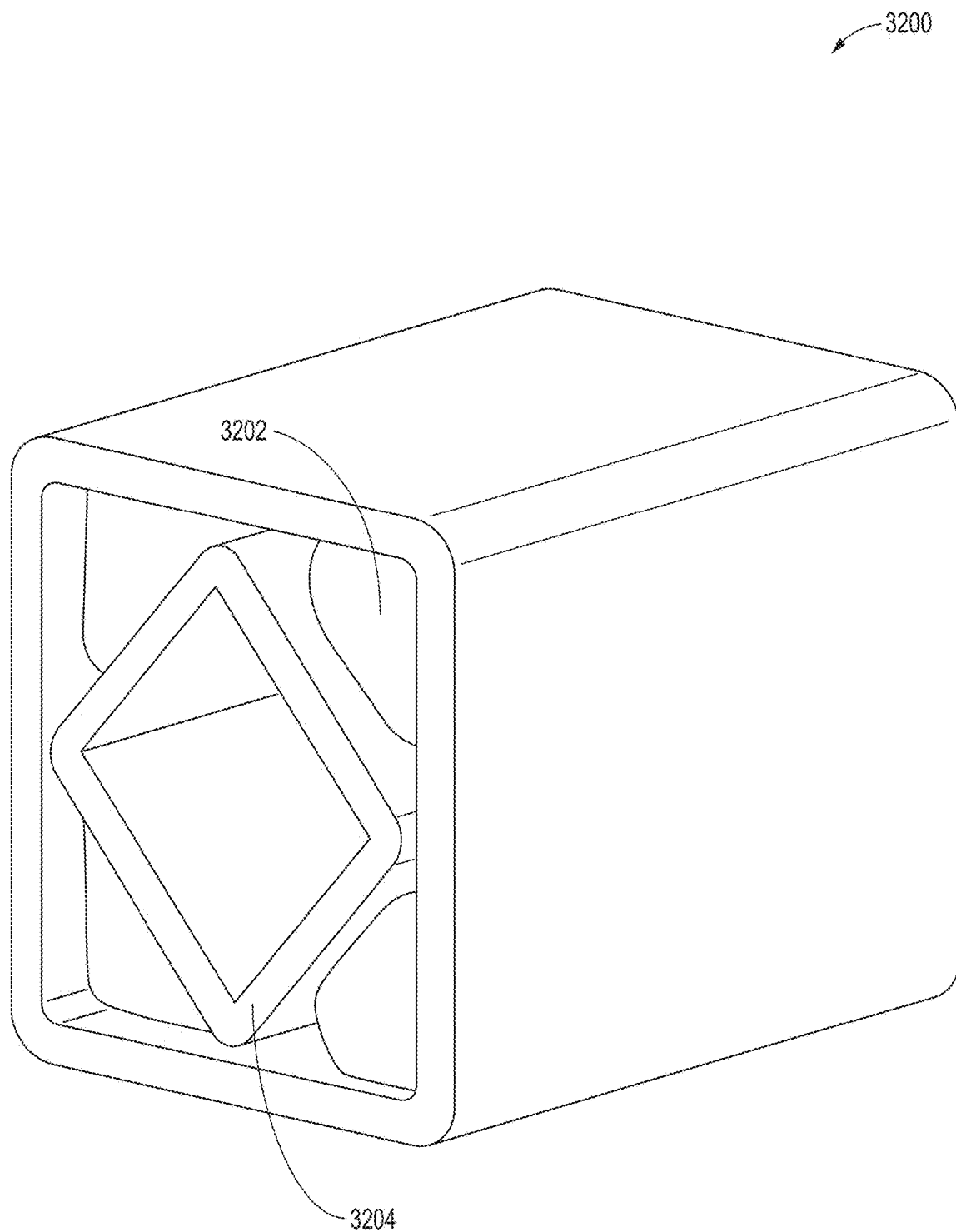
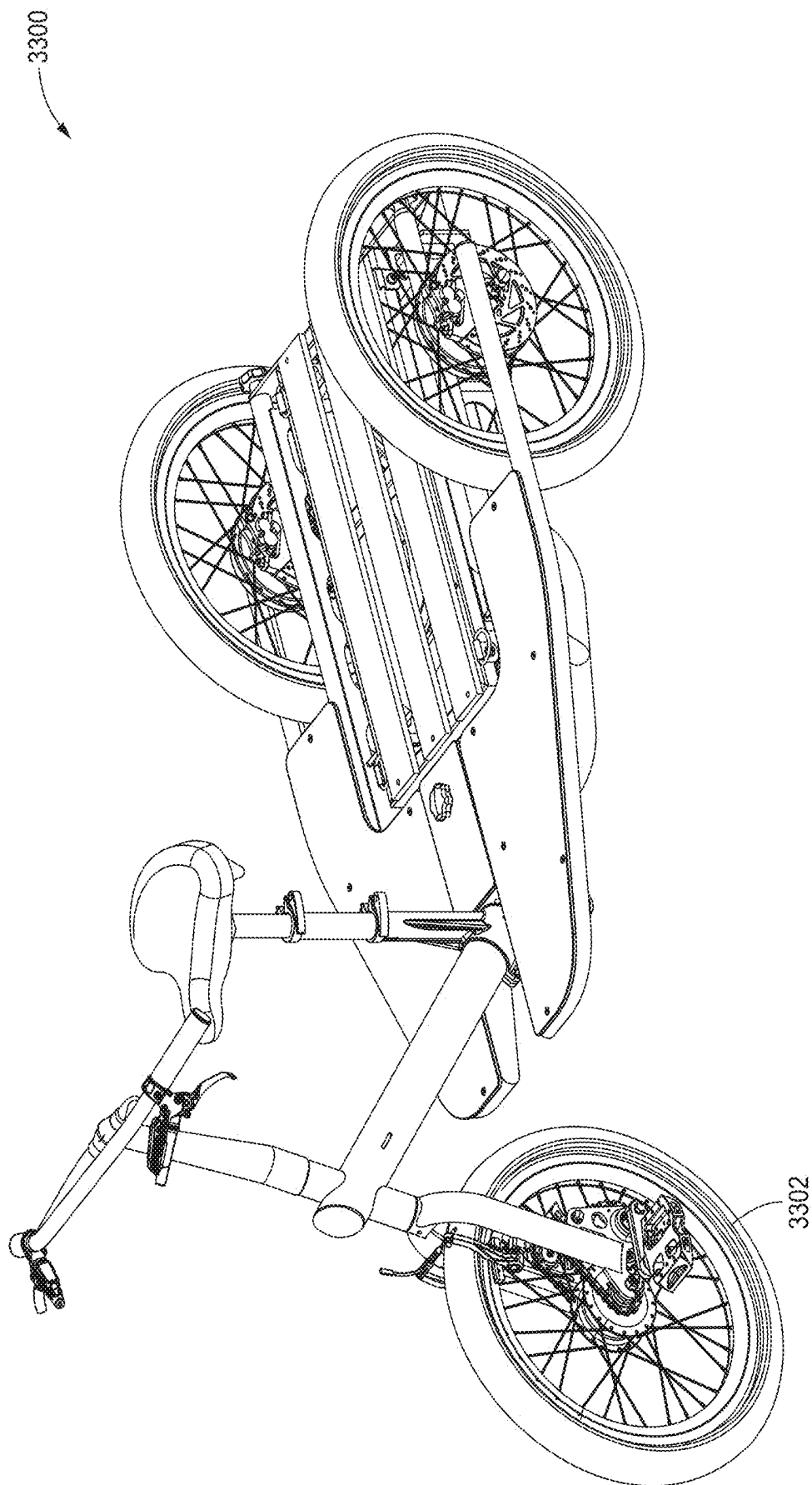


FIG. 32



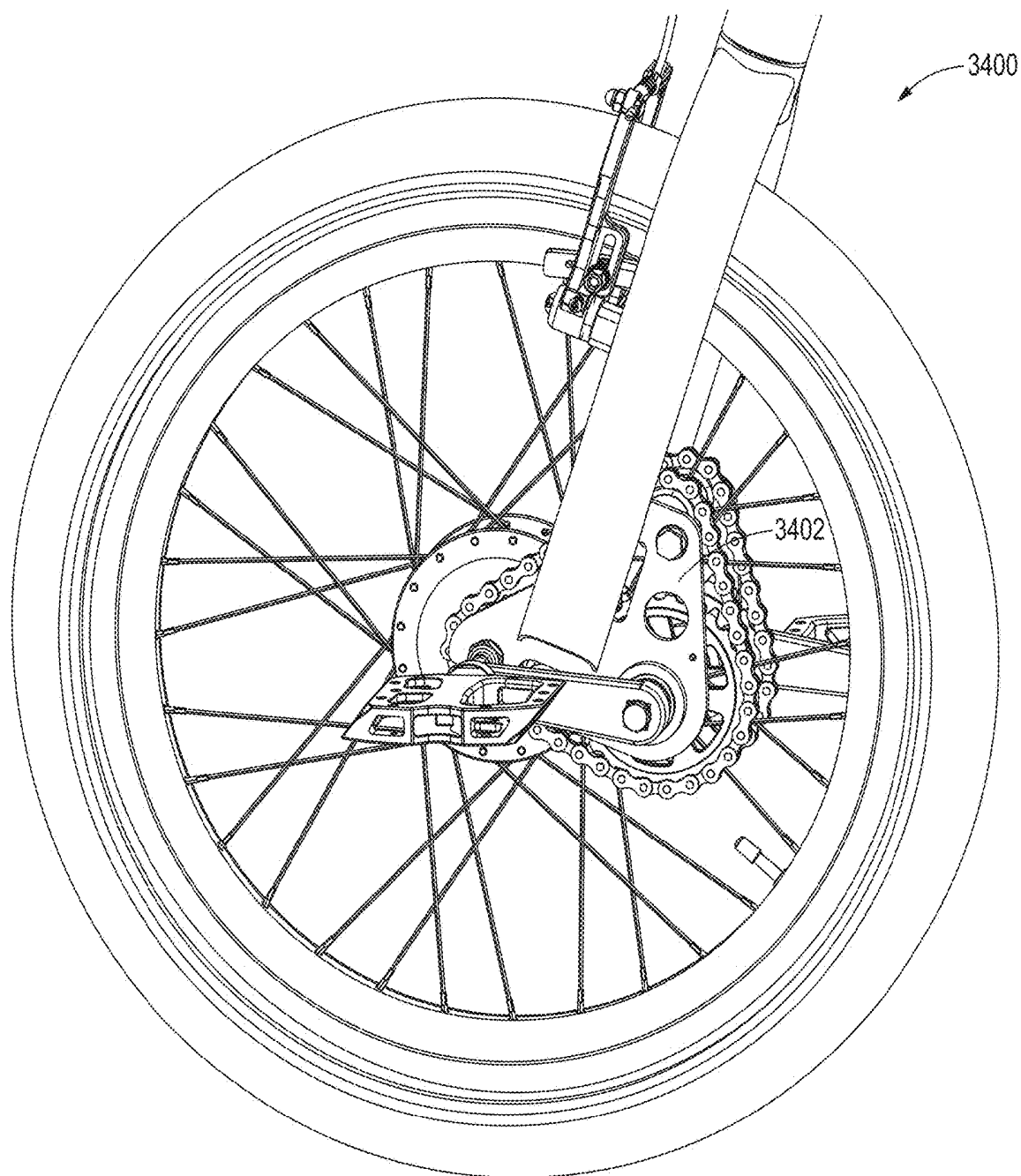


FIG. 34

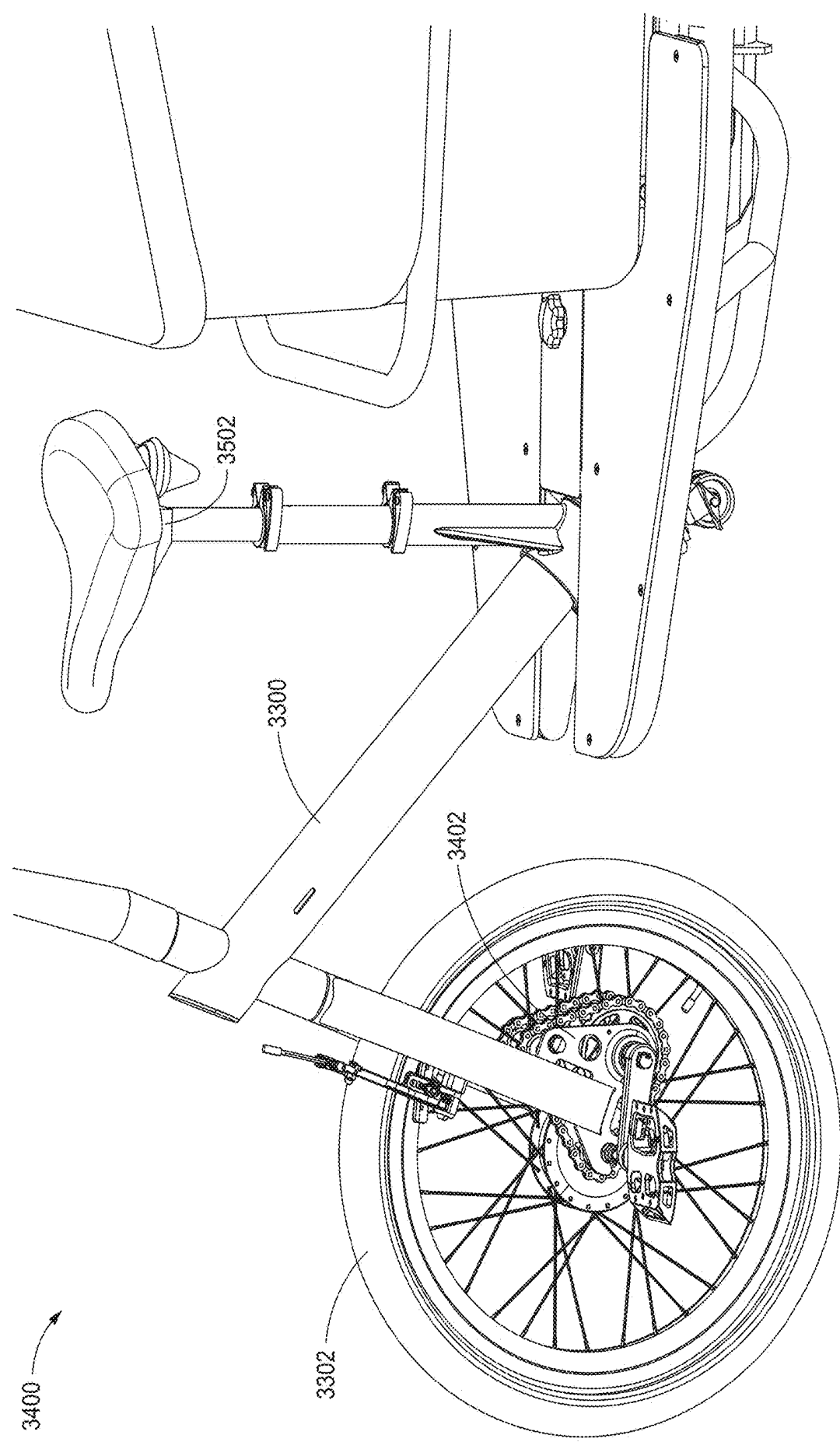


FIG. 35

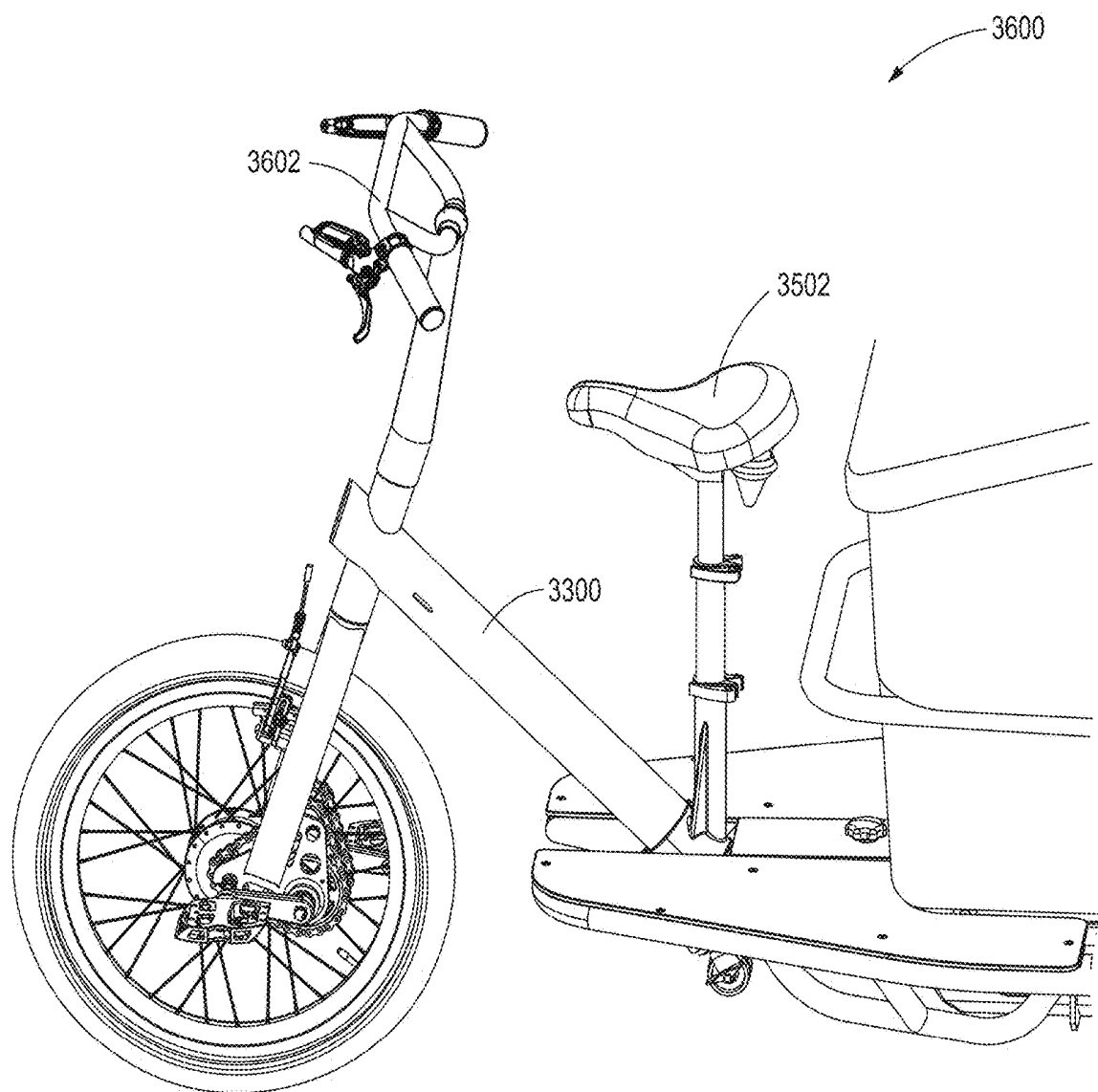


FIG. 36

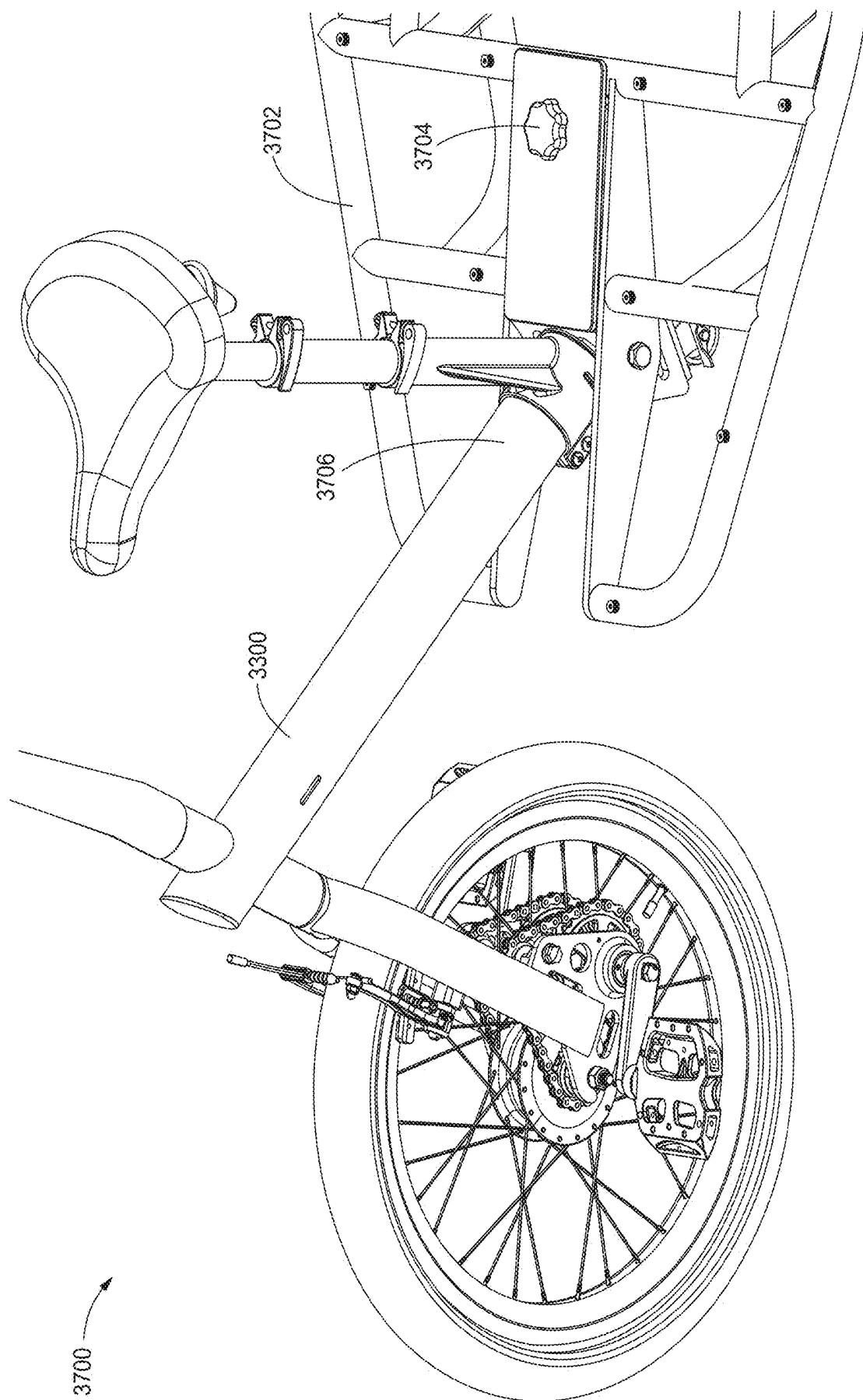
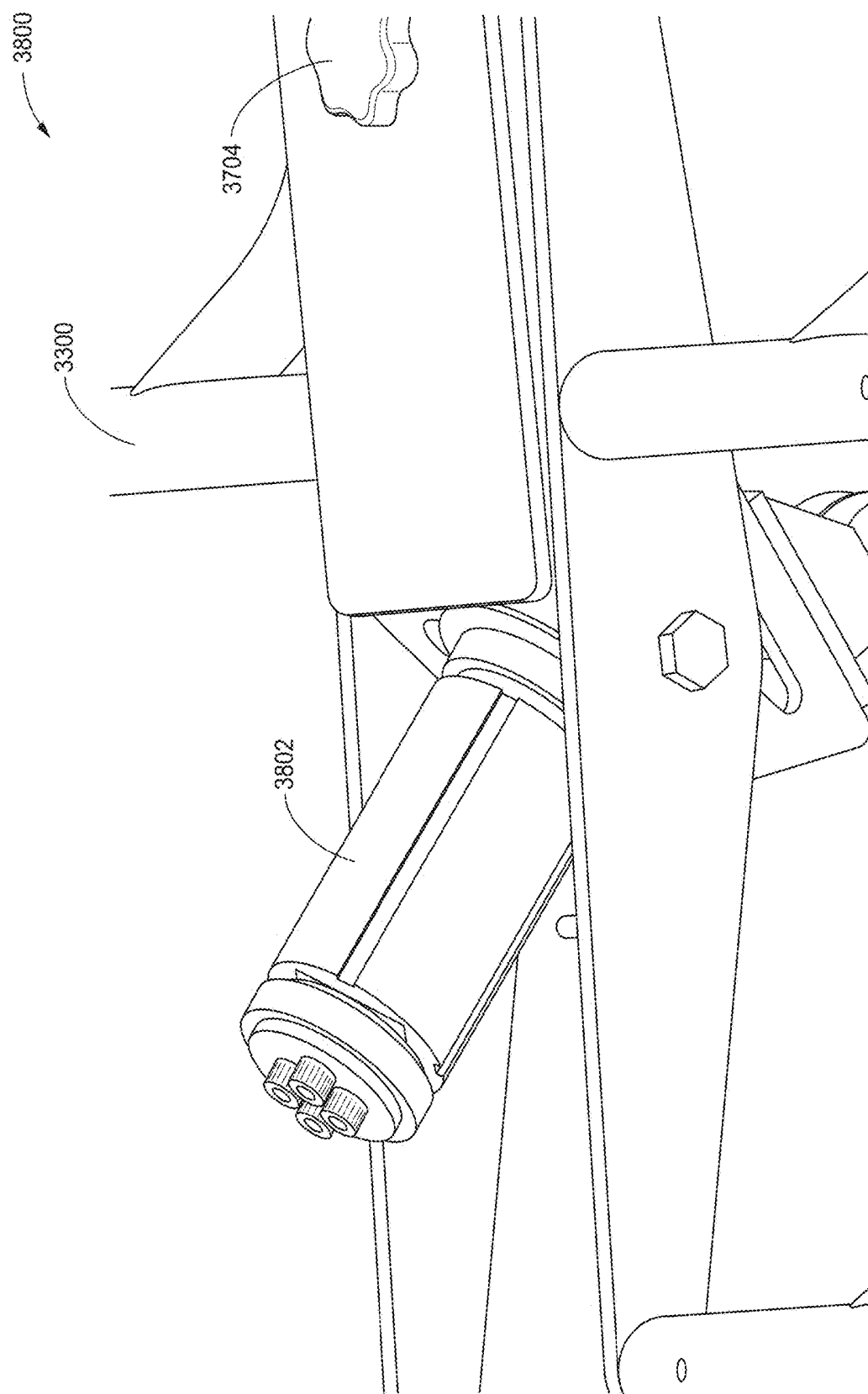


FIG. 37



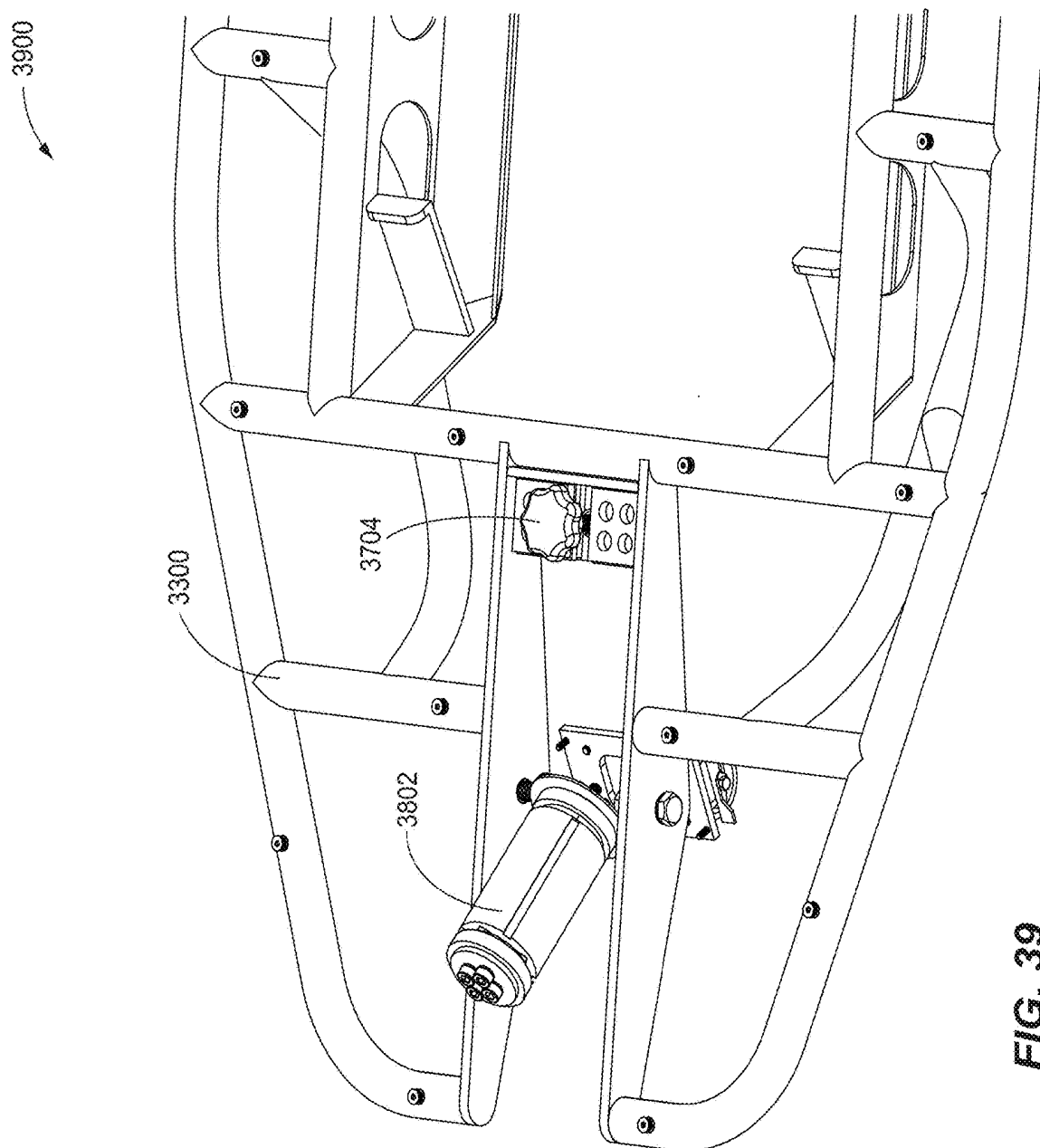
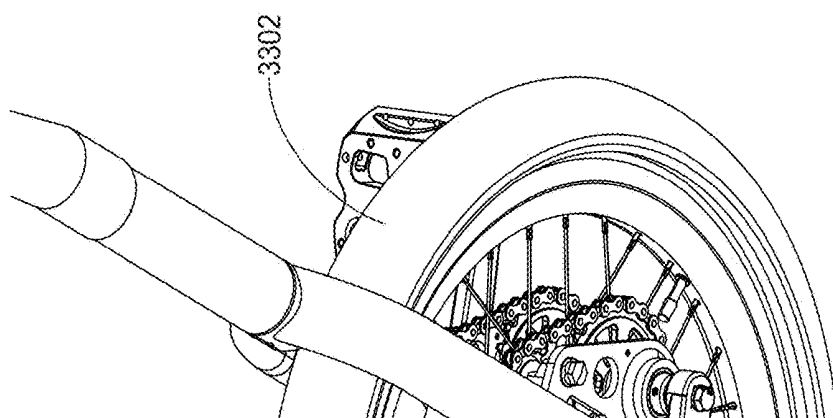


FIG. 39



4000

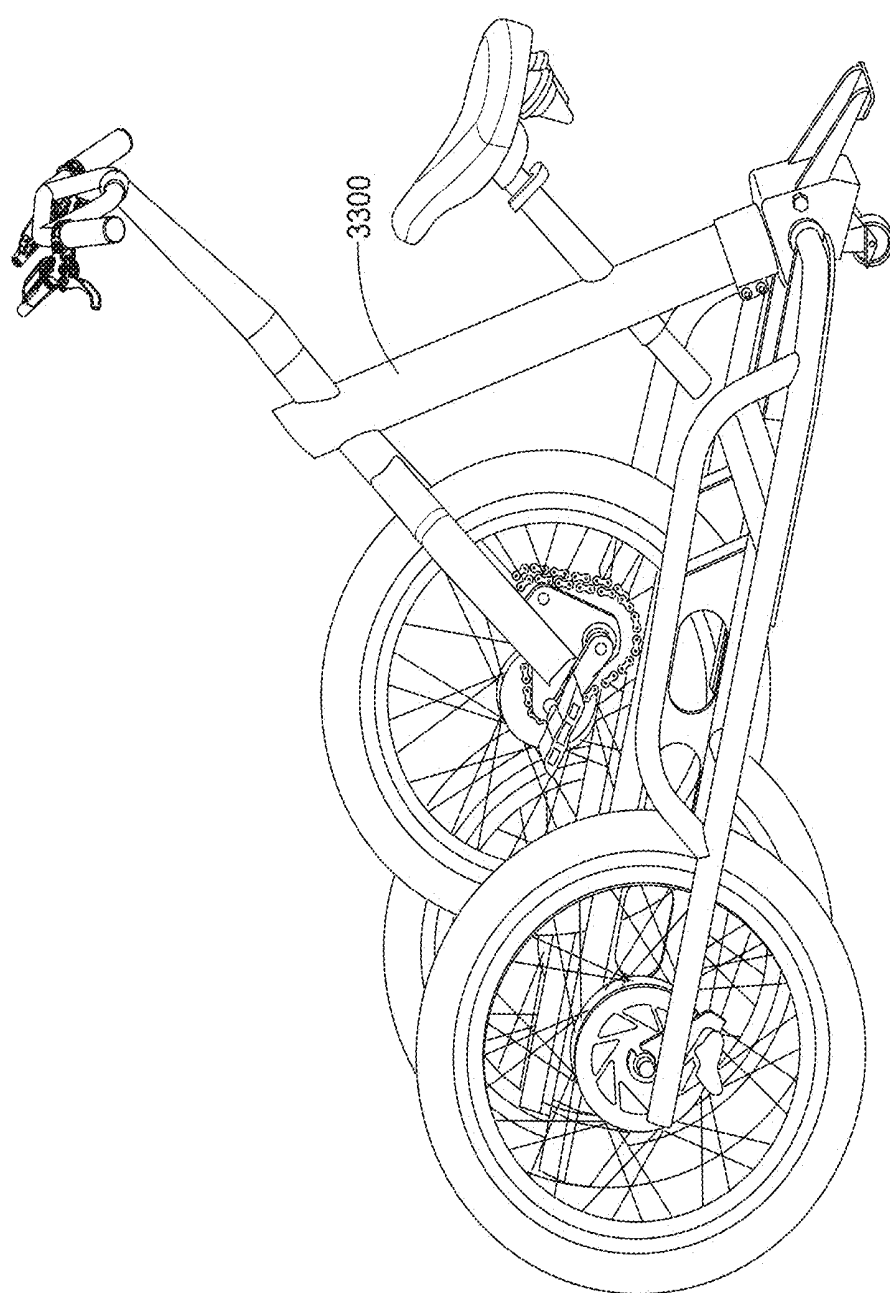


FIG. 40

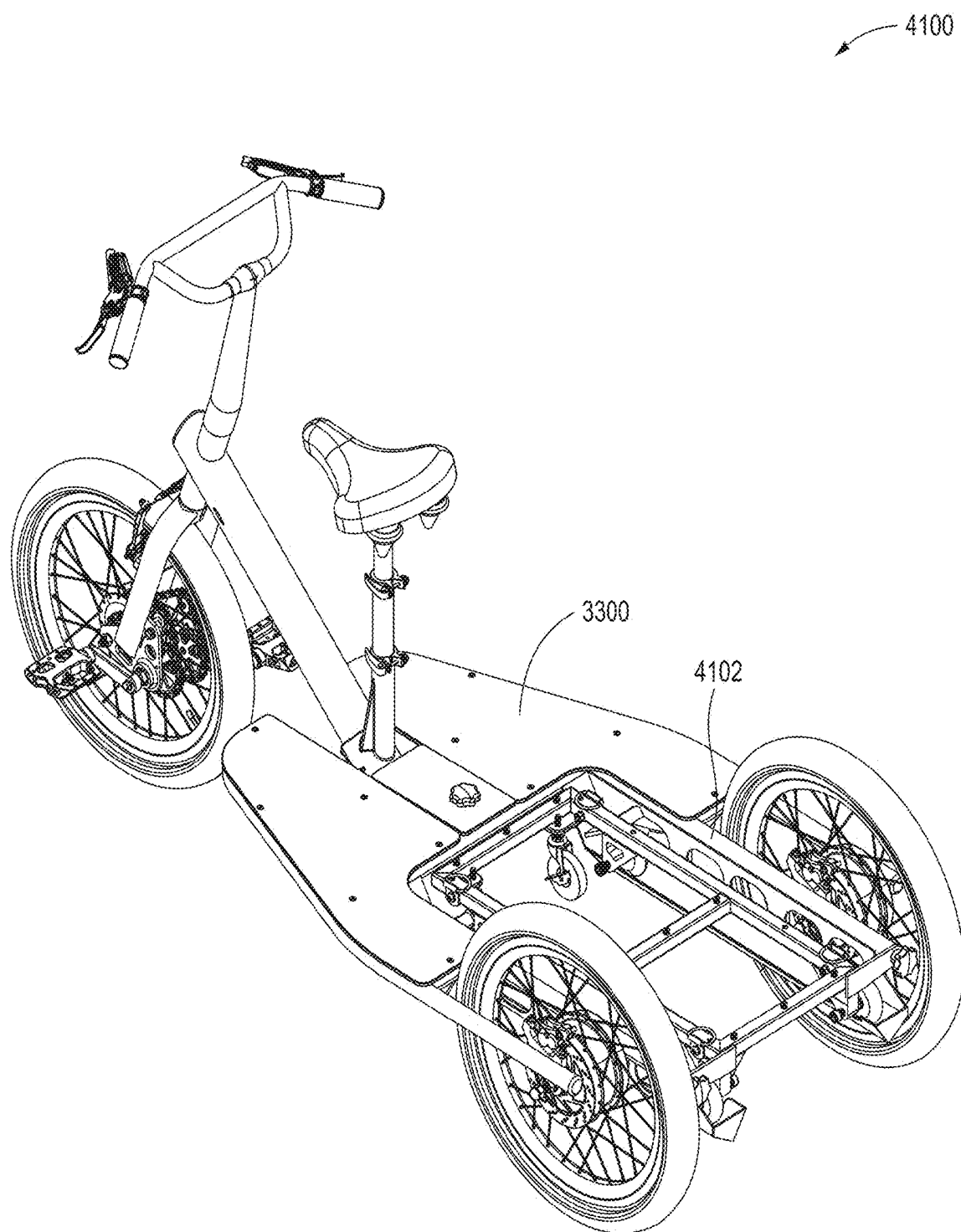


FIG. 41

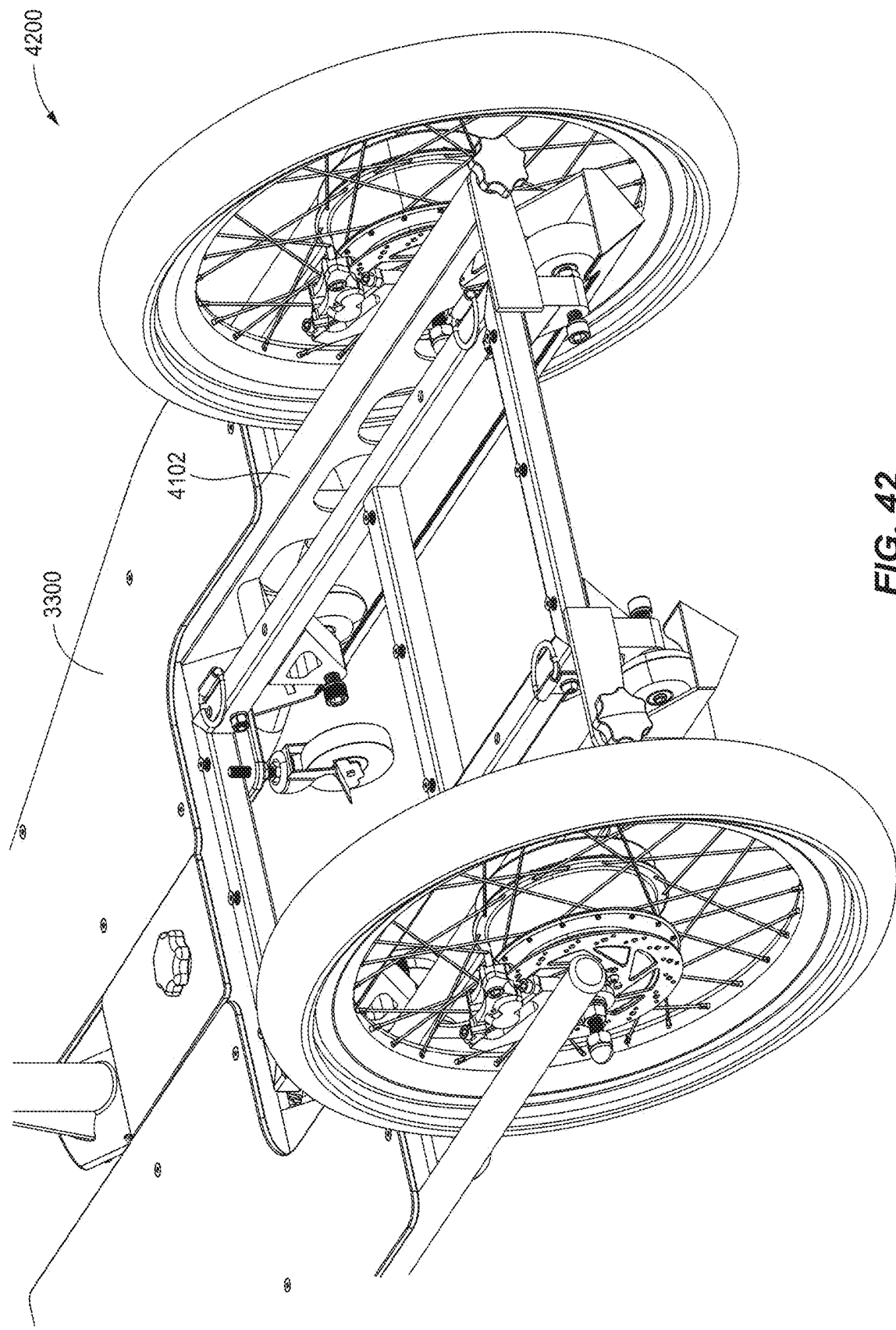


FIG. 42

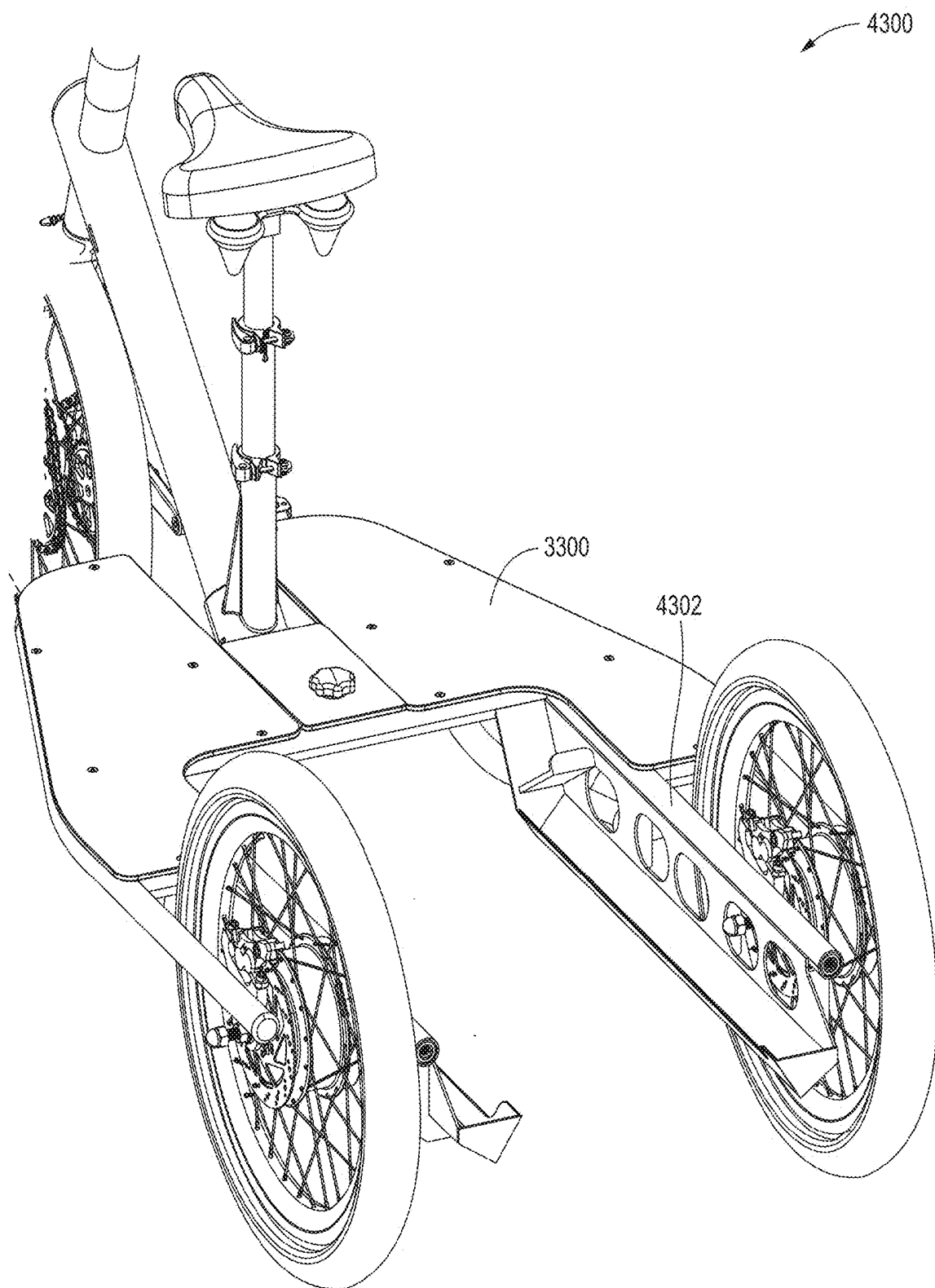


FIG. 43

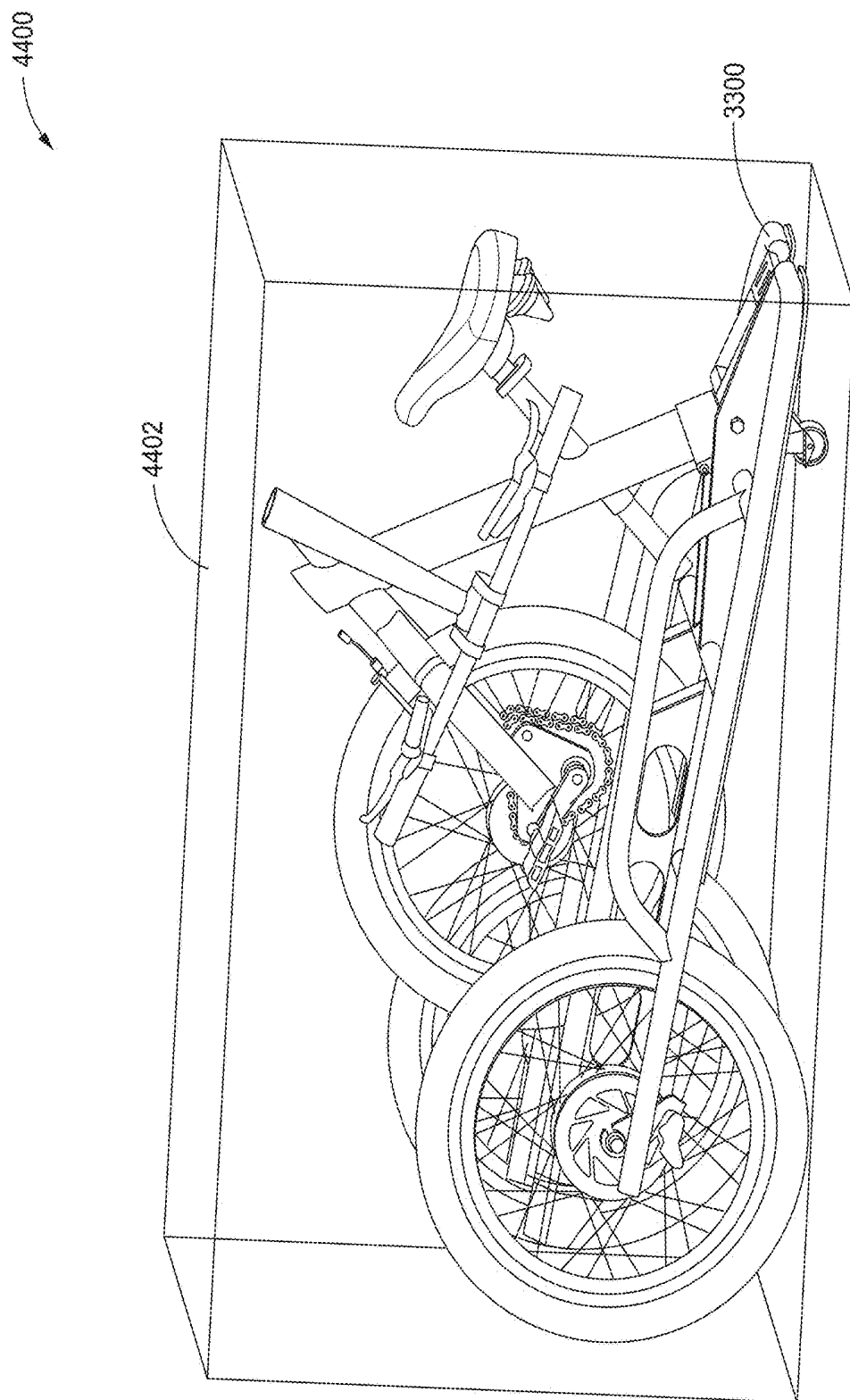


FIG. 44

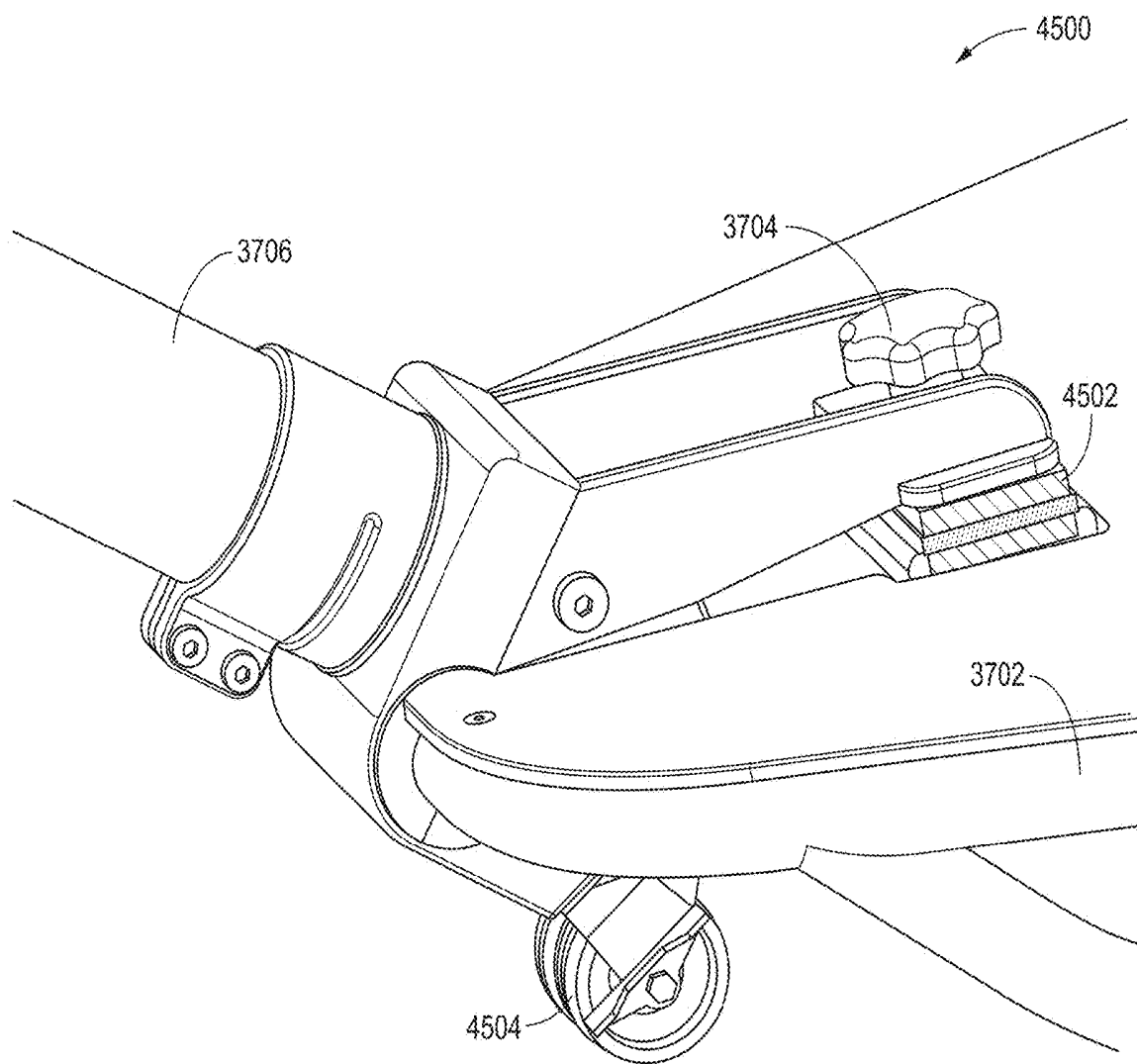


FIG. 45

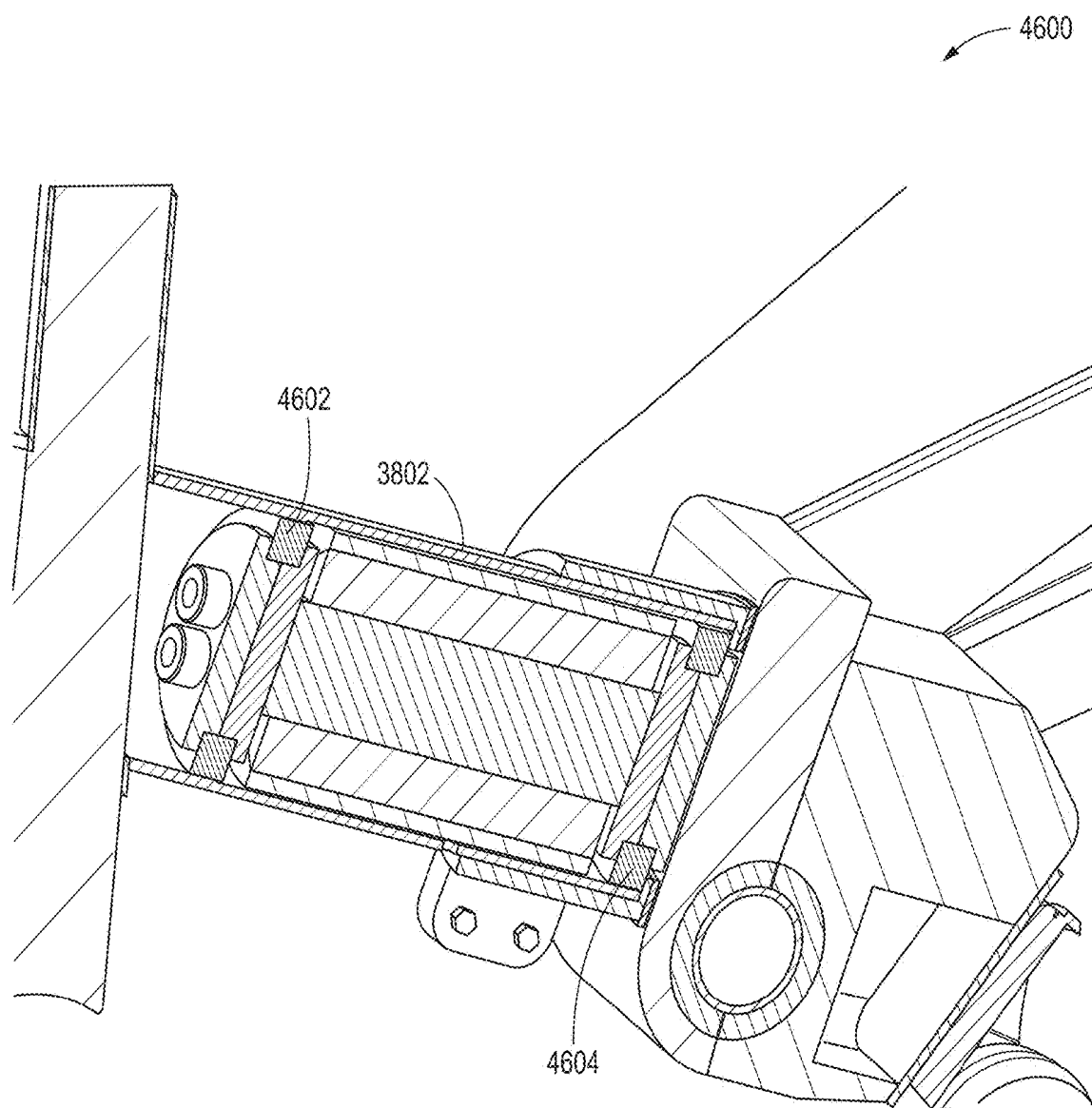


FIG. 46

FOLDING E-TRIKE

BACKGROUND

[0001] This application claims the priority benefit of provisional patent application No. 63/652,378 titled “Folding E-Trike Combining Features Which Enhance Safety and Useability” filed on May 28, 2024, the disclosure of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to a folding electrically-assisted tricycle (e-trike) that combines features which enhance safety and useability.

BACKGROUND ART

[0003] To address serious inner-city congestion and air pollution concerns, electrically-assisted transportation is growing in popularity, with both two-wheeled bicycles (bikes) and three-wheeled tricycles (trikes). Electrical assistance enables a user of the transportation vehicle to conserve personal energy, while being able to travel a longer distance. Despite their advantages, trikes (including electrically-assisted trikes) have several shortcomings that need to be addressed. A rear-drive trike has to transfer the power inputs from the rider to the rear wheels, and this results in a relatively complex powertrain that precludes adding any foldability features to the trike. Front wheel pedal propulsion overcomes this issue, but gives rise to a zig-zag motion, similar to a unicycle, due to user pedal inputs.

SUMMARY

[0004] Aspects of the invention are directed to an electrically-assisted trike (e-trike) that includes multiple mechanical features that help enhance rideability and stability.

[0005] In one aspect, an e-trike is a transportation device that includes a rear assembly and a front assembly. The rear assembly may further comprise a rear frame, and a first rear wheel and a second rear wheel mounted to the rear frame. A first and second electric motor mechanically connected to the first rear wheel and the second rear wheel respectively may be configured to provide electrical assistance to a user of the transportation device. The electric motors may be powered by an electrical power source comprising a battery.

[0006] In one aspect, the front assembly includes a saddle configured to support the user, and a front wheel connected to the saddle via a wheel hub and a fork. An elastomeric torsional element may be used to connect the front assembly and the rear assembly. The elastomeric torsional element can be configured to permit a range of motion of the front assembly relative to the rear assembly, about a longitudinal axis referenced to the transportation device. In an aspect, the range of motion is constrained by a combination of one or more mechanical stops at the end of the range of motion. An elastic force may be exerted by the elastomeric torsional element against the range of motion when the front assembly is moved away from a neutral position.

[0007] Another aspect includes the rear assembly mechanically connected to the front assembly. This front assembly may include a saddle configured to support the user, a front wheel connected to the saddle via a wheel hub and a fork, and a pedal assembly configured to transfer mechanical inputs from the user to the front wheel, to propel

the transportation device. The pedal assembly may be offset to a rearward position referenced to the wheel hub.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Non-limiting and non-exhaustive embodiments of the present disclosure are described with reference to the following figures, wherein like reference numerals refer to like parts throughout the various figures unless otherwise specified.

[0009] FIG. 1 is a rear three-quarter view of an e-trike

[0010] FIG. 2 is a side view of an e-trike.

[0011] FIGS. 3A-3C are schematic drawings showing a folding sequence of an e-trike.

[0012] FIG. 4 is a schematic depicting a folded e-trike packaged with a detachable cargo box in a shipping box.

[0013] FIG. 5 is a view of an e-trike.

[0014] FIG. 6 is a view of an e-trike.

[0015] FIG. 7 is a view of a demountable cargo box.

[0016] FIG. 8 is a view of an e-trike with a cargo box removed.

[0017] FIG. 9 is view of an e-trike with a cargo box configured to transport a child.

[0018] FIG. 10 is a view of a detachable windshield for an e-trike.

[0019] FIG. 11 is a view of a color multifunction display attached to an e-trike handlebar.

[0020] FIG. 12 is a close-up view of a color multifunction display attached to an e-trike handlebar.

[0021] FIG. 13 is a view of an LED headlamp attached to an e-trike.

[0022] FIG. 14 is a view of an offset crank and pedal assembly associated with an e-trike.

[0023] FIG. 15A is an isometric view of a pedal assembly.

[0024] FIG. 15B is a rear view of a pedal assembly.

[0025] FIG. 15C is a cross-sectional view of a front wheel hub assembly.

[0026] FIG. 16 is a view of a portion of an e-trike showing an elastomeric torsional element.

[0027] FIG. 17 is a close-up view of a self-latching fold lock in an engaged position.

[0028] FIG. 18 is a close-up view of a self-latching fold lock in a disengaged position.

[0029] FIG. 19 is a view depicting a steering lock for an e-trike.

[0030] FIG. 20 is view depicting a lever used to adjust a handlebar angle for an e-trike.

[0031] FIG. 21 is a view depicting an offset crank pedal of an e-trike.

[0032] FIG. 22 is a view depicting a disk brake on a rear wheel of an e-trike.

[0033] FIG. 23 is a view depicting a saddle of an e-trike mounted to a front wheel arch.

[0034] FIG. 24 is a view of a saddle and front wheel arch of e-trike 100 connected directly to an elastomeric torsional element.

[0035] FIG. 25 is a view of a saddle rigidly attached to a rear assembly of an e-trike.

[0036] FIG. 26 is a view of an e-trike.

[0037] FIG. 27 is a view of an e-trike.

[0038] FIG. 28 is a view of an e-trike.

[0039] FIG. 29 is a close-up view of a folding and tilting mechanism of an e-trike.

[0040] FIG. 30A is a view of a rickshaw attachment mounted on an e-trike.

[0041] FIG. 30B is a view of a rickshaw attachment demounted from an e-trike.

[0042] FIG. 31A is a view of a flatbed attachment mounted on an e-trike.

[0043] FIG. 31B is a view of a flatbed attachment demounted from an e-trike.

[0044] FIG. 32 is a view of an elastomeric torsional element.

[0045] FIG. 33 is a view of an e-trike.

[0046] FIG. 34 is a view of a front wheel of an e-trike.

[0047] FIG. 35 is a view of a front portion of an e-trike.

[0048] FIG. 36 is a view of an e-trike depicting a handlebar and a saddle.

[0049] FIG. 37 is a view depicting a connection between a front assembly and a rear assembly of an e-trike.

[0050] FIG. 38 is a close-up view of an e-trike depicting an elastomeric torsional element.

[0051] FIG. 39 is a view of a portion of an e-trike.

[0052] FIG. 40 is a view depicting a folded e-trike.

[0053] FIG. 41 is a view of an e-trike depicting an accessory mounting chassis

[0054] FIG. 42 is a close-up view of an e-trike depicting an accessory mounting chassis.

[0055] FIG. 43 is a rear view of an e-trike depicting a rear-mounting rail.

[0056] FIG. 44 is a view depicting a folded e-trike in a shipping box.

[0057] FIG. 45 is a view depicting a connection between a front assembly and a rear assembly of an e-trike.

[0058] FIG. 46 is a view depicting an elastomeric torsional element.

DETAILED DESCRIPTION

[0059] In the following description, reference is made to the accompanying drawings that form a part thereof, and in which is shown by way of illustration specific exemplary embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the concepts disclosed herein, and it is to be understood that modifications to the various disclosed embodiments may be made, and other embodiments may be utilized, without departing from the scope of the present disclosure. The following detailed description is, therefore, not to be taken in a limiting sense.

[0060] Reference throughout this specification to “one embodiment,” “an embodiment,” “one example,” or “an example” means that a particular feature, structure, or characteristic described in connection with the embodiment or example is included in at least one embodiment of the present disclosure. Thus, appearances of the phrases “in one embodiment,” “in an embodiment,” “one example,” or “an example” in various places throughout this specification are not necessarily all referring to the same embodiment or example. Furthermore, the particular features, structures, databases, or characteristics may be combined in any suitable combinations and/or sub-combinations in one or more embodiments or examples. In addition, it should be appreciated that the figures provided herewith are for explanation purposes to persons ordinarily skilled in the art and that the drawings are not necessarily drawn to scale.

[0061] Embodiments in accordance with the present disclosure may be embodied as an apparatus, method, or computer program product. Accordingly, the present disclo-

sure may take the form of an entirely hardware-comprised embodiment, an entirely software-comprised embodiment (including firmware, resident software, micro-code, etc.), or an embodiment combining software and hardware aspects that may all generally be referred to herein as a “circuit,” “module,” or “system.” Furthermore, embodiments of the present disclosure may take the form of a computer program product embodied in any tangible medium of expression having computer-usable program code embodied in the medium.

[0062] Any combination of one or more computer-usable or computer-readable media may be utilized. For example, a computer-readable medium may include one or more of a portable computer diskette, a hard disk, a random-access memory (RAM) device, a read-only memory (ROM) device, an erasable programmable read-only memory (EPROM or Flash memory) device, a portable compact disc read-only memory (CDROM), an optical storage device, a magnetic storage device, and any other storage medium now known or hereafter discovered. Computer program code for carrying out operations of the present disclosure may be written in any combination of one or more programming languages. Such code may be compiled from source code to computer-readable assembly language or machine code suitable for the device or computer on which the code can be executed.

[0063] Embodiments may also be implemented in cloud computing environments. In this description and the following claims, “cloud computing” may be defined as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned via virtualization and released with minimal management effort or service provider interaction and then scaled accordingly. A cloud model can be composed of various characteristics (e.g., on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service), service models (e.g., Software as a Service (“SaaS”), Platform as a Service (“PaaS”), and Infrastructure as a Service (“IaaS”)), and deployment models (e.g., private cloud, community cloud, public cloud, and hybrid cloud).

[0064] The flow diagrams and block diagrams in the attached figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments of the present disclosure. In this regard, each block in the flow diagrams or block diagrams may represent a module, segment, or portion of code, which includes one or more executable instructions for implementing the specified logical function(s). It is also noted that each block of the block diagrams and/or flow diagrams, and combinations of blocks in the block diagrams and/or flow diagrams, may be implemented by special purpose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and computer instructions. These computer program instructions may also be stored in a computer-readable medium that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable medium produce an article of manufacture including instruction means which implement the function/act specified in the flow diagram and/or block diagram block or blocks.

[0065] Aspects of the systems and methods described herein are related to an electrically-assisted trike that addresses the deficiencies of prior trike designs. A combination of features that includes at least one electric motor, an adjustable suspension component, a tilting and/or steering column, offset pedals, a demountable box-cart, and a folding capability provides several advantages to the end user.

[0066] FIG. 1 is a rear three-quarter view of an e-trike 100. FIG. 2 is a side view 200 of e-trike 100. As seen in FIGS. 1 and 2, e-trike 100 includes standard features such as a saddle for a user (rider), handlebars to steer the e-trike 100, and a pedal assembly (described subsequently) that drives a front wheel of e-trike 100 via user input. The rear end of the e-trike has two wheels that are supported by a frame. The frame may be made of metal, plastic, carbon fiber composite, or some other material that provides adequate support strength and stiffness. The frame also supports a removable/demountable cargo box 202. The cargo box 202 may have wheels of its own, so that the cargo box may be transported off of the e-trike 100 when demounted. When attached, secure fastening mechanisms may be used to secure the cargo box 202 to the frame of the e-trike 100. The cargo box 202 may be used to transport one or more items, pets, or even children.

[0067] Some features of an embodiment of (folding) e-trike 100 are presented in table 1.

TABLE 1

Features of folding e-trike 100	
Features	Benefit
Tilting, folding, ultra-compact (bakfiets) trike	Low C-of-G, Safer cornering, easier transportation
Standard bicycle ride height	Excellent ride, safer to "see and be seen"
High-capacity demountable Cargo "Box-Cart" 280 liters (75 gallons US)	Ideal for: deliveries, shopping, transportation
In use length-220 cm (86")	Natural ride dynamic
In Use Width-83 cm (33") PIC	Ease of access/storage/transportation
Folded Length-100 cm (40")	Upright, can be transported into and out of double-door elevators
Folded width 78 cm-(31")	Total weight 30 Kg (65 lbs) excluding battery/ accessories.
Lightweight, aircraft aluminum 6061-T6 frame	Smooth ride, adjustable to suit rider
Coil-over shock, mid-suspension	Easy mount/dismount, no kickstand, safer Load/Unload
Step thru, free standing design	Automatic Bluetooth control, low noise, long range with 36 V, 250 W, 35 NM torque, 20 Ah Battery
Compact, high torque geared motor (two electric motors, one driving each rear wheel of the e-trike)	Excellent stopping power
Single lever, dual disc brakes to each rear wheel	
Minimalistic design	Stylish, easier/lower maintenance
Ships fully assembled	Saves cost and "Ready to Go"
High Quality	Reliable, easy maintenance and long lasting

[0068] FIGS. 3A-3C are schematic drawings showing a folding sequence 300 of e-trike 100. In an aspect, a front-drive configuration of the folding e-trike 100 for rider inputs enables the e-trike 100 to be folded or collapsed for storage or transport. Sequence 300 shows an unfolded e-trike (FIG. 3A), a partially-folded e-trike (FIG. 3B), and a fully-folded e-trike (FIG. 3C). In one aspect, the cargo box 202 needs to be removed before the e-trike is folded.

[0069] FIG. 4 is a schematic 400 depicting a folded e-trike 100 packaged with detachable cargo box 202 in a shipping

box 402. An e-trike may be shipped fully-assembled by the manufacturer, in a single box similar to the packaging and with dimensions as depicted in FIG. 4.

[0070] Advantages of a trike-based platform used as a basis to design e-trike 100 are:

[0071] Trikes inherently more stable and with a "tilting" front end (described subsequently), they ride like a bike for safer cornering.

[0072] Free-standing for safer load/unloading

[0073] No kickstand required

[0074] Safer for carrying larger loads and a wider range of uses:

[0075] Transportation, shopping, tradesman, last mile deliveries, etc.

[0076] FIG. 5 is a view 500 of e-trike 100. View 500 depicts cargo box 202 attached to e-trike 100. In one aspect, the cargo box 202 is a demountable component of the e-trike 100. The cargo box 202 (also referred to as a "box cart" or a "cargo boxcart") may be demountable from the e-trike 100 chassis by using a foot latch. The cargo box 202 may be supported on supports such as wheels, runners or casters when resting on the ground while being detached/demounted from the e-trike 100. These supports allow the cargo box 202 to be moved along the ground by pushing or pulling. The cargo box 202 may be used to carry cargo (e.g., groceries), or occupants such as children or pets.

[0077] The cargo box 202 may include one or more accessories. For example, a fiberglass lockable cover 502 may be used to cover goods or items such as groceries, stored in the cargo box.

[0078] FIG. 6 is a view 600 of e-trike 100. View 600 depicts cargo box 202 attached to e-trike 100. FIG. 6 also depicts cargo box 202 covered with a Lexan™ ventilated cover 602. The Lexan™ ventilated cover 602 may be used to protect pets or animals during transportation, while the ventilation feature allows the pets to breathe comfortably.

[0079] FIG. 7 is a view 700 of demountable cargo box 202. In one aspect, an inner volume associated with the cargo box 202 may be separated into multiple compartments (e.g., upper and lower compartments), by using one or more box boards 702 and 704. These box boards 702 and 704 may be attachable to and detachable from cargo box 202, to increase cargo volume versatility and flexibility. For example, box boards 702 and 704 may be used to form shelves or seats within the volume enclosed by the cargo box 202. In one embodiment, box boards 702 and 704 may be sold as accessories for the e-trike 100, with a pack of three such box boards being sold as a set.

[0080] FIG. 8 is a view 800 of an e-trike 100 with cargo box 202 removed.

[0081] FIG. 9 is view 900 of e-trike 100 with a cargo box (similar to cargo box 202) configured to transport a child. In some embodiments, cargo box 202 may include tethers or latches that can enable the installation of child safety restraints (e.g., child car seats). In this configuration, e-trike 100 with the cargo box 202 installed may be used to transport a child, as depicted in FIG. 9.

[0082] FIG. 10 is a view of a detachable windshield 1000 for e-trike 100. Embodiments of e-trike 100 may include one or more accessories, such as detachable windshield 1000. For example, detachable windshield 1000 may be installable on the e-trike 100. In one aspect, detachable windshield 1000 is made of transparent Lexan™. Detachable windshield 1000 may reduce wind resistance to forward motion

and provides some comfort for a rider of e-trike **100** in inclement weather conditions.

[0083] FIG. **11** is a view **1100** of a color multifunction display **1102** attached to a handlebar associated with e-trike **100**. Another accessory that may be attached to the e-trike is a color multifunction display, such as color multifunction display **1102**. Color multifunction display **1102** may be any of an LCD or an OLED display of a suitable size, attached to the e-trike **100** at a position where it is visible to the rider/user. For example, color multifunction display **1102** may be attached to the handlebars of e-trike **100** for appropriate user visibility. FIG. **11** depicts color multifunction display **1102** in an “OFF” state attached to handlebars of e-trike **100**.

[0084] FIG. **12** is a close-up view **1200** of color multifunction display **1102** attached to a handlebar of e-trike **100**. In FIG. **12**, color multifunction display is shown in an “ON” state, displaying various operational parameters of e-trike **100**.

[0085] In one aspect, color multifunction display **1102** is powered by the one or more batteries that also power e-trike **100** (e.g., the electric motors that drive the rear wheels of e-trike **100**). Color multifunction display **1102** may be configured to display various operating parameters associated with the e-trike, such as:

- [0086] Battery charge
- [0087] Battery power consumption (instantaneous and average)
- [0088] Miles traveled (odometer)
- [0089] Current speed (speedometer)
- [0090] Average speed
- [0091] Trip computer
- [0092] Metrics displaying instantaneous charge/discharge state of battery based on user inputs

[0093] FIG. **13** is a view **1300** of an LED headlamp **1302** attached to e-trike **100**. Other accessories that may be attached to the e-trike **100** include a headlamp (e.g., LED headlamp **1302**) tail lamps, a security lock, one or more reflectors, etc. The lamps such as LED headlamp **1302** may be powered by the one or more batteries that power e-trike **100**.

[0094] FIG. **14** is a view **1400** of an offset crank and pedal assembly **1402** associated with e-trike **100**. An embodiment of e-trike **100** is designed to be a front-drive platform for rider inputs, where the rider’s pedal inputs are transmitted to the front wheel of the e-trike **100**, and the e-trike **100** is driven via the front wheel. A disadvantage of directly coupling rider inputs to the front wheel of a pedal-driven vehicle is observed on vehicles such as motorcycles. When a motorcycle is pedaled and is in motion, the system dynamics result in a zigzag motion relative to an intended path of travel. A similar behavior can be observed in a trike with a front-drive configuration.

[0095] To mitigate the yaw/zigzag effects of direct pedal inputs to the front wheel of the e-trike **100**, the crank associated with the pedal is offset towards the rear of the front wheel, as depicted in view **1400** (i.e., pedal assembly **1402**). Other than pedal assembly **1402**, e-trike **100** may also be with an option of a dynamic, lever operated band clamp to completely eliminate a zigzag motion on start-up and until momentum renders this unnecessary.

[0096] FIG. **15A** is an isometric view of pedal assembly **1500** (similar to pedal assembly **1402**). As depicted, pedal assembly **1500** includes pedals **1502** and **1504**, where the

pedals **1502** and **1504** are configured to receive pedaling inputs for propulsion from a user/rider of e-trike **100**. The pedal inputs are transmitted to wheel hub **1510** via chains **1506** and **1508**. These transmitted inputs to wheel hub **1510** rotate and drive the front wheel of e-trike **100**. This is a unique aspect to synchronize pedals **1502** and **1504**. In one aspect, the front wheel hub **1510** is a part of a front wheel hub assembly that comprises an inner non-rotating axle attached to the drop-outs of the fork, around which, mounted on independent bearings, includes an intermediate rotating cylinder with identical sprockets fixed to each end. This intermediate cylinder ensures opposing pedals **1502** and **1504** remain synchronized at **180** degrees to one another. The rotation of the intermediate cylinder transmits the input torque driven by the pedals, via a “sprag clutch” (freewheel) to the hub shell to which the spokes are attached. An example embodiment of such a front wheel hub assembly is depicted in FIG. **15C**. Such a front-wheel drive mechanism acts as a solid axle, while advantageously providing a turns ratio increase for the mechanical system associated with e-trike **100**.

[0097] FIG. **15B** is a rear view of pedal assembly **1500** (also referred to as a “fork assembly”). The offset pedal system associated with pedal assembly **1500** facilitates a reduction in yaw. Different embodiments can be constructed with a choice of different sockets and different turn ratios offered as an ordering option for e-trike **100**. One possible option is a turns ratio of 1.4:1, wherein one complete rotation of a pedal crank included in pedal assembly **1500** results 1.4 rotations of the front wheel of e-trike **100**, having a diameter of, for example, 29" (74 cm) at a typical 1 second cadence, (rotation of the pedals) yielding a speed of 15 mph (24 Km/Hr).

[0098] FIG. **15C** is a cross-sectional view of front wheel hub assembly **1512**. As depicted, front wheel hub assembly **1512** includes wheel hub **1510**, independent bearings **1514** and **1518**, inner non-rotating axle **1516**, sprag clutch **1520**, and intermediate cylinder **1522**. As described above, front wheel hub assembly **1512** includes inner non-rotating axle **1516** attached to the drop-outs of the fork, around which, mounted on independent bearings **1514** and **1518**, includes an intermediate rotating cylinder **1522** with identical sprockets fixed to each end. This intermediate cylinder **1522** ensures opposing pedals **1502** and **1504** remain synchronized at **180** degrees to one another. The rotation of the intermediate cylinder **1522** transmits the input torque driven by the pedals **1502** and **1504**, via a sprag clutch **1520** (freewheel) to the hub shell to which the spokes are attached.

[0099] Some aspects of the e-trike **100** include a cadence sensor to sense a pedaling cadence associated with user inputs, where the user inputs are received via pedals **1502** and **1504**. The cadence sensor may be connected to pedal assembly **1500** to measure rider pedal cadence inputs. If the cadence sensor detects that the user has stopped pedaling (i.e., zero pedal inputs), the power inputs to the electric motors mechanically coupled to the rear wheels of e-trike **100** are correspondingly terminated, as a processing system connected to the electronic circuitry of the e-trike **100** determines that no power input is needed. Such situations arise, for example, when a user is riding downhill, or is coasting.

[0100] In an embodiment, the cadence sensor is connected to the electric motors (e.g., via motor and battery control electronics) via a wireless connectivity protocol such as

Bluetooth. Using wireless connectivity allows the e-trike to be designed without needing electrical cables that connect the cadence sensor to the batteries and electric motors.

[0101] Some aspects of the e-trike **100** may include a speed controller mounted on the handlebar. The speed controller enables the user/rider of e-trike **100** to select a battery power output depending on their need. For example, when ascending a hill, the user may request higher battery assist (i.e., higher battery power). When descending a hill, the user may request lower (or zero) battery assist. In an aspect, the speed controller may be connected to motor and battery control electronics via a wireless connectivity protocol such as Bluetooth. Using a wireless connectivity protocol enables the e-trike **100** to be designed without the need to run electrical cables between the speed controller and the motor and battery control electronics (that may be mounted towards the rear of the e-trike).

[0102] FIG. **16** is a view **1600** of a portion of an e-trike **100** showing an elastomeric torsional element **1602**. View **1600** also depicts tilt lock lever **1604**, full mid suspension **1606**, and self-latching fold lock **1608**.

[0103] Due to wheel configurations, bicycles and tricycles (trikes) inherently have different motion dynamics. While riding a bicycle, a rider's weight can shift to the left or to the right, due to available degrees of freedom available in the associated lateral directions. This allows the bicycle rider to lean into a turn and safely negotiate the turn. This feature is not available on a trike, due to which a trike can potentially become unstable in a turn, causing the trike to possibly tip over.

[0104] Some embodiments of the e-trike **100** incorporate aspects of the dynamics of bicycles, via adjustable elastomeric torsional element **1602** disposed at the front end of the rear frame, where the rear frame connects with the saddle assembly of e-trike **100**. In one aspect, elastomeric torsional element **1602** is also referred to as a "dynamic tilt control". The elastomeric torsional element **1602** allows the handlebar, front wheel and pedal assembly of e-trike **100** to tilt relative to the rear frame, against elastic/spring tension exerted by the elastomeric torsional element **1602**, about a longitudinal axis associated with the e-trike **100**. In another embodiment, the handlebar, the front wheel and pedal assembly, and the saddle of e-trike **100** are allowed to tilt, against elastic/spring tension exerted by the elastomeric torsional element **1602**, about a longitudinal axis associated with the e-trike **100**.

[0105] When turning, a rider of e-trike **100** can lean into the turn against elastic/spring tension exerted by the elastomeric torsional element **1602**, in a manner similar to how a bicyclist leans into the turn. Leaning into a turn enables a rider to shift their center of gravity to compensate for a centrifugal force effect generated due to the turning motion and facilitates counter steering, which is fundamental to bicycle ride dynamics. The elastomeric torsional element **1602** simulates an additional degree of freedom of motion to the rider of the e-trike **100** that is normally not available on a regular trike. This precessional effect of compensating for centrifugal force due to a turn by the rider of the e-trike **100** leaning into the turn provides an additional safety feature to the e-trike **100**. This aspect where the longitudinal axis of the trike includes a suspension component (i.e., the elastomeric torsional element **1602**) also allows for tighter turns to be made, thereby improving a maneuverability of the e-trike **100**. The elastomeric torsional element **1602** allows a low-

ering of the effective center of gravity of the e-trike **100**, where components comprising a front portion of the e-trike **100** (i.e., a front assembly including the front wheel and pedal assembly (e.g., pedal assembly **1500**), the handlebars, and the saddle) tilt, but a rear portion (a rear assembly including at least a rear frame and the two rear wheels with the associated electric drive motors) of the e-trike **100** does not. Essentially, the e-trike **100** combines the most advantageous features of a bicycle and a trike, providing the stability of a trike due to the three-wheel configuration, while providing the safer dynamics and ride quality of a bicycle in turns.

[0106] In an aspect, tilt lock lever **1604** may be used to lock or unlock elastomeric torsional element **1602** via a tilt lock. When tilt lock lever **1604** is locked, elastomeric torsional element **1602** is locked and is not free to move about the longitudinal axis. In this case, the e-trike **100** behaves like a regular trike. This lock feature may be activated by a user, using tilt lock lever **1604**, at low speeds or when the e-trike **100** is stationary. Activating the tilt lock may be used to stabilize the e-trike **100**, preventing the e-trike **100** from tipping over when stationary and when the rider is off the e-trike **100**, or when the rider is embarking on/disembarking from the e-trike **100**. For example, a parent taking their child to school may engage the tilt lock lever **1604** when they are off the e-trike **100**. The tilt lock engaged by tilt lock lever **1604** may also be used (i.e., be engaged) at low speeds, when there is a lesser risk of the e-trike **100** tipping over during a turn.

[0107] In an aspect, full mid suspension **1606** provides a cushioning/spring suspension effect, smoothing out road imperfections while providing a comfortable ride for the rider, and for passengers or cargo. The self-latching fold lock **1608** allows the e-trike to be securely and rigidly locked in place when unfolded. This is a safety feature that reduces any chances of motion along the folding axes while the e-trike is in use. Details of the self-latching fold lock **1608** are presented subsequently.

[0108] FIG. **17** is a close-up view **1700** of a self-latching fold lock **1608** in an engaged position. In one aspect, self-latching fold lock **1608** engages with lock pin **1704** when the e-trike **100** is unfolded and locked. A second lock pin analogous to lock pin **1704** disposed on the other side (not visible in view **1700**) also engages with self-latching fold lock **1608** when the e-trike **100** is unfolded and locked. In an aspect, the e-trike **100** folds and unfolds about axis **1702**. When the e-trike **100** is unfolded and locked via self-latching fold lock engaging with lock pin **1704** and the other lock pin, any motion about axis **1702** is substantially prevented by the engaging, thereby stably locking the e-trike **100** into the unfolded position. This locking feature prevents any undesired motion about axis **1702** at any time, when the e-trike **100** is in motion or at rest. FIG. **17** also depicts full mid suspension **1606**.

[0109] FIG. **18** is a close-up view **1800** of a self-latching fold lock **1608** in a disengaged position. As depicted in view **1800**, the self-latching fold lock **1608** is disengaged from lock pin **1704** and the second lock pin. In this configuration, the rear frame and the front assembly (including the front wheel and pedal assembly, handlebars and saddle) of the e-trike **100** can now rotate about axis **1702** for folding, as depicted in the sequence of FIGS. **3A-3C**. FIG. **18** also depicts full mid suspension **1606**.

[0110] In one aspect, during an unfolding process, a user unfolds the e-trike 100 from its fully folded position to a fully unfolded position about axis 1702, where self-latching fold lock 1608 engages with lock pin 1704 and the second lock pin to lock the e-trike 100 in the fully-unlocked position. On the other hand, to fold the e-trike from its fully unfolded position, a user depresses a lever to unlatch self-latching lock 1608 such that self-latching lock 1608 disengages from each of lock pin 1704 and the second lock pin. The e-trike can now be rotated about axis 1702, to a fully-folded position.

[0111] FIG. 19 is a view 1900 depicting a steering lock 1902 for e-trike 100. In one aspect, steering lock 1902 is implemented as a latch (not depicted in FIG. 19) is used to prevent a zigzag motion on start-up or when putting the tricycle in the folding mode. In one aspect, the steering lock 1902 is a screw-in knob to lock steering when folding. A user may operate a screw associated with steering lock 1902 to lock the handlebar of the e-trike 100 in place, as depicted in FIG. 19. In the locked position, the handlebar remains locked in a central position, and is unable to be rotated in either a left or a right direction. From an operational standpoint, the user can engage the steering lock 1902 prior to folding the e-trike 100. When the e-trike 100 is unfolded and is in use, the user unlocks the steering lock 1902 to allow a full range of motion of the handlebars. This facilitates regular steering for the e-trike 100.

[0112] FIG. 20 is view 2000 depicting a lever 2002 used to adjust a handlebar angle for e-trike 100.

[0113] FIG. 21 is a view 2100 depicting an offset crank pedal 2102 of e-trike 100. In an aspect, crank pedal 2102 is similar to any of pedals 1502 or 1504, and is connected to pedal assembly 1500. In one embodiment, the e-trike 100 includes a 29-inch, 700c front wheel that provides a lower rolling resistance as compared to smaller front wheels. The relatively larger wheel size also helps to smooth out the ride for a rider.

[0114] In one aspect, pedal assembly 1500 receives front-drive user inputs for the e-trike 100, which has an all-wheel drive (AWD) drivetrain. As depicted in FIGS. 15A, 15B and FIG. 21, the crank is offset to the rear to give comfortable access to a leg length of a rider based on a position of the saddle, and also to minimize the zigzagging effect that is observed on a tricycle.

[0115] FIG. 22 is a view 2200 depicting a disk brake 2202 on a rear wheel of e-trike 100. Some embodiments of the e-trike 100 include a dual braking system, which comprises one lever actuating two rear disk brakes, with one disk brake being associated with each of the two rear wheels. An example embodiment of a disk brake on an e-trike 100 is disk brake 2202.

[0116] In one aspect, each of the rear wheels of e-trike 100 is powered by an electric motor. Each electric motor may be controlled by a motor control system that is monitored by multifunction display panel 1102. A motor control system of e-trike 100 may be configured to communicate via Bluetooth connectivity with each of the two electric motors. In one embodiment, the electric motors produce a total of 40 (×2 with dual motors) Nm of torque. Each motor may be powered by a rechargeable electric battery of capacity 40 Ah, 48 W. The two batteries may be mounted underneath the rear frame of the e-trike 100 for a lower center of gravity.

[0117] FIG. 23 is a view 2300 depicting a saddle 2302 of e-trike 100 mounted to a front wheel arch of e-trike 100 (i.e.,

mounted as a part of the front assembly). Saddle 2302 may be a configurable (e.g., height-adjustable) saddle. In an alternate embodiment, saddle 2302 is mounted to the rear assembly of e-trike 100.

[0118] FIG. 24 is a view 2400 of a saddle and front wheel arch 2404 of e-trike 100 connected directly to elastomeric torsional element 2402. Elastomeric torsional element 2402 may be similar to elastomeric torsional element 1602. In one aspect, the elastomeric torsional element (e.g., elastomeric torsional element 1602/2402) controls an amount of tilt necessary for the e-trike 100. A tricycle configuration such as that used for the e-trike 100 is inherently stable, having three wheels, rather than a bicycle that has two wheels. At the same time, the tilt feature provided by the elastomeric torsional element 1602/2402 enables a rider to lean into the corners so although the e-trike 100 has the three-wheel stability of a trike, it rides like a bicycle in the corners. This feature is important for safety when traveling at speed.

[0119] In one aspect, the saddle of the e-trike may 100 be mounted such that the saddle is connected to the elastomeric torsional element. In this case, the saddle is directly connected to the front wheel arch, and can tilt in unison with the front wheel assembly. This allows the rider to lean their body into a turn while turning. Element 2404 in view 2400 depicts such a saddle construction directly connected to elastomeric torsional element 2402.

[0120] FIG. 25 is a view 2500 of a saddle 2502 rigidly attached to a rear assembly 2504 of e-trike 100. In this embodiment, only the front wheel assembly and the handlebars (collectively referred to as the “front frame” or “front assembly”) 2508 are connected to the elastomeric torsional element 2506 (similar to elastomeric torsional element 1602), and are enabled to tilt. The saddle 2502, on the other hand, is cannot tilt, since the saddle is rigidly attached to the rear assembly 2504.

[0121] In an aspect, the saddle itself 2502 is adjustable, and can be raised or lowered depending on a leg length of the rider. In one aspect, the elastomeric torsion element 2506 is selected or designed such that an elastic torque exerted by the elastomeric torsion element 2506 ensures that the steering column (a part of front frame 2508) returns to vertical when stationary or not under an external force exerted by the rider. At the same time, this elastic torque is not too high to prevent requisite tilt to for tangential impingement of the front wheel to the road surface while turning.

[0122] When the saddle 2502 is affixed to the non-tilting rear frame 2504 and the elastomeric torsional element 2506 is attached to the front frame 2508, this arrangement allows the steering column to tilt adequately and for the rider to shift their weight to counteract the centrifugal force for the dynamic/variable conditions depending upon turn radius and velocity.

[0123] In one embodiment, the front frame suspension and pedal assembly (e.g., pedal assembly 1500) of e-trike 100 allows rider to backpedal, coast or freewheel just like a regular bicycle. Both pedals (i.e., pedals 1502 and 1504) are fully synchronized due to the use of a two-chain system (i.e., chains 1506 and 1508), each driving the wheel hub 1510 in a forward direction. Inside the wheel hub 1510 is a triple-axle system with a rolling clutch. This results in silent operation when backpedaling, instead of the clicking sound that is a characteristic commonly seen in bicycles. In this regard, the e-trike 100 is smooth and quiet.

[0124] In an aspect, the each of the front and rear assembly of e-trike **100** may be comprised of an aluminum frame that can be made much lighter in weight as compared to a regular tricycle, whose frame has to be very strong and rigidly welded together. These front and rear assemblies may be connected by a combination of the elastomeric torsional element **1602** and the mid suspension **1606**. Mid suspension **1606** is configured to provide a smooth ride for both the rider and for occupants or cargo in the cargo box **202**. In an aspect, mid suspension **1606** is implemented using a coil over shock (or damper) mechanism that absorbs a large portion of an impact when the e-trike **100** travels over bumps.

[0125] In general, a tricycle frame needs to be made structurally rigid to provide the requisite structural strength to the frame. The downside of this construction is that the corresponding ride over bumps and rough terrain can be very uncomfortable and jarring for the rider, as the bumps are transmitted substantially unattenuated to the rider. In an aspect, the frame connecting the front and rear wheels for the e-trike **100** does not need to be made strong and rigid when the midframe suspension component (i.e., mid suspension **1606**) is used. In the e-trike **100**, the weight is distributed throughout the structure, and the dynamic load is absorbed by the shock (e.g., a mid-frame suspension component, or mid suspension **1606**).

[0126] In one aspect, a center of gravity of the e-trike **100** is designed to be as low as possible. The rider's center of gravity is important so that the centrifugal force when steering around corners can be counteracted. As far as the load carried by the e-trike **100** (e.g., in the cargo box **202**) is concerned, it is desirable that the load itself remain flat and parallel to the ground and contribute as little as possible to the centrifugal force on cornering. To further lower the center of gravity of the rear frame, the batteries are mounted under the rear frame, and the cargo box **202** is designed so that the main mass carried in the cargo box **202** is as low as possible. In one aspect, the mass carried in the cargo box **202** is at the center of the rear wheels. In a particular aspect the rear wheels are 20 inches in diameter. The rear wheels each have the same cross section as the front wheel, of 2.25 inch. This provides further shock absorbing properties for a smoother ride.

[0127] In an aspect, the cargo box **202** is a demountable box cart. In this sense, the cargo box **202** is also referred to as a "cargo boxcart". The cargo box **202** can be released and demounted from the e-trike **100**, and moved around on wheels. Once the lock for the cargo box **202** is released, the cargo box **202** can be lifted up and demounted, and wheeled around like a cart. In an aspect, the cargo box **202** can be used as a shopping cart. A rider transporting children can demount the cargo box **202** and transport the children through a supermarket while using the cargo box **202** on wheels as a shopping cart. In this way, the rider can bring their children or valuables with them, and does not need to leave their children or valuables outside with the e-trike **100**. After the rider is done with their shopping trip, they can attach the cargo box **202** back on the e-trike **100** and ride away.

[0128] Another feature of having the box cart demountable **202** is that the e-trike **100** can be folded when the cargo box **202** is demounted. The steps for folding the e-trike are as follows:

[0129] Lock the steering column of e-trike **100** (e.g., by using the steering lock **1902**).

[0130] Use the quick release (e.g., self-latching fold lock **1608**) to unlock the midsection lock of the e-trike **100**.

[0131] The e-trike **100** can now be folded and rested on its two rear wheels and a jockey wheel. The e-trike is maneuverable in the folded state, and can be rolled into a building.

[0132] No tools are required to fold or unfold the e-trike **100**.

[0133] The folded e-trike **100** can fit into an elevator, and be wheeled into an apartment. In this way, an owner of the e-trike **100** does not need to store the e-trike outdoors (e.g., in the street). The folded e-trike **100** is relatively compact, and this feature addresses issue of storing a large cargo trike with an attached cargo box. It is important to note that the cargo box **202** needs to be removed before the e-trike **100** can be folded (or unfolded).

[0134] To unfold the e-trike **100**, a reverse sequence of operations can be performed:

[0135] Unfold the e-trike **100** so that self-latching fold lock **1608** engages

[0136] Unlock the steering lock **1902** to allow a full range of motion for the steering.

[0137] The relative simplicity of folding and unfolding the e-trike **100** is advantageous to an owner/rider, especially for owners living in an apartment. The demountable cargo box **202** advantageously has versatility, as it can be used not only for transport while mounted on the e-trike **100**, but also as a wheeled cart to carry and transport children and/or cargo when demounted from the e-trike.

[0138] In summary, the features of the e-trike **100** include:

[0139] The tilting e-trike **100** is inherently safer than a cargo bike, since the three-wheel configuration is inherently stable as compared to a cargo bike. A rider of the e-trike **100** does not have to worry about balancing the vehicle on two wheels, particularly when starting and stopping. In addition, the tilting feature of the e-trike **100** addresses the associated instability of a three-wheeled platform (i.e., a tricycle) when negotiating turns. In the e-trike **100**, the tilting aspect (i.e., dynamic tilt control) is achieved by the elastomeric torsion element **1602**, as described previously.

[0140] The folding feature of the e-trike **100** (with the cargo box **202** demounted) allows an owner to transport and store the e-trike **100** in relatively compact spaces. For example, the folded e-trike **100** can be wheeled into a building, into an elevator, and then into an apartment. This allows an owner of the e-trike **100** to store the e-trike indoors. In part, the folding capability is achieved by the front-drive capability of the e-trike **100** for rider inputs, where rider inputs are directly transmitted to the front wheel via, for example, pedal assembly **1500**. This front-drive configuration prevents the need for mechanical linkage to transmit power to the rear wheels (as would be required for a rear-drive configuration similar to a bicycle). Not having such a mechanical linkage further facilitates folding.

[0141] The full mid suspension **1606** helps improve ride comfort by eliminating the need for a solid tricycle frame assembly. Mid suspension **1606** is configured to absorb dynamic impacts due to bumps and uneven

terrain. This aspect reduces stress on the e-trike 100 assembly, as well as improves ride comfort.

- [0142] The e-trike 100 is configured as an all-wheel drive vehicle via a direct rider inputs to the front wheel, and an electric motor at each of the rear wheels. This all-wheel drive configuration is advantageous, as the rear motors provide rider assist to reduce an amount of effort exerted by the rider when pedaling. At the same time, the all-wheel drive configuration can be designed to provide better traction and ride stability as compared to front-only or rear-only drive configurations. This provides a greater margin of safety for the rider, making the e-trike 100 a safer vehicle than its front-drive or rear-drive counterparts.
- [0143] In an aspect, the cargo box 202 may be configured to be used as a hot/cold vending storage system. Specifically, the cargo box 202 may be modified with insulating properties and/or heating or cooling features that may be used to keep hot items hot, and cold items cold. This allows the e-trike 100 to be used as a hot food vending system, or a cold food (e.g., ice cream or desserts) vending system.
- [0144] FIGS. 26-28 show some of many different possible configurations for e-trike 100.
- [0145] FIG. 26 is a view 2600 of an e-trike 100. As depicted, view 2600 shows the following features of e-trike 100:
- [0146] A Lexan™ passenger rain cover 2604 for the cargo box 202. This rain cover is transparent for passenger comfort. An embodiment also includes a rear hinge for the passenger rain cover 2604, that also includes a locking feature.
- [0147] A safety frame 2608 that encircles and holds the cargo box 202 in place while also providing a level of crash resistance.
- [0148] Lift handles and child step 2606 to allow the safety frame to be lifted, and to facilitate children getting in and out of the cargo box 202, respectively.
- [0149] Caster wheel(s) 2602 that enhance maneuverability of the e-trike when folded. The e-trike is shown to be resting on such a caster in FIG. 3C. Caster wheel(s) 2602 may be used to wheel e-trike 100 when folded, in conjunction with the rear wheels of e-trike 100.
- [0150] FIG. 27 is a view 2700 of e-trike 100. As depicted, FIG. 27 shows the following features of e-trike 100:
- [0151] Steering lock lever 2712 to lock steering wheel/handlebar assembly prior to folding the e-trike.
- [0152] Brake levers such as brake lever 2710 mounted on the handlebar, that actuate dual rear-mounted disc brakes.
- [0153] Elastomeric torsional element 2704 that allows the front assembly comprising the handlebar, front wheel and pedal assembly to tilt as described above.
- [0154] Seat post/saddle 2708 mounted rigidly on the rear frame.
- [0155] Hard shell lockable cover 2702 for the cargo box 202 as an alternative to the Lexan™ passenger rain cover 2604.
- [0156] Dual battery and/or dual motor options 2706 for electric assist features. The batteries are mounted below the rear frame to lower the center of gravity of the e-trike 100.
- [0157] FIG. 28 is a view 2800 of an e-trike 100. As depicted, view 2800 includes:
- [0158] Demountable box cart/cargo box 202 demounted from the e-trike 100. Cargo box 202 is shown to have cover 2702 attached.
- [0159]
- [0160] A pair of guide rails 2804 that allow the cargo box 202 to be rolled on or off the e-trike 100 when mounting or demounting the cargo box 202.
- [0161] Load/unload wheels 2806 on the cargo box 202 that slide/roll on the guide rails 2804 when mounting or demounting the cargo box 202.
- [0162] Double casters 2808, similar to the front wheels of a shopping cart, on cargo box 202. In an aspect, a swiveling capability of the double casters 2808 allow the cargo box 202 to be maneuvered in a manner similar to a shopping cart. This feature can be helpful in places such as malls or supermarkets.
- [0163] FIG. 29 is a close-up view 2900 of a folding and tilting mechanism of e-trike 100. As depicted, view 29 includes:
- [0164] Front frame 2902 attached to the elastomeric torsional 2912 element to control steering tilt. Elastomeric torsional element 2912 is rigidly attached to rear frame 2908.
- [0165] Caster 2910 that allows the folded e-trike 100 to be rolled around (for example, into an elevator).
- [0166] Teflon bushings 2916 that enable folding while also functioning as suspension bearings.
- [0167] One of two self-latching fold locks 2906 that hold open the e-trike 100 rigidly in the unfolded state.
- [0168] A spring coil-over shock absorber 2904, as described previously.
- [0169] A reaction damping adjustment 2914 to adjust the response of the shock absorber to uneven terrain and bumps.
- [0170] FIG. 30A is a view 3000 of a rickshaw attachment 3002 mounted on e-trike 100. The rickshaw attachment 3002 may allow the e-trike 100 to be configured as a rickshaw to transport passengers. The rickshaw attachment 3002 may have a similar base structure as the cargo box 202 (including, for example, the base frame, attachment points, etc., that enable the rickshaw attachment 3002 to be mounted to the rear frame of the e-trike 100, and wheeled casters for transport when demounted from the e-trike 100).
- [0171] FIG. 30B is a view 3001 of rickshaw attachment 3002 demounted from e-trike 100. As seen in FIGS. 30A and 30B, the rickshaw attachment 3002 may include a seat with side handles that may accommodate one or two passengers. FIG. 30B shows the rickshaw attachment 3002 resting on casters when demounted from the e-trike 100. The casters allow the rickshaw attachment 3002 to be easily transported (e.g., wheeled or rolled).
- [0172] FIG. 31A is a view 3100 of a flatbed attachment 3102 (also referred to as a “cargo rack”) mounted on e-trike 100. The flatbed attachment 3102 may allow the e-trike 100 to transport cargo, with the flatbed attachment 3102 acting as a pallet. The flatbed attachment 3102 may have a similar base structure as the cargo box 202 (including, for example, the base frame, attachment points, etc., that enable the flatbed attachment 3102 to be mounted on the rear frame of the e-trike 100, and wheeled casters for transport when demounted from the e-trike 100).

[0173] FIG. 31B is a view 3101 of flatbed attachment 3102 demounted from e-trike 100. View 3100 shows the flatbed attachment resting on casters when demounted from the e-trike. The casters allow the flatbed attachment to be easily transported (e.g., wheeled or rolled).

[0174] FIG. 32 is a view of elastomeric torsional element 3200. As depicted, elastomeric torsional element 3200 includes central core 3204, surrounded by four elastic (e.g., rubber) restraints such as elastic restraints 3202. Central core 3204 may be made of metal, and configured to rotate about a rotational axis that may be substantially parallel to a longitudinal axis associated with e-trike 100. A rotation of central core 3204 may be opposed by restorative elastic forces generated by each of the elastic restraints, including elastic restraint 3202. Central core 3204 may be rigidly affixed to the front assembly (e.g., at least the front wheel, wheel arch and handlebars) of e-trike 100. Elastomeric torsional element 3200 may be a component of elastomeric torsional element 1602 or 2506.

[0175] FIG. 33 is a view of e-trike 3300. E-trike 3300 may be similar to e-trike 100, the only differences being:

[0176] A smaller front wheel 3302 on e-trike 3300 as compared to e-trike 100. In one aspect, all three wheels on e-trike 3300 are 20" in diameter. The smaller front wheel size helps reduce packaging and storage size, whilst the sprocket sizes are chosen to maintain the turns: velocity ratio. An embodiment of e-trike 3300 includes a folding handlebar stem to further reduce packing volume.

[0177] An anti-vibration shock absorber (described subsequently) used in place of spring coil-over shock absorber 2904.

[0178] FIG. 34 is a view 3400 of front wheel 3302 of e-trike 3300. View 3400 also depicts pedal assembly 3402 that is similar to pedal assembly 1500.

[0179] FIG. 35 is a view 3500 of a front portion of e-trike 3300. View 3500 depicts front wheel 3302, pedal assembly 3402, and saddle 3502.

[0180] FIG. 36 is a view 3600 of an e-trike 3300 depicting handlebar 3602 and saddle 3502.

[0181] FIG. 37 is a view 3700 depicting a connection between front assembly 3706 (including front wheel 3302) and rear assembly 3702 of e-trike 3300. View 3700 also depicts locking knob 3704 that, when tightened by a user, rigidly locks the front assembly 3706 of e-trike 3300 to the corresponding rear assembly 3702 when e-trike 3300 is unfolded. Prior to folding e-trike 3300, a user has to loosen locking knob 3704.

[0182] FIG. 38 is a close-up view 3800 of e-trike 3300 depicting elastomeric torsional element 3802. Elastomeric torsional element 3802 may be similar to elastomeric torsional element 1602. The elastomeric torsional element 3802 allows the handlebar 3602, front wheel 3302, and pedal assembly 3402 (in general, front assembly 3706) to tilt relative to the rear frame (in general, rear assembly 3702), against elastic/spring tension exerted by the elastomeric torsional element 3802, about a longitudinal axis associated with the e-trike 3300. In another embodiment, the handlebar 3602, the front wheel 3302, the pedal assembly 3402, and the saddle 3502 are allowed to tilt, against elastic/spring tension exerted by the elastomeric torsional element 3802, about a longitudinal axis associated with the e-trike 3300. FIG. 38 also depicts locking knob 3704. View 3800 is a

sectional view that does not depict the connection portion of the front assembly to the rear assembly of e-trike 3300.

[0183] FIG. 39 is a view 3900 of a portion of e-trike 3300, depicting front wheel 3302, elastomeric torsional element 3802, and locking knob 3704. View 3900 is a sectional view that does not depict the connection portion of the front assembly to the rear assembly of e-trike 3300.

[0184] FIG. 40 is a view 4000 depicting folded e-trike 3300. In an aspect, e-trike 3300 is configured to fold in a manner similar to e-trike 100, for compact transportation and storage. Also, e-trike 3300 may be designed such that all the accessories for e-trike 100 are compatible with e-trike 3300.

[0185] FIG. 41 is a view 4100 of e-trike 3300 depicting accessory mounting chassis 4102. Accessory mounting chassis 4102 may be used as a base for accessories such as cargo box 202, rickshaw attachment 3002, and flatbed attachment 3102. Accessory mounting chassis 4102 may include one or more wheels and casters that:

[0186] Enable an accessory to be wheeled around like a shopping cart when demounted from e-trike 3300, and

[0187] Enable the accessory to be smoothly rolled onto or off of e-trike 3300 when respectively mounting or demounting the accessory on or off of e-trike 3300.

[0188] FIG. 42 is a close-up view 4200 of e-trike 3300 depicting accessory mounting chassis 4102.

[0189] FIG. 43 is a rear view 4300 of e-trike 3300 depicting rear-mounting rail 4302. E-trike 3300 may include a second rear-mounting rail that is only partially visible in view 4300. In an aspect, rear-mounting rail 4302 and the second rear-mounting rail are used as guide rails and form a supporting frame on e-trike 3300, on which accessory chassis 4102 is rolled on and rigidly connected when mounting the respective accessory. Rear-mounting rail 4302 and the second rear-mounting rail may also be used as guide rails when rolling the respective accessory off of e-trike 3300 while demounting the accessory. Rear-mounting rail 4302 and the second rear-mounting rail are thus used for supporting an accessory when mounted on e-trike 3300, and to guide a motion of the accessory when mounting or demounting the accessory on or off e-trike 3300.

[0190] FIG. 44 is a view 4400 depicting folded e-trike 3300 in a shipping box 4402. In one aspect, the dimensions of the shipping box depicted in view 4400 may be 1.4 meters long x 0.9 meters wide x 0.8 meters tall (55"x35"x32"). This shipping box size is smaller than the shipping box for e-trike 100. In this sense, e-trike 3300 has an advantage of being more compact in folded size as compared to e-trike 100.

[0191] FIG. 45 is a view 4500 depicting a connection between front assembly 3706 and rear assembly 3702 of e-trike 3300. In an aspect, the connection between front assembly 3706 and rear assembly 3702 is enabled via a mechanical connection that includes anti-vibration shock absorber 4502. This mechanical connection can be locked or unlocked via locking knob 3704. Anti-vibration shock absorber 4502 is configured to as a shock absorber that absorbs shock and vibrations due to road impacts, thereby improving ride quality for a rider. In an aspect, anti-vibration shock absorber 4502 is comprised of an elastic material such as rubber. Anti-vibration shock absorber 4502 may perform functions similar to spring coil-over shock absorber 2904. View 4500 also depicts caster 4504 for moving e-trike 3300 when folded.

[0192] FIG. 46 is a view 4600 depicting elastomeric torsional element 3802. View 4600 is a cross-sectional view of elastomeric torsional element 3802. In an aspect, elastomeric torsional element 3802 includes Teflon bearings 4602 and 4604. Each of Teflon bearings 4602 and 4604 is configured to allow the front assembly 3706 of e-trike 3300 to rotate about elastomeric torsional element 3802 to facilitate the tilting of handlebar 3602, front wheel 3302, and pedal assembly 3402 relative to rear assembly 3702.

[0193] Features of e-trike 3300 are summarized in the following table.

TABLE 2

Features of folding e-trike 3300	
Features	Benefit
Tilting "Delta" Trike	Low C-of-G, Safer cornering,
Folding, ultra compact, high capacity	easier transportation
Unloaded weight circa 16 Kg (35 lbs.)	Ultra-smooth ride
Adjustable "mid-suspension"	
Standard bicycle ride height	Safer to "see and be seen"
Ultralight-compact design circa 50 lbs ++	Easier parking/transportation
In use length-220 cm (86")	Natural ride dynamic
Width-76 cm (30")	Ease of access/storage
Folded Length-100 cm (40")	Upright, goes in double door elevators
Lightweight Aluminum 6061-T6 frame	Total weight 30 Kg (65 lbs) excluding battery/accessories.
Coil-over shock, mid-suspension	Smooth ride, adjustable to suit rider.
Low Step-Thru, free-standing design	Easy mount/dismount, no kickstand, safer Load/Unload
Ultra compact geared motor	Class 1, low noise, high torque, long range.
36 V 250 W (35 nM torque) 20 Ah Battery	
Front & Rear disc brakes	Single lever stopping power
Minimalistic design	Stylish, easier/lower maintenance
Large demountable/Interchangeable "Box-Cart" High capacity 300 liters (75 US gallons)	Facilitates folding/transportation/storage. Ideal for: deliveries, shopping, transportation
100 Kg (220 Lbs)	(excluding accessories)
Ships fully assembled	Saves cost and "Ready to Go"
Bluetooth motor control	Stylish, fewer cables, easier cleaning & maintenance
Great Quality	Reliable and long lasting
All wheel drive	
Optional Accessories	
Seat Boards	Converts from seat/foot well, to storage compartment.
LED Head, Side and Tails lights	Improved safety-"See and be Seen"
Tonneau and/or Canopy cover	Keeps contents dry
Aerodynamic windshield/fairing	Reduced wind resistance and driving rain to face.
All-Wheel drive. Front wheel pedals, dual motor/battery to each rear wheel	Combined Torque 70 nM., extended range
Front wheel lock	Convenient/Improved security
Box Cart	
Flat Bed	Two totes
Rickshaw	Two children, up to 100 Kg total
Maneuverability of a BMX	

[0194] Although the present disclosure is described in terms of certain example embodiments, other embodiments

will be apparent to those of ordinary skill in the art, given the benefit of this disclosure, including embodiments that do not provide all of the benefits and features set forth herein, which are also within the scope of this disclosure. It is to be understood that other embodiments may be utilized, without departing from the scope of the present disclosure.

What is claimed is:

1. A transportation device comprising:

a rear assembly including:

a rear frame;

a first rear wheel and a second rear wheel mounted to the rear frame;

a first electric motor and a second electric motor mechanically connected to the first rear wheel and the second rear wheel respectively, wherein the first electric motor and the second electric motor are configured to provide electrical assistance to a user of the transportation device; and

an electrical power source comprising a battery, configured to power the first electric motor and the second electric motor; and

a front assembly comprising:

a saddle configured to support the user;

a front wheel connected to the saddle via a wheel hub and a fork; and

an elastomeric torsional element connecting the front assembly and the rear assembly, wherein the elastomeric torsional element is configured to permit a range of motion of the front assembly relative to the rear assembly, about a longitudinal axis referenced to the transportation device, and wherein the range of motion is constrained by a combination of one or more mechanical stops at the end of the range of motion, and an elastic force exerted by the elastomeric torsional element against the range of motion when the front assembly is moved away from a neutral position.

2. The transportation device of claim 1, further comprising a mechanical lock that overrides the elastomeric torsion element, to prevent any motion of the front assembly relative to the rear assembly.

3. The transportation device of claim 1, wherein the front assembly further includes a pedal assembly configured to transfer mechanical inputs from the user to the front wheel, to propel the transportation device, wherein the pedal assembly is offset to a rearward position referenced to the wheel hub.

4. The transportation device of claim 3, wherein the offset reduces a yawing motion of the transportation device when the transportation device is being pedaled by the user.

5. The transportation device of claim 3, wherein the mechanical inputs are transmitted from the user to the front wheel via the pedals, and via a chain assembly connecting the pedals to the front wheel.

6. The transportation device of claim 4, wherein a turn ratio associated with the chain assembly is 1.4:1, which is further associated with a pedaling cadence of 1 inch by the user, corresponding to a speed of 15 mph associated with the transportation device.

7. The transportation device of claim 1, wherein the transportation device is foldable about an axis at a point of connection between the front assembly and the rear assembly.

8. The transportation device of claim 7, wherein a self-latching or a manually-actuated lock locks the transportation device in an unfolded state.

9. The transportation device of claim 1, further comprising a cadence sensor configured to sense a pedaling cadence associated with user inputs.

10. The transportation device of claim 9, wherein the cadence sensor is mechanically connected to the pedal assembly.

11. The transportation device of claim 10, wherein if the cadence sensor detects that the user has stopped pedaling, the power inputs to the first electric motor and the second electric motor are correspondingly terminated.

12. The transportation device of claim 11, wherein one or more commands to terminate power inputs to the first electric motor and the second electric motor are transmitted by a wireless communication link.

13. The transportation device of claim 12, wherein the communication link is a Bluetooth communication link.

14. A transportation device comprising:

a rear assembly including:

a rear frame;

a first rear wheel and a second rear wheel mounted to the rear frame;

a first electric motor and a second electric motor mechanically connected to the first rear wheel and the second rear wheel respectively, wherein the first electric motor and the second electric motor are configured to provide electrical assistance to a user of the transportation device; and

an electrical power source comprising a battery, configured to power the first electric motor and the second electric motor; and

a front assembly mechanically connected to the rear assembly, the front assembly comprising:

a saddle configured to support the user;

a front wheel connected to the saddle via a wheel hub and a fork; and

a pedal assembly configured to transfer mechanical inputs from the user to the front wheel, to propel the transportation device, wherein the pedal assembly is offset to a rearward position referenced to the wheel hub.

15. The transportation device of claim 14, wherein the offset reduces a yawing motion of the transportation device when the transportation device is being pedaled by the user.

16. The transportation device of claim 14, wherein the mechanical inputs are transmitted from the user to the front wheel via the pedals, and via a chain assembly connecting the pedals to the front wheel.

17. The transportation device of claim 15, wherein a turn ratio associated with the chain assembly is 1.4:1, which is further associated with a pedaling cadence of 1 inch by the user, corresponding to a speed of 15 mph associated with the transportation device.

18. The transportation device of claim 14, wherein the front assembly further includes an elastomeric torsional element connecting the front assembly and the rear assembly, wherein the elastomeric torsional element is configured to permit a range of motion of the front assembly relative to the rear assembly, about a longitudinal axis referenced to the transportation device, and wherein the range of motion is constrained by a combination of one or more mechanical stops at the end of the range of motion, and elastic force exerted by the elastomeric torsional element against the range of motion when the front assembly is moved away from a neutral position.

19. The transportation device of claim 18, further comprising a mechanical lock that overrides the elastomeric torsion element, to prevent any motion of the front assembly relative to the rear assembly.

20. The transportation device of claim 14, further comprising a cadence sensor configured to sense a pedaling cadence associated with user inputs.

21. The transportation device of claim 20, wherein the cadence sensor is mechanically connected to the pedal assembly.

22. The transportation device of claim 21, wherein if the cadence sensor detects that the user has stopped pedaling, the power inputs to the first electric motor and the second electric motor are correspondingly terminated.

23. The transportation device of claim 22, wherein one or more commands to terminate power inputs to the first electric motor and the second electric motor are transmitted by a wireless communication link.

24. The transportation device of claim 23, wherein the communication link is a Bluetooth communication link.

* * * * *



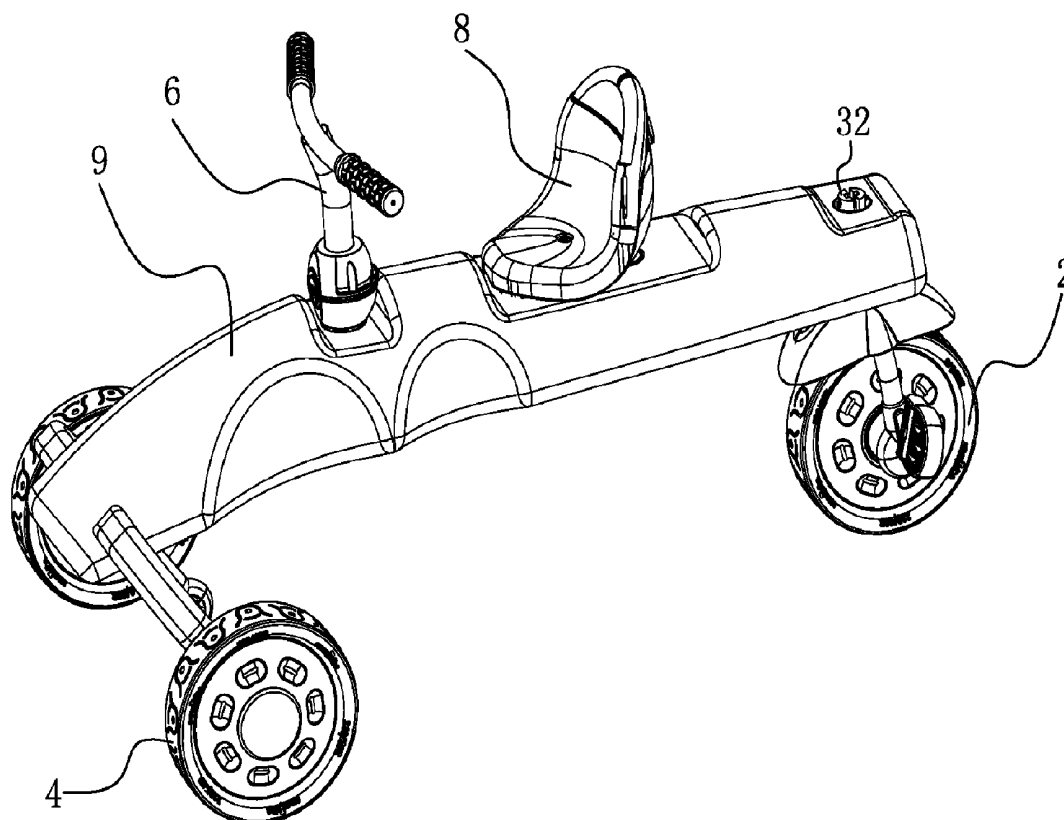
US 20160304149A1

(19) **United States**(12) **Patent Application Publication**
BEN MEIR(10) **Pub. No.: US 2016/0304149 A1**(43) **Pub. Date: Oct. 20, 2016**(54) **TRICYCLE WITH TWO RIDING MODES****B62K 23/08** (2006.01)**B62K 5/05** (2006.01)(71) Applicant: **SMART TRIKE MNF PTE LTD.**,
Singapore (SG)(52) **U.S. Cl.**CPC . **B62K 5/06** (2013.01); **B62K 5/05** (2013.01);**B62K 21/16** (2013.01); **B62K 23/08** (2013.01)(72) Inventor: **Ilan BEN MEIR**, Hong Kong (CN)(73) Assignee: **SMART TRIKE MNF PTE LTD.**(21) Appl. No.: **15/190,531**(22) Filed: **Jun. 23, 2016****Related U.S. Application Data**(63) Continuation of application No. 14/388,048, filed on
Sep. 25, 2014, now Pat. No. 9,376,157, filed as
application No. PCT/CN2012/077863 on Jun. 29,
2012.**Foreign Application Priority Data**

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Publication Classification(51) **Int. Cl.****B62K 5/06** (2006.01)**B62K 21/16** (2006.01)**ABSTRACT**

The present invention discloses a tricycle having two riding modes, the tricycle comprising: a frame, a single-wheel assembly and a first handlebar mounting base that are disposed at one longitudinal end of the frame, a double-wheel assembly and a second handlebar mounting base that are disposed at the other longitudinal end of the frame, a transmission mechanism disposed between the second handlebar mounting base and the first handlebar mounting base, and a handlebar assembly selectively disposed on the first handlebar mounting base or the second handlebar mounting base, the single-wheel assembly comprising a steering wheel and a first pedal for driving the steering wheel to roll, the double-wheel assembly comprising two wheels widthwise spaced apart and a second pedal for driving the two wheels to roll. The tricycle has a first riding mode with single front wheel and double rear wheels and a second riding mode with double front wheels and single rear wheel. The tricycle of the present invention may easily switch between two riding modes and may increase the fun of riding.



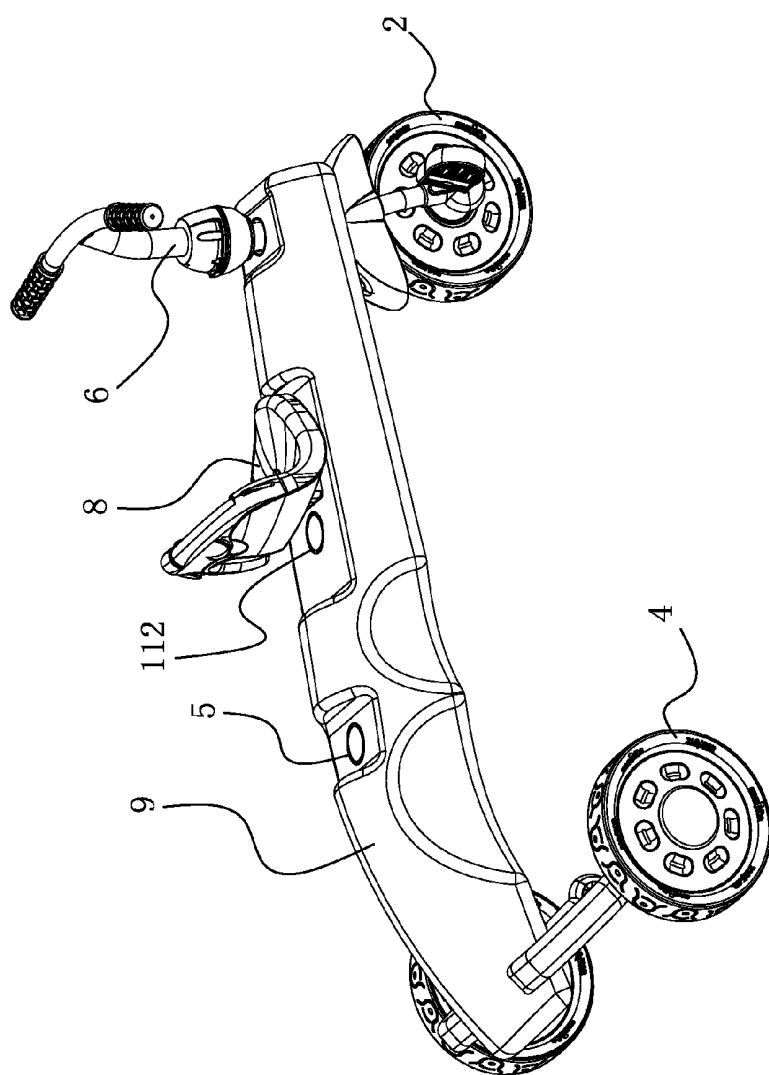


Fig.1

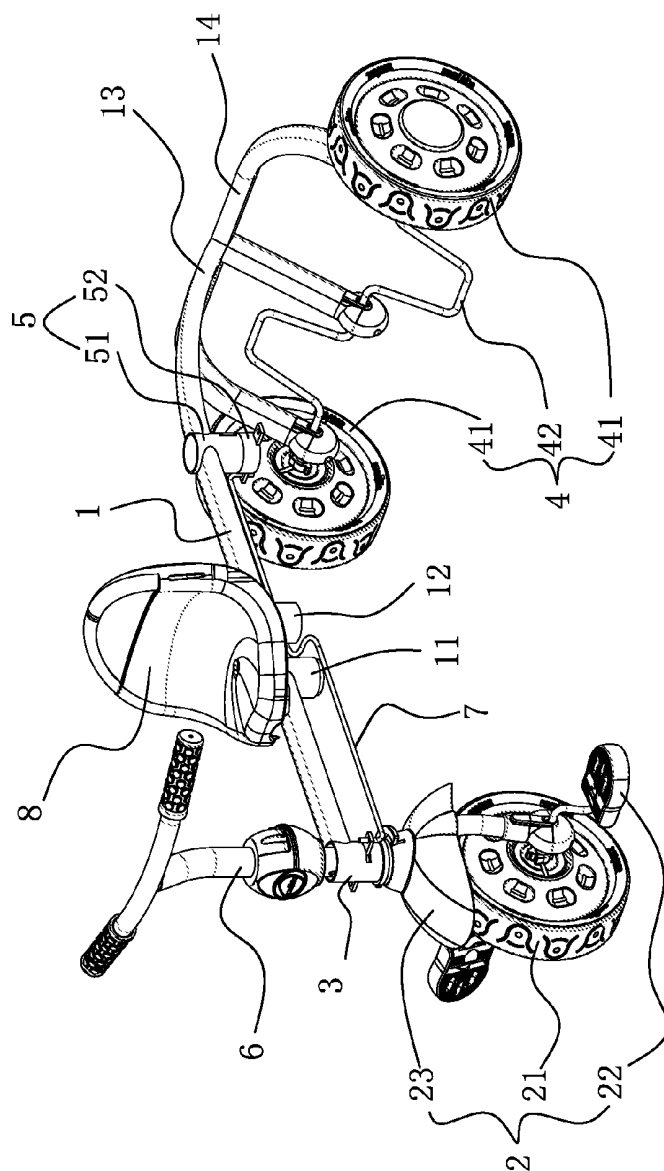


Fig.2

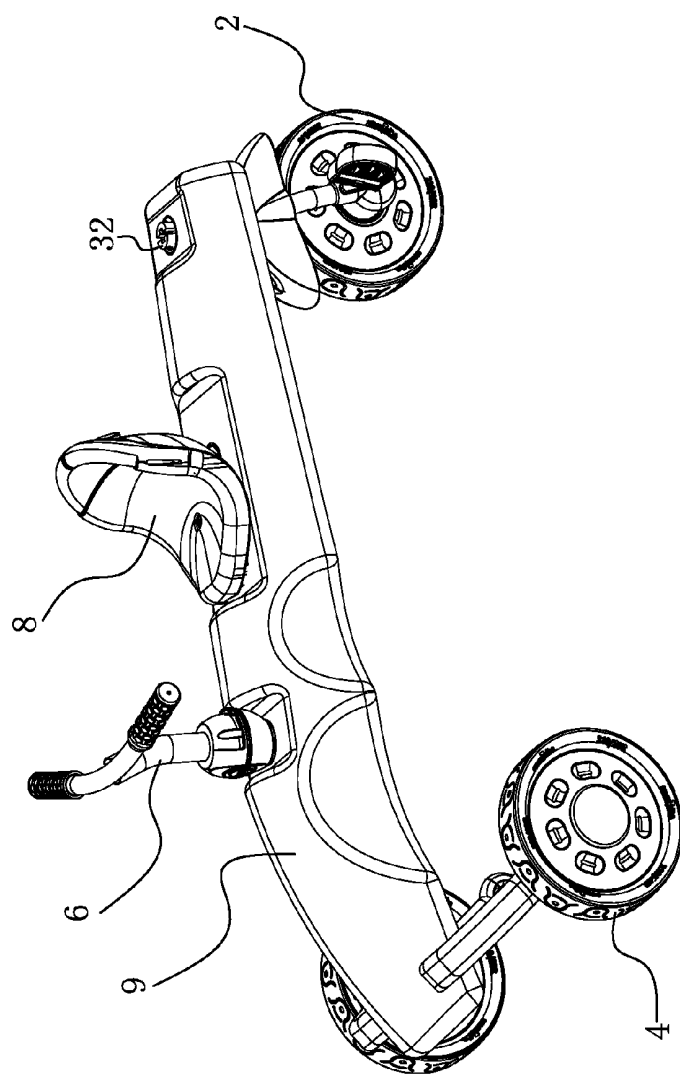


Fig.4

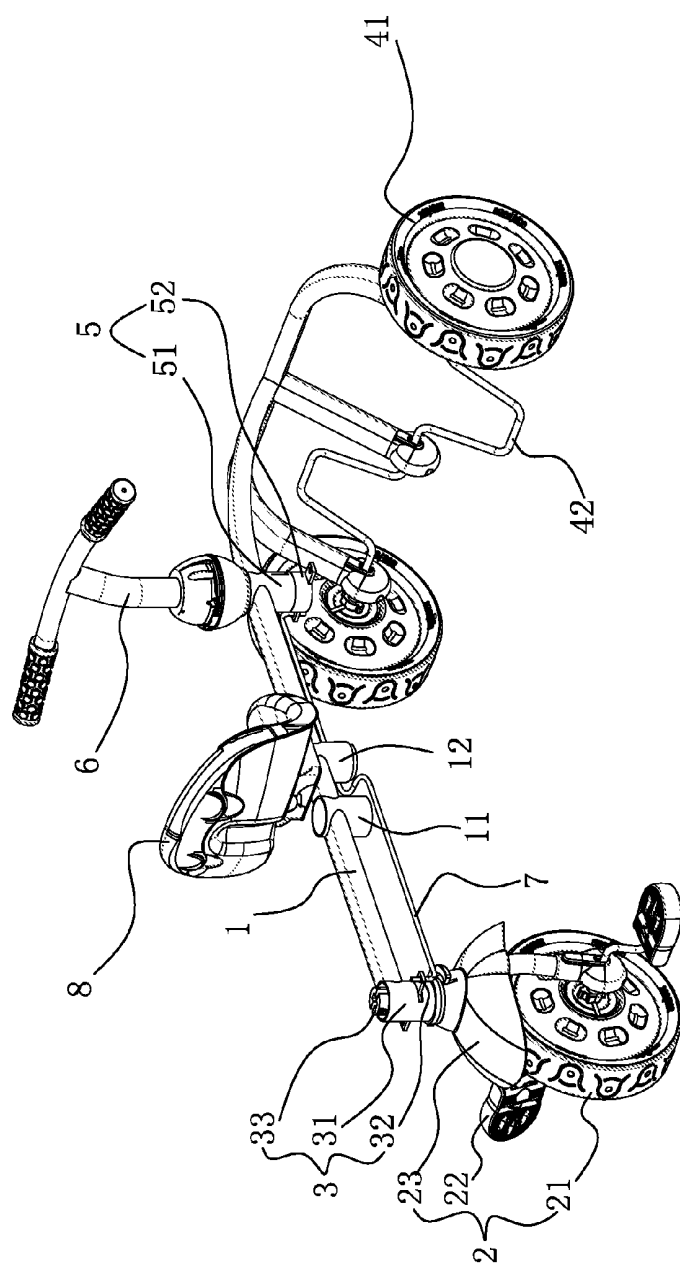


Fig.5

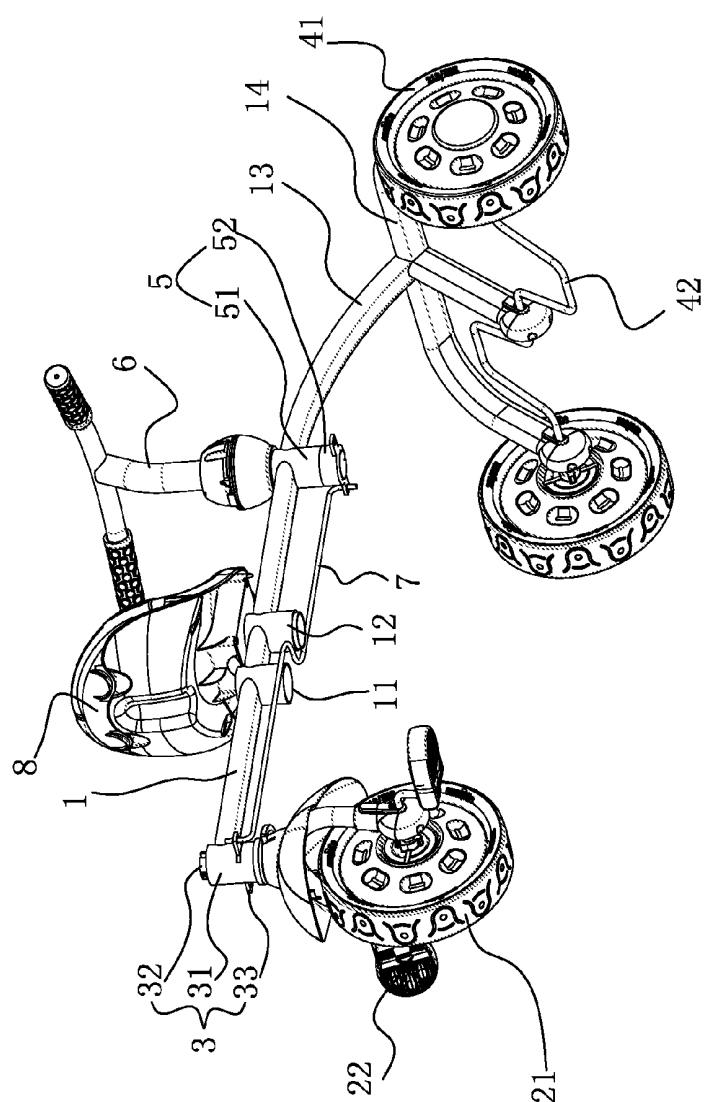


Fig.6

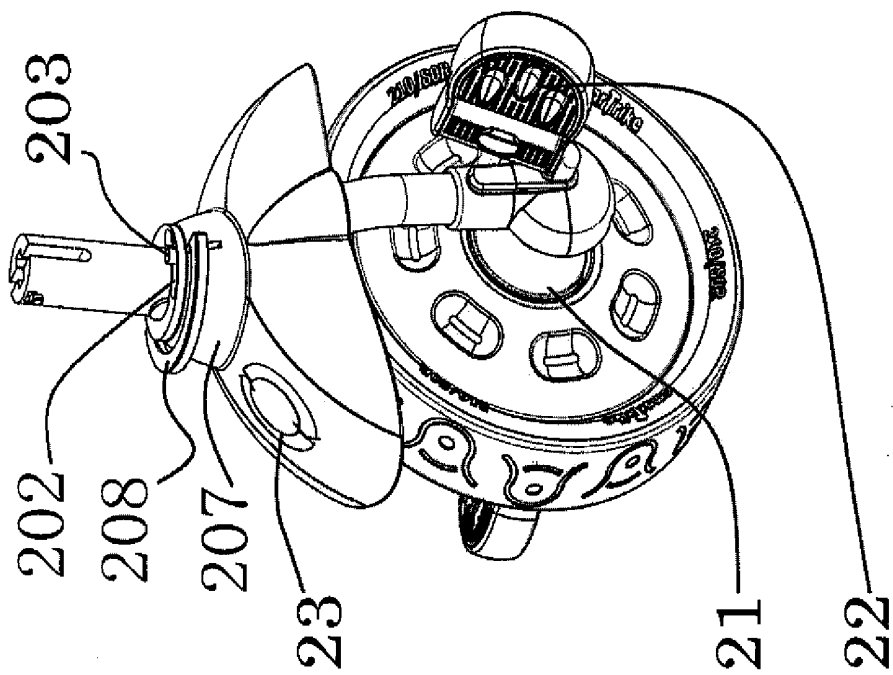


Fig. 7

TRICYCLE WITH TWO RIDING MODES

TECHNICAL FIELD

[0001] The invention relates to tricycles. More specifically, it relates to a tricycle with two riding modes, one mode being implemented with single front wheel and double rear wheels while the other mode being implemented with double front wheels and single rear wheel.

BACKGROUND ART

[0002] The normal riding mode of existing tricycles ridden by children is implemented with single front wheel and double rear wheels, where the single front wheel is a steering wheel which may be controlled via a handlebar to control steering. For sake of riding safety, the riding mode of some tricycles is implemented with double front wheels and single rear wheel. For example, the Chinese patent application CN 101830264A discloses a novel front-mounted type tricycle vehicle, including a novel front-mounted type motor tricycle, a novel front-mounted type electric tricycle, and a novel front-mounted type tricycle. The tricycle vehicle has the structure of two front wheels and one rear wheel. A front fork portion comprises a direction control lever, a left-and-right eccentric steering mechanism, a front fork fixing frame, a damping device, a left wheel and a right wheel. The direction control lever has a pivot point in its middle, and is coupled to the front fork fixing frame by a pivot shaft. The front fork fixing frame is coupled and integrated together with the ridge of the tricycle body. The rear wheel is disposed under the crossbar of the tricycle body. A front saddle and a back saddle are disposed above the rear wheel. For another example, the Chinese patent application CN 1572644A discloses a three-wheel rolling vehicle with a front two-wheel steering mechanism, the vehicle comprising a frame, a handlebar, a rear wheel rotating with respect to the frame, and a steering assembly which operates two front wheels. Two horizontal crossbars are disposed, and coupled to side tubes via hinges and coupled to the frame via additional hinges. The side tubes rotatably support steering tubes. All these existing tricycles have only one riding mode, either a mode of single front wheel and double rear wheels or a mode of double front wheels and single rear wheel. It is not possible to simultaneously have two riding modes implemented on the same tricycle, not to mention to switch between two riding modes. In other words, if riders are to enjoy the fun of two riding modes, they have to own two tricycles having different riding modes, which is not convenient for the riders.

SUMMARY OF THE INVENTION

[0003] The technical problem to be solved by the invention is to overcome the deficiencies existed in the prior art. The invention provides a tricycle, which may easily switch between two riding modes and may increase the fun of riding.

[0004] The present invention discloses a tricycle having two riding modes, the tricycle comprising: a frame, a single-wheel assembly and a first handlebar mounting base that are disposed at one end of the frame along its longitude, a double-wheel assembly and a second handlebar mounting base that are disposed at the other end of the frame along its longitude, a transmission mechanism disposed between the second handlebar mounting base and the first handlebar

mounting base, and a handlebar assembly selectively disposed on the first handlebar mounting base or the second handlebar mounting base, the single-wheel assembly comprising a steering wheel and a first pedal for driving the steering wheel to roll, the double-wheel assembly comprising two wheels horizontally spaced apart and a second pedal for driving the two wheels to roll, the tricycle having a first riding mode with single front wheel and double rear wheels and a second riding mode with double front wheels and single rear wheel.

[0005] The tricycle further comprises a saddle, the frame having disposed thereon a first saddle mounting base and a second saddle mounting base, the saddle being disposed on the first saddle mounting base in the first riding mode, while the saddle being disposed on the second saddle mounting base in the second riding mode.

[0006] The first saddle mounting base is closer to the single-wheel assembly and the first handlebar mounting base compared with the second saddle mounting base.

[0007] The frame comprising at its end where the double-wheel assembly and the second handlebar mounting base are disposed: a longitudinal ridge which extends longitudinally and downwards at an angle of inclination and a mounting frame which extends from the end of the longitudinal ridge and downwards at an angle of inclination, the mounting frame being in the shape of "E" and comprising a horizontal ridge horizontally extending from the end of the longitudinal ridge and three cantilevers extending longitudinally from the horizontal ridge and downwards at an angle of inclination, where the two outer cantilevers having respectively disposed at their outer side one of the two wheels in the double-wheel assembly and having respectively disposed at their inner side two ends of the second pedal in the double-wheel assembly, and the middle cantilever having correspondingly disposed a central part of the second pedal.

[0008] The single-wheel assembly further comprises a wheel impact absorption mechanism for buffering the bounce of the steering wheel; and/or the double-wheel assembly further comprises two wheel impact absorption mechanisms respectively disposed in two wheels for buffering the bounce of the two wheels.

[0009] The single-wheel assembly further comprises a clutching mechanism disposed in the steering wheel for controlling whether the horizontal axis of the steering wheel and the first pedal are coupled together; and/or the double-wheel assembly further comprises two clutching mechanisms respectively disposed at the two wheels for respectively controlling whether the horizontal axes of the two wheels and the second pedal are coupled together.

[0010] The first handlebar mounting base comprises: a vertically-disposed tube, a body of steering mechanism that is disposed in the tube, and a first transmission interface mechanism coordinating with the body of steering mechanism, the body of steering mechanism being coupled to the single-wheel assembly, and directly coordinating with the handlebar assembly to form a steering assembly in a first riding mode.

[0011] The second handlebar mounting base comprising: a vertically-disposed tube, a second transmission interface mechanism disposed in the tube, where the body of steering mechanism coordinating with the handlebar assembly through the first transmission interface mechanism, the

transmission mechanism and the second transmission interface mechanism so as to form a steering assembly in a second riding mode.

[0012] The steering assembly comprises: two discontinuous recessed members, each recessed member being an arch having two ends and distributing along the circumference of the tube; a guidance member which may be configured to rotate in the two recessed members, where the rotation is limited by the two ends of each recessed member; a supporting structure for supporting the tube; a pressure transmission member non-rotatably fixed on the supporting structure and coupled to the guidance member that may push the guidance member into one of the two recessed members, where the pressure transmission member being configured to quit the guidance member from one of the two recessed members in response to a pressure.

[0013] The tricycle further comprises a housing detachably disposed on the frame.

[0014] Compared with the prior art, the tricycle of the present invention may easily switch between two riding modes and may increase the fun of riding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

[0016] FIG. 1 is a perspective view of the tricycle of the present invention in a first riding mode.

[0017] FIG. 2 and FIG. 3 are perspective views of the tricycle in a first riding mode from two different perspectives according to the present invention.

[0018] FIG. 4 is a perspective view of the tricycle of the present invention in a second riding mode.

[0019] FIG. 5 and FIG. 6 are perspective views of the tricycle in a second riding mode from two different perspectives according to the present invention.

[0020] FIG. 7 is a perspective view of the single-wheel assembly of the present invention.

[0021] The reference numerals are listed as follows: 1: frame; 11: first saddle mounting base; 12: second saddle mounting base; 13: longitudinal ridge; 14: mounting frame; 2: single-wheel assembly; 21: steering wheel; 22: first pedal; 3: first handlebar mounting base; 31: tube; 32: body of steering mechanism; 33: first transmission interface mechanism; 4: double-wheel assembly; 41: wheel; 42: second pedal; 5: second handlebar mounting base; 51: tube; 52: second transmission interface mechanism; 6: handlebar assembly; 7: transmission mechanism; 8: saddle; 9: housing.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] In the following description, the present utility model is further described in detail with reference to accompanying drawings.

[0023] With reference to FIGS. 1, 2, and 3, the tricycle of the present invention is in a first riding mode. The tricycle generally comprises: a frame 1, a single-wheel assembly 2 and a first handlebar mounting base 3 that are disposed at one longitudinal end of the frame, a double-wheel assembly 4 and a second handlebar mounting base 5 that are disposed at the other end of the frame along its longitude, a transmission mechanism 7 disposed between the second handlebar mounting base 5 and the first handlebar mounting base

3, and a handlebar assembly 6 disposed on the first handlebar mounting base 3. The single-wheel assembly 2 comprises a steering wheel 21 and a first pedal 22 for driving the steering wheel 21 to roll. The double-wheel assembly 4 comprises two wheels 41 widthwise spaced apart, and a second pedal 42 for driving the two wheels 41 to roll.

[0024] The tricycle further comprises a housing 9 detachably disposed on the frame 1. The tricycle may have a variety of different appearances by changing the shape or color of the housing 9.

[0025] The tricycle further comprises a saddle 8. The frame 1 has disposed thereon a first saddle mounting base 11 and a second saddle mounting base 12. In the first riding mode, the saddle 8 is disposed on the first saddle mounting base 11.

[0026] More specifically, the frame 1 comprises, at its end where the double-wheel assembly 4 and the second handlebar mounting base 5 are disposed, a longitudinal ridge 13 which extends longitudinally and downwards at an angle of inclination and a mounting frame 14 which extends from the end of the longitudinal ridge 13 and downwards at an angle of inclination. The mounting frame 14 is in the shape of "E" and comprises a horizontal ridge extending horizontally from the end of the longitudinal ridge and three cantilevers extending longitudinally from the horizontal ridge and downwards at an angle of inclination, where the two outer cantilevers have been respectively disposed at their outer sides with one of the two wheels 41 in the double-wheel assembly 4 and have been respectively disposed at their inner sides with two ends of the second pedal 42 in the double-wheel assembly 4, and the middle cantilever has been correspondingly disposed with a central part of the second pedal 42.

[0027] The single-wheel assembly 2 further comprises a wheel impact absorption mechanism for buffering the bounce of the steering wheel 21. The single-wheel assembly 2 further comprises a clutching mechanism disposed in the steering wheel 21 for controlling whether the horizontal axis of the steering wheel 21 and the first pedal 22 are coupled together.

[0028] The double-wheel assembly 4 further comprises two wheel impact absorption mechanisms respectively disposed in two wheels 41 for buffering the bounce of the two wheels 41. The double-wheel assembly 4 further comprises two clutching mechanisms respectively disposed at the two wheels 41 for respectively controlling whether the horizontal axes of the two wheels 41 and the second pedal 42 are coupled together.

[0029] The wheel impact absorption mechanism may be implemented by disposing a coupling member above the horizontal axis of the wheel, a spring contacting against and located above the coupling member, and a groove located below the coupling member and having a cylindrical surface matching with the horizontal axis of the wheel.

[0030] There are a variety of implementations of the clutching mechanism, which are not herein described in detail for sake of brevity.

[0031] In a first riding mode, the clutching mechanism in the single-wheel assembly 2 shall be operated to connect the horizontal axis of the steering wheel 21 and the first pedal 22, since a first pedal 22 is needed to drive the steering wheel 21 to roll while the double-wheel assembly 4 is in a passive status. Further, for the sake of safety, the two clutching mechanisms in the double-wheel assembly 4 may be oper-

ated so as to detach the horizontal axis of the two wheels 41 from the second pedal 42 so that the rolling of the two wheels 41 would not bring along the rotation of the second pedal 42.

[0032] The first handlebar mounting base 3 comprises: a vertically-disposed tube 31, a body of steering mechanism 32 disposed in the tube 31, and a first transmission interface mechanism 33 coordinating with the body of steering mechanism 32. The body of steering mechanism 32 is coupled to the single-wheel assembly 2. The body of steering mechanism 32 directly coordinates with the handlebar assembly 6 to form a steering assembly in a first riding mode.

[0033] One implementation of the steering assembly comprises: disposing two discontinuous recessed members (such as discontinuous recessed member 202 at FIG. 7), each recessed member being an arch having two ends and distributing along the circumference of the tube 31; disposing a guidance member 203 which may be configured to rotate in the two recessed members, where the rotation is limited by the two ends of each recessed member; disposing a supporting structure 207 for supporting the tube 31; and disposing a pressure transmission member 208 non-rotatably fixed on the supporting structure 207 and coupled to the guidance member 203, the pressure transmission member 208 pushing the guidance member 203 into one of the two recessed members, where the pressure transmission member 208 may be configured to quit the guidance member 203 from one of the two recessed members in response to a pressure. The recessed members may be disposed in the tube 31, while the guidance member 203, the supporting structure 207, and the pressure transmission member 208 may be disposed in the body of steering mechanism 32. With such a structure, the radian of the recessed member may limit the rotation angle of the handlebar assembly 6 since the radian of the accessed member may limit the rotation angle of the guidance member and the guidance member may move simultaneously with the handlebar assembly 6. Accordingly, it is ensured that the rotation of handlebar assembly 6 may bring along the steering of steering wheel 21, while the rider is protected from being hit by the rotation of the handlebar assembly 6.

[0034] With reference to FIGS. 4, 5, and 6, the tricycle of the present invention is in a second riding mode. The tricycle in the second riding mode differs from that in the first riding mode mainly in that: the handlebar assembly 6 is disposed on the second handlebar mounting base 5 rather than on the first handlebar mounting base 3 as illustrated in the first riding mode. The saddle 8 is disposed on the second saddle mounting base 12.

[0035] In the second riding mode, the two clutching mechanisms in the double-wheel assembly 4 shall be operated to couple the horizontal axis of the two wheels 41 with the second pedal 42, since a second pedal 42 is needed to drive the two wheels 41 to roll while the steering wheel 21 is in a passive status. Further, for the sake of safety, the clutching mechanism in the single-wheel assembly 2 may be operated so as to detach the horizontal axis of the steering wheel 21 from the first pedal 22 so that the rolling of the steering wheel 21 would not bring along the rotation of the first pedal 22.

[0036] The second handlebar mounting base 5 comprises: a vertically-disposed tube 51, a second transmission interface mechanism 52 disposed in the tube 51, where the

handlebar assembly 6 may coordinate with the body of steering mechanism 32 through the second transmission interface mechanism 52, the transmission mechanism 7, and the first transmission interface mechanism 33 so as to form a steering assembly in a second riding mode. The steering assembly in the second riding mode is similar to the steering assembly in the first riding mode in their structures and operation principals, except that the tube 31 in the first riding mode is substituted with the tube 51. The structures and operation principals are not herein described in detail for sake of brevity.

[0037] It is to be noted that, in the present embodiment, the first saddle mounting base 11 is, compared with the second saddle mounting base 12, closer to the single-wheel assembly 2 and the first handlebar mounting base 3. In another embodiment, the second saddle mounting base 12 may be designed to be closer to the single-wheel assembly 2 and the first handlebar mounting base 3 compared with the first saddle mounting base 11. In other embodiments, only one saddle mounting base may be disposed, where the orientations of the saddle 8 may be adjusted by spinning around for the two riding modes. Further, the saddle 8 may be designed without backrest so that the orientation of the saddle does not need to be adjusted to be suitable for the two riding modes.

[0038] Besides, in the second riding mode, the structure of the longitudinal ridge 13 and the mounting frame 14 have the function of protection since the structure is in front of riding while the second pedal is disposed behind the structure. In other words, the safety of the rider is effectively ensured when facing the impact from external objects.

[0039] Compared with the prior art, the tricycle of the present invention with two riding modes have been disposed on the frame 1 with a first handlebar mounting base 3 and a second handlebar mounting base 5, and may easily switch between a first riding mode and a second riding mode by simply changing the mounting position of the handlebar assembly 6. The first riding mode with single front wheel and double rear wheels may be implemented by mounting the handlebar assembly 6 on the first handlebar mounting base 3, so that the rider may enjoy the fun of a common tricycle by controlling the handlebar assembly 6 and the first pedal 22. The second riding mode with two front wheels and single rear wheel may be implemented by simply mounting the handlebar assembly 6 on the second handlebar mounting base 5, so that the rider may enjoy the fun of an inverted-type tricycle by controlling the handlebar assembly 6 and the second pedal 42.

[0040] The above descriptions are merely preferred embodiments of the present invention, and are not intended to limit the implementations of the present invention. According to the primary concept and spirit of the present invention, those skilled in the art may readily alter or modify these embodiments. The scope of protection of the present invention is limited by the claims.

1. A tricycle having two riding modes, the tricycle comprising:

- a frame;
- a single-wheel assembly and a first handlebar mounting base that are disposed at one longitudinal end of said frame, wherein said single-wheel assembly comprises a steering wheel;
- a double-wheel assembly and a second handlebar mounting base that are disposed at the other longitudinal end

of said frame, wherein said double-wheel assembly, comprises two wheels widthwise spaced apart, and a pedal for rolling said two wheels;

a handlebar assembly selectively disposed on said first handlebar mounting base or on said second handlebar mounting base; and

a transmission mechanism, which is capable of coordinating between said handlebar assembly and said steering wheel, when said handlebar assembly is disposed on said second handlebar mounting base, for forming a steering assembly.

2. The tricycle of claim 1, further comprising a saddle, said frame having disposed thereon a first saddle mounting base and a second saddle mounting base, the saddle being disposed on the first saddle mounting base in the first riding mode, while the saddle being disposed on the second saddle mounting base in the second riding mode.

3. The tricycle of claim 1, wherein the single-wheel assembly further comprises a wheel impact absorption mechanism disposed in the steering wheel for buffering the bounce of the steering wheel.

4. The tricycle of claim 1, wherein the double-wheel assembly further comprises two wheel impact absorption

mechanisms respectively disposed in two wheels for buffering the bounce of the two wheels.

5. The tricycle of claim 1, wherein the double-wheel assembly further comprises two clutching mechanisms respectively disposed at the two wheels for respectively controlling whether the horizontal axes of the two wheels and the pedal are coupled together.

6. The tricycle of claim 1, wherein the first handlebar mounting base comprises: a vertically-disposed tube, a body of steering mechanism disposed in the tube, said body of steering mechanism being coupled to the single-wheel assembly and directly coordinating with the handlebar assembly to form a steering assembly in the first riding mode.

7. The tricycle of claim 1, wherein the second handlebar mounting base comprises: a vertically-disposed tube, a transmission interface mechanism disposed in the tube, where the transmission mechanism coordinates between the handlebar assembly and the steering wheel through said transmission interface mechanism, so as to form a steering assembly in the second riding mode.

8. The tricycle of claim 1, wherein the tricycle further comprises a housing detachably disposed on the frame.

* * * * *



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- (71) **Applicant : BERESNITZKY, Bernardo** [BR/US]; 684 Crown Street, Brooklyn, New York 11213 (US).
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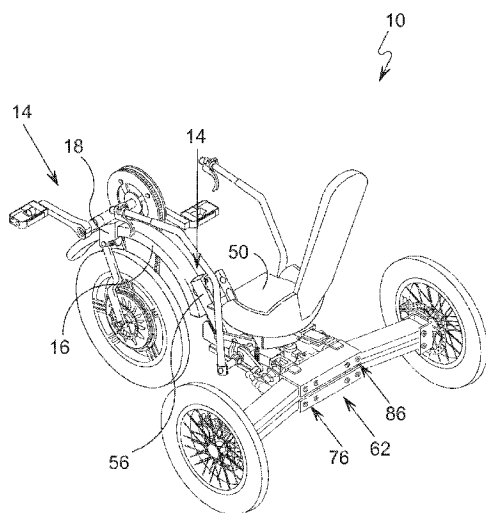


FIG. 1

(57) **Abstract:** A collapsible tricycle having linkage to all three wheels enabling a smaller turning radius when all three wheels are tilted during a turn. The tricycle folds through the rear frame having a hinged rear axle with linkage to pivotal handle bars mounted to the rear frame that when pivoted from their storage position to their operative position also pivots the rear axle through said linkage from its stored position under the rear frame into its operative position. The rear axle is segmented so that when moved to its stored position under the rear frame each of the rear wheels can be pivotally collapsed against the frame.

COLLAPSIBLE TRICYCLE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of priority from United States Utility Application No. 14/830,669, filed August 19, 2015, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to land vehicles and, more specifically, to a collapsible tricycle having a front frame portion and a rear frame portion with the front frame having linkage to all three wheels enabling a smaller turning radius when all three wheels are tilted during a turn.

Furthermore, the tricycle folds to a smaller footprint through the rear frame having a hinged rear axle with linkage to a pair of pivotal handle bars mounted to the rear frame that when pivoted from their storage position to their operative position also pivots the rear axle through said linkage from its stored position under the rear frame into its deployed operative position.

The rear axle is segmented so that when moved to its stored position under the rear frame each of the rear wheels can be pivotally collapsed against the frame.

The rear axle comprises a stationary subjacent axle portion and a movable superjacent axle portion with each hinged at their distal ends to a left and right rear wheel bracket with each bracket having an exteriorly extending spindle with a wheel mounted thereon. The wheel bracket has a top end and a bottom end connected to a respective superjacent movable portion and a bottom stationary portion with each wheel spindle positioned between the bracket's axle connections so that linear movement of the superjacent axle portion relative to the stationary subjacent axle portion causes the rear wheels to tilt in tandem.

The tricycle also provides adjustable linkage for moving the pedal assembly for either foot or hand power.

Furthermore, the collapsible tricycle provides a segmented front frame comprising a

curvilinear rail-like segment and seat support segment fastened to the curvilinear rail-like segment where by pivoting the seat support segment causes a corresponding rotation of the curvilinear rail-like segment. Also provided is a seat adjustably attachable within a transverse slot in the seat support so that an operator steers the tricycle by shifting their weight causing the steering rail segment and curvilinear rail-like segment to pivot along with tilting the rear wheels in tandem. In operation, left movement of the seat results in a right turn of the front wheel with corresponding rear wheel camber and a right movement of the seat results in a left turn of the front wheel with corresponding rear wheel camber.

DESCRIPTION OF THE PRIOR ART

There are other land vehicles which provide for operator steering by shifting their weight. While these land vehicles may be suitable for the purposes for which they were designed, they would not be as suitable for the purposes of the present invention as heretofore described.

It is thus desirable to provide a tricycle having a seat support serving as steering rail with linkage extending to a rear axle superjacent movable axle portion so that when the seat support steering rail is moved to the left the front wheel turns to the right the superjacent rear axle movable portion tilts the rear wheel to the right and visa-versa when the operator moves the steering rail to the right thereby creating a smaller turning radius for said tricycle.

It is further desirable to provide a collapsible tricycle having linkage for moving the handles bars from a stored frame coplanar position to an operator selective tangential position with said handle bars having linkage to the tricycle rear axle which moves in tandem from a folded stored position to a deployed operative position.

SUMMARY OF THE PRESENT INVENTION

A primary object of the present invention is to provide a collapsible tricycle having linkage for moving the handles bars from a stored frame coplanar position to an operator selective tangential position with said handle bars having linkage to the tricycle rear axle which moves in tandem from a folded stored position to a deployed operative position.

Another object of the present invention is to provide a collapsible tricycle having a front wheel frame and a rear wheels frame with said front wheels frame pivotally attached to said rear frame.

Yet another object of the present invention is to provide a collapsible tricycle wherein said front wheel frame segment comprises a curvilinear rail-like segment and seat support steering rail segment fastened to said curvilinear rail-like segment.

Still yet another object of the present invention is to provide a collapsible tricycle wherein said curvilinear rail-like segment has a pedal assembly mount selectively positionable and latchable to said curvilinear rail-like segment.

An additional object of the present invention is to provide a collapsible tricycle wherein said curvilinear rail-like segment further provides a spindle projecting tangentially from the rear distal end providing mount for said seat support steering rail segment.

A further object of the present invention is to provide a collapsible tricycle wherein said seat support steering rail segment comprises a bar-like structure having a longitudinal portion extending into an obtuse angular portion wherein said longitudinal portion has a transverse slot for mounting a seat therein.

A yet further object of the present invention is to provide a collapsible tricycle wherein said seat support steering-rail segment obtuse-angular portion terminates in a fastenable clamp whereby said seat support steering rail segment mounts to the spindle of the curvilinear frame segment.

A still yet further object of the present invention is to provide a collapsible tricycle wherein said seat support steering-rail segment further provides linkage extending approximately from the steering wheel segment dog leg through a rear frame rotative steering linkage post then fastened to the movable superjacent rear axle portion causing the superjacent axle portion to move linearly relative to its stationary subjacent axle portion.

Another object of the present invention is to provide a collapsible tricycle having linkage means for varying the position of the guide wheel and pedal assembly mount.

Yet another object of the present invention is to provide a collapsible tricycle having means for adjusting the back rest of the seat in a vertical movement.

Still yet another object of the present invention is to provide a collapsible tricycle having means for adjusting the inclination of the back rest of the seat.

An additional object of the present invention is to provide a collapsible tricycle where the pedal assembly can be positioned whereby the rider can use their hands to power the vehicle.

A further object of the present invention is to provide a collapsible tricycle where the front wheel can be moved closer to or further from the rear axle.

A yet further object of the present invention is to provide a collapsible tricycle where the rider can steer the guide wheel by means of the seat by shifting their weight left and right.

Additional objects of the present invention will appear as the description proceeds.

The present invention overcomes the shortcomings of the prior art by providing a collapsible tricycle having a front wheel frame and a rear wheels frame with the front wheel frame having linkage to all three wheels enabling a smaller turning radius when all three wheels are tilted during a turn. The tricycle folds to a smaller footprint through the rear frame having a hinged rear axle with linkage to a pair of pivotal handle bars mounted to the rear frame that when extended from their storage position to their operative position also pivots the rear axle through said linkage from its stored position under the rear frame into its deployed operative position. The rear axle is segmented so that when moved to its stored position under the rear frame each of the rear wheels can be collapsed against the frame.

The foregoing and other objects and advantages will appear from the description to follow. In the description reference is made to the accompanying drawing, which forms a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments will be described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that structural changes may be made without departing

from the scope of the invention. In the accompanying drawing, like reference characters designate the same or similar parts throughout the several views.

The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is best defined by the appended claims.

DESCRIPTION OF THE REFERENCED NUMERALS

Turning now descriptively to the drawings, in which similar reference characters denote similar elements throughout the several views, the Figures illustrate the Foldable Tricycle of the present invention. With regard to the reference numerals used, the following numbering is used throughout the various drawing figures.

- 10 Foldable Tricycle of the present invention
- 12 user
- 14 frame
- 16 front wheel frame of 14
- 17 pedal assembly of 16
- 18 pedal assembly mount of 17
- 20 mount lock of 17
- 22 sprocket of 17
- 24 chain of 17
- 26 chain guides of 17
- 28 cranks of 17
- 32 pedals of 17
- 34 shock absorbers/ suspension fork of 17

- 36 front wheel
- 38 cogset of 36
- 40 derailleur of 36
- 42 motor of 36
- 44 seat assembly spindle of 16
- 46 seat assembly of 16
- 48 seat support / steering rail segment of 16
- 50 seat of 48
- 52 steering linkage fastener of 48
- 54 steering linkage rail
- 56 rear wheels frame of 14
- 58 spindle bearing of 56
- 60 pivotal axle hinge of 56
- 62 rear axle of 56
- 64 rotative steering linkage post of 56
- 66 rail guide channel of 64
- 68 superjacent axle rail bracket
- 70 axle tether rail
- 72 pivot fastener of 70
- 74 handle bar bushing of 56
- 76 subjacent axle portion
- 78 hinged section of 76
- 80 spacers of 76

- 82 springs of 76
- 84 pivotal strut sections of 76
- 86 superjacent axle portion
- 88 hinged section of 86
- 92 pivotal strut sections of 86
- 94 rear wheels
- 96 bracket of 94
- 98 upper fastener apertures of 96
- 100 fastener of 98
- 102 lower fastener apertures of 96
- 104 fastener of 102
- 106 handlebar shaft in 74
- 108 handlebar pivot linkage of 106
- 110 pivot of 108
- 112 handle bar lock of 110
- 114 handlebar bar fastener
- 116 handlebar
- 118 handlebar grip/controls
- 120 axle extension linkage
- 122 axle extension strut of 120
- 124 struts shaft of 122
- 126 pivot strut of 120
- 128 strut pivot of 126

- 130 axle pivot of 126
- 132 latch of 120
- 134 shaft of 132
- 136 pivot of 134
- 138 pivotal bar of 132
- 140 pivot of 134, 138
- 142 open/closed stop cavity of 134
- 144 handle of 138
- 146 spring of 134
- 148 shock absorber of 86
- 150 pivot of 148
- 152 disc brake
- 154 cables of 152
- P pressure

BRIEF DESCRIPTION OF THE DRAWING FIGURES

In order that the invention may be more fully understood, it will now be described, by way of example, with reference to the accompanying drawing in which:

Figure 1 is an illustrative view of the collapsible tricycle of the present invention.

Figure 2 is a side view of the collapsible tricycle present invention.

Figure 3 is a top deployed view of the tricycle present invention.

Figure 4 is a top collapsed view of the tricycle present invention.

Figure 5 is a top view of the tricycle in a left turn.

Figure *SA* is a partial rear view of the tricycle in a left turn.

Figure 6 is a top view of the tricycle in a right turn.

Figure 6A is a partial rear view of the tricycle in a right turn.

Figure 7 is a perspective view of the tricycle with the seat and seat latching exploded.

Figure 8 is a partial enlarged view, taken from Fig 7 as indicated showing the axle extension linkage.

Figure 9 is an illustrated view of the hinged rear axle folded beneath the rear wheels frame.

Figure 10 is a partial enlarged view, taken from Fig 9 as indicated, showing the axle extension linkage in a folded state.

Figure 11 is an illustrated view of the hinged rear axle folded beneath the rear wheels frame with the wheels in dashed line.

Figure 12 is an illustrated view of the tricycle of the present invention in the folded storage state.

Figure 13A is a partial side view of the tricycle pedal assembly incorporating movable chain guides.

Figure 13B is a side view of the tricycle with movable pedal assembly incorporating movable chain guides.

Figure 13C is a side view of the pedal assembly having chain guides.

Figure 13D is a front view of the pedal assembly having chain guides.

Figure 14 is a side view of the tricycle of the present invention having chain guides in use.

Figure 15A is a side view of pedal assembly incorporating chain guides and pedal assembly post.

Figure 15B is a side view of the pedal assembly having chain guides and pedal assembly post.

Figure 15C is a front view of the pedal assembly having chain guides and pedal assembly post.

Figure 16 is a side view of the tricycle of the present invention having chain guides and post in hand use.

Figure 17A is a side view of pedal assembly incorporating chain guides and slidable pedal assembly.

Figure 17B is a side view of the slidable pedal assembly incorporating chain guides.

Figure 17C is a front view of the pedal assembly having chain guides and slidable pedal assembly.

Figure 18 is a partial front view of the slidable pedal assembly mounted onto the front frame of the tricycle of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following discussion describes in detail one embodiment of the invention (and several variations of that embodiment). This discussion should not be construed, however, as limiting the invention to those particular embodiments, practitioners skilled in the art will recognize numerous other embodiments as well. For definition of the complete scope of the invention, the reader is directed to appended claims.

Referring to Figure 1, shown is an illustrative view of the tricycle of the present invention. The present invention is a foldable tricycle **10** having a split frame **14** comprising a front wheel frame **16** and a rear wheels frame **60** having a pivotal rear axle **62** comprising a subjacent axle portion **76** and superjacent axle portion **86** that moves linearly left/right relative to the subjacent axle portion **74** through the user pivotally moving the tricycle seat **50** by leaning left whereupon the front wheel turns to the right in tandem seat linkage to the superjacent axle portion **86** tilts the rear wheels in the same direction as the front wheel and by leaning right the front wheel turns to the left in tandem seat linkage to the superjacent axle portion **86** tilts the rear wheels in the same

direction as the front wheel. Also shown is pedal assembly 17 slidably mounted onto the front wheel frame 16.

Referring to Figure 2, shown is a side view of the present invention. The foldable tricycle 10 of the present invention has a front wheel frame 16 with a slideable pedal assembly bracket 18 mounted approximate one end and seat assembly mounting spindle 44 approximate the other end of frame 16. Rear wheel frame 56 provides bearing 58 mounted onto spindle 44 providing a rotative front wheel frame 16. Seat assembly 46 comprises seat support 48 that is mounted onto spindle 44 and seat 50 that is mounted onto and selectively positionable on seat support 48.

Referring to Figure 3 and Figure 4, respectively shown is a top view of the tricycle of the present invention in a deployed operative position and a top view of the tricycle in a folded storage position. The foldable tricycle 10 of the present invention comprises frame 14 having a front wheel frame 16 and a rear wheel frame 56 with a rear axle 62 comprising a superjacent axle portion 86, subjacent axle portion 76 and axle extension linkage 120 that deploys and folds the rear axle 62 beneath the rear wheel frame 56 via linkage 108.

In Figure 3, handlebar pivot linkage 108 has fastener 114 that receives handle bar 116, forming a somewhat right angle with fastener 114, on one distal end and on the other end pivot joint 110 is fixedly attached to handlebar shaft 106 with handlebar lock 112, shown in dashed line for clarity, to fixedly position the handlebars 116 in a user desired operative location.

Handlebar 116 that is rigidly attached via fastener 114 to handlebar pivot linkage 108 has two operative states. In a folded state, shown in Fig 4, respective handlebars 116 extend in co-planar fashion toward the tricycle front with the hinged axle lying under the rear wheel frame 56 with tether rail 70 extended.

Several linkages are provided for controlling the deployment and retraction of the rear axle 62. Rear axle 62 is pivotally attached to rear wheels frame 56 by hinge 60. Frame 56 also has bushing 74 with handlebar shaft 106 therein. Attached to shaft 106 is axle extension linkage 120 comprising fixedly attached axle extension struts 122, struts shaft

124 fixedly attached to a respective strut **122** and pivot struts **126** pivotally attached to a respective subjacent pivotal strut **84** through axle pivot **130**, shown in Figure 4, at one end and having strut pivot **128** on the other end.

Rear frame **56** also provides superjacent axle rail bracket **68** having pivot fastener **72** attached to axle tether rail **70**, which is extended when the bike axle is in the folded state, shown in Fig 4. A subjacent steering linkage rail **54**, which is part of the steering linkage extending from steering linkage fastener **52** fixedly attached to seat support **48**, through the rail guide channel **66** of rotative steering linkage post **64** then fastened to superjacent axle rail bracket **68**, has longitudinal tracks with the tether rail **70** having mating channels so that in an operative state the rails matingly overlay serving to move the superjacent axle portion **86** relative to the subjacent axle portion **76** either left or right by the user leaning and thereby moving the seat support **48** in the desired direction.

The split rail then serves two functions; when overlaying each other the rails mate and are used to steer the bike, when folded the mating rails - tracks and channels - keep the steering mechanism rails aligned and aid in guiding the tether rail when moving rear axle **62** to a deployed position.

The second handlebar operative state (deployed position) is to deploy the rear axle **62** using the handlebars and attached axle extension linkage **120**.

As aforementioned, the handlebars **116** are collapsed longitudinally against the bike in the folded state with the rear axle **62** folded under the rear frame and tether rail **70** extended.

Handlebars **116** and pivot linkages **108** provide torque in rotating handlebar shaft **106** and fixedly attached struts **122** and strut shaft **124** driving to a deployed position pivot struts **126** fastened to a respective subjacent strut **84** through axle pivot **130**, shown in Fig 4. Concurrently, hinged section **78** of subjacent axle portion **76** is pivotally driven to a deployed state through pivotal axle hinge **60** pivotally attached to rear frame **56**. Simultaneously, the tether rail **70** in its extended position having one end within rail guide channel **66** and its channels engaging the tracks of steering rail **54** is driven by rail bracket **68** fastener **72**

attached to hinged section **88** of superjacent axle portion **86** to overlay rail **54** whereafter the bike is deployed to its operative state, as shown in Fig 3.

Further provided is steering linkage latch **132** holding the steering linkage **120** in either a folded position or a deployed operative position comprising shaft **134** attached to rear frame **56** by pivot **136**, pivot bar **138** having handle **144** and pivot **140**. Handle **144** pivots the pivot bar raising shaft **134** having respective open/closed stop cavities **142**, that latch onto the axle extension strut **122** in a respective cavity of shaft **134** when the tricycle is in a folded state or a deployed operative state. Extension strut **122** also provides a tension spring **146** that will return strut **122** to a seated position when handle **144** is released. As a safety feature, since the handlebars can be pivoted inward then moved forward and downward, which can fold the rear axle and extend the tether rail, the latching locks the axle extension linkage **120** in either a deployed or folded position.

Rear axle **62** comprises superjacent axle portion **86** and subjacent axle portion **76** with each having respective hinged portions **78**, **88** and distal end struts **84**, **92**, shown clearly in Fig 4. Positioned within the opposing hinged strut sections **78**, **88** are a pair of pivotal spacers, **80** and springs **82** enabling the superjacent hinged portion **88** to longitudinally move left or right over the subjacent hinged portion **78**. Shock absorbers **148** are pivotally attached **150** to distal ends of superjacent hinge section **88** and fixedly attached to a respective strut **92**. Superjacent struts **92** are attached to the top end apertures **102** of wheel bracket **96** by fasteners **104** and subjacent struts **84** are attached to the bottom end apertures **98** by fasteners **100**. Wheel brackets **96** are rigidly attached to respective wheels **94** so that simultaneously wheel camber is produced by longitudinal movement of the superjacent hinged section **88** through a respective strut **92** tilting a wheel either left or right.

Also shown are wheels **94** having disk brakes **152** and brake cables **154**, which extend (not shown) to handlebar controls **118**. Further illustrated is pedal assembly mount **18** slidably mounted onto front wheel frame **16** having mount lock **20** for selectively fastening **18** at a desired location.

Referring to Figure S and Figure *SA*, depicted is a top view of the tricycle in a left turn and a back view of the rear axle's position. Figure *S* illustrates the tricycle **10** having a front wheel frame **16** having seat assembly **46** with seat support **48** mounted to spindle **44** and a rear wheels frame **56** having rear axle **62** with a subjacent axle portion **76** and a superjacent axle portion **86** that linearly moves relative to the subjacent axle portion **76** through linkage extending from seat support **48** through rear frame rotative linkage post **64** to superjacent axle

84 depicted in Figure *SA*.

Referring to Figure 6 and Figure 6A, depicted is a top view of the tricycle in a right turn and a back view of the rear axle's position. Figure 6 illustrates the tricycle **10** having a front wheel frame **16** having seat assembly **46** with seat support **48** mounted to spindle **44** and a rear wheels frame **56** having rear axle **62** with a subjacent axle portion **76** and a superjacent axle portion **86** that linearly moves relative to the subjacent axle portion **76** through linkage extending from seat support **48** through rear frame rotative linkage post **64** to superjacent axle **86** depicted in Figure 6A.

Referring to Figure 7, shown is a perspective view of the tricycle of the present invention. Illustrated is the tricycle **10** having a seat support **48** mounted on spindle **44** of front wheel frame **16**. Seat assembly **46** comprises seat support **48** forming mount for seat **50** and steering linkage fastener **52** so that when seat support **48** is moved in one direction the steering linkage extending through linkage post **64** of rear wheel frame **56** moves superjacent axle **84** in the opposite direction, which then tilts the rear wheels **94** via wheel bracket **96** in the same direction as the front wheel **36**.

Referring to Figure 8, depicted is a partial enlarged view, taken from Figure 7 as indicated, showing the axle extension linkage. The axle extension linkage **120** has a pair of extension struts **122** and pivot struts **126** with the extension struts fixedly attached to pivotal handlebar shaft **106** and pivot struts having pivots on each distal end. Strut pivot **128** links strut **122** with strut **126** and axle pivot **130** attached to a respective subjacent strut **84**. To collapse the bicycle to a folded state the handle bar lock **112** is unlatched allowing the handlebars **116** to be pivoted inward through pivot **110** of pivot linkage **108**. Once pivoted

the handlebars **116** and pivot linkage **108** are substantially perpendicular to handlebar shaft **106** providing optional torque in folding the rear axle **62** under rear frame **56** through the axle extension linkage **120**.

Referring to Figure 9, illustrated is the hinged rear axle folded beneath the rear wheels frame. Several linkages are provided for controlling the deployment and retraction of the rear axle **62**. Rear axle **62** is pivotally attached to rear wheels frame **56** by hinge **60**. To collapse the bicycle to a folded state the handle bar lock **112** is unlatched allowing the handlebars **116** to be pivoted inward through pivot **110** of pivot linkage **108**. Once pivoted the handlebars **116** and pivot linkage **108** are substantially perpendicular to handlebar shaft **106** providing optional torque in folding the rear axle **62** under rear frame **56** by pushing the handlebars **116** down thereby rotating handlebar shaft **106** and fixedly attached axle extension strut **122** pivoting pivot strut **126** having pivot **128**. Pivot strut **126** having pivot **128** attached to strut **122** is also pivotally attached to subjacent pivotal strut section **84**, which then pivots rear axle **62** beneath the rear wheels frame **56**.

Referring to Figure 10, depicted is a partial enlarged view, taken from Fig 9 as indicated, showing the axle extension linkage in a folded state. The axle extension linkage **120** has a pair of extension struts **122** and pivot struts **126** with the extension struts fixedly attached to pivotal handlebar shaft **106** and pivot struts having pivots on each distal end. Strut pivot **128** links strut **122** with strut **126** and axle pivot **130** attached to a respective subjacent strut **84**. To collapse the bicycle to a folded state the handle bar lock **112** is unlatched allowing the handlebars **116** to be pivoted inward through pivot **110** of pivot linkage **108**, which is then substantially perpendicular to handlebar shaft **106** with the handlebars **116** at a substantial right angle to shaft **106** whereupon handlebars **116** are used to produce torque in moving the tricycle rear axle **62** beneath rear wheels frame **56**.

Referring to Figure 11, shown is the rear axle folded beneath the rear wheels frame. Once the rear axle **62** has been folded beneath the rear wheels frame **56**, inward pressure applied to wheels **94**, shown in dashed line, pivots the superjacent and subjacent pivotal strut sections **84**, **92** against the folded tricycle **10**. The pivotal strut sections, **84**, **92** are

pivotally attached to a respective hinged section **76, 86** with the respective wheel bracket **96** providing apertures **98** and fasteners **100** that pivotally fastens subjacent pivotal struts **84** towheel bracket and providing apertures **102** and fasteners **104** that pivotally fastens superjacent pivotal struts **92** to said wheel bracket.

Referring to Figure 12, shown is the rear axle folded beneath the rear wheels frame. Once the rear axle **62** has been folded beneath the rear wheels frame **56**, inward pressure applied to wheels **94**, pivots the superjacent and subjacent pivotal strut sections **84, 92** against the folded tricycle **10**. The pivotal strut sections, **84, 92** are pivotally attached to a respective hinged section **76, 86** with the respective wheel bracket **96** providing apertures **98** and fasteners **100** that pivotally fastens subjacent pivotal struts **84** to said wheel bracket and providing apertures **102** and fasteners **104** that pivotally fastens superjacent pivotal struts **92** to said wheel bracket.

Referring to Figure 13A through 13D, shown is a side view of the tricycle of the present invention having a slidable pedal assembly and side and front views of the pedal assembly. Figure 13A is a side view of the tricycle front end having front wheel frame **16** with a slideable pedal assembly bracket **18** thereon with chain guides **26** mounted thereto. Also shown are sprocket **22**, crank **28** and said pedals **32**. Front frame **16** has shock absorbers **34** fastened to the front wheel spindle having cogset **38**, wheel **36**, motor **42** and derailleur **40** mounted thereon. Figure 13B shows the foldable tricycle **10** of the present invention having a front wheel frame **16** with a slideable pedal assembly bracket **18** mounted on the tricycle front frame portion **16** and seat support **48** mounted onto the front frame spindle **44**. Rear wheel frame **56** provides bearing **58** mounted onto spindle **44** providing a rotative front wheel frame **16**. Seat assembly **46** comprises seat support **48** that is mounted onto spindle **44** and seat **50** that is mounted onto and selectively positionable on seat support **48**. Figure 13C shows a side view of the pedal assembly and Figure 13D shows a front view of the pedal assembly comprising pedal assembly mount **18** having mount lock **20**, and chain guides **26**, with sprocket **22**, crank **28** and pedals **32**.

Referring to Figure 14, shown is a side view of the tricycle of the present invention having a slidable pedal assembly in use. The foldable tricycle **10** of the present invention having a front wheel frame **16** with a slideable pedal assembly bracket **18** mounted on the tricycle front frame portion **16** and seat support **48** mounted onto the front frame spindle **44**. Rear wheel frame **56** provides bearing **58** mounted onto spindle **44** providing a rotative front wheel frame **16**. Seat assembly **46** comprises seat support **48** that is mounted onto spindle **44** and seat **50** that is mounted onto and selectively positionable on seat support **48**. The slidable pedal assembly **17** comprises pedal assembly mount **18** having mount lock **20**, and chain guides **26**, with sprocket **22**, crank **28** and pedals **32**.

Referring to Figure 15A through 15C, shown is a side view of the tricycle of the present invention having a slidable pedal assembly and side and front views of the pedal assembly. Figure 15A shows the foldable tricycle **10** of the present invention having a front wheel frame **16** with a slideable pedal assembly bracket **18** mounted on the tricycle front frame portion **16** and seat support **48** mounted onto the front frame spindle **44**. Rear wheel frame **56** provides bearing **58** mounted onto spindle **44** providing a rotative front wheel frame **16**. Seat assembly **46** comprises seat support **48** that is mounted onto spindle **44** and seat **50** that is mounted onto and selectively positionable on seat support **48**. Figure 15B shows a side view of the pedal assembly and Figure 15C shows a front view of the pedal assembly comprising pedal assembly mount **18** having mount lock **20**, and chain guides **26**, with sprocket **22**, crank **28** and pedals **32** enabling the user to adjust the distance between the pedal assembly and their arm length.

Referring to Figure 16, shown is a side view of the tricycle of the present invention having chain guides and post in hand use. Shown is the foldable tricycle **10** of the present invention having a front wheel frame **16** with a slideable pedal assembly bracket **18** mounted on the tricycle front frame portion **16** and seat support **48** mounted onto the front frame spindle **44**. Rear wheel frame **56** provides bearing **58** mounted onto spindle **44** providing a rotative front wheel frame **16**. Seat assembly **46** comprises seat support **48** that is mounted onto spindle **44** and seat **50** that is mounted onto and selectively positionable on seat support **48**. The pedal assembly provides pedal assembly mount **18** having mount lock **20**, and chain

guides **26**, with sprocket **22**, crank **28** and pedals **32** mounted to a post enabling the user to adjust the distance between the pedal assembly and their arm length.

Referring to Figure 17A through 17C, shown is a side view of the tricycle of the present invention having a slidable pedal assembly and side and front views of the pedal assembly. Figure 17A shows the foldable tricycle **10** of the present invention having a front wheel frame **16** with a slideable pedal assembly bracket **18** mounted on the tricycle front frame portion **16** and seat support **48** mounted onto the front frame spindle **44**. Rear wheel frame **56** provides bearing **58** mounted onto spindle **44** providing a rotative front wheel frame **16**. Seat assembly **46** comprises seat support **48** that is mounted onto spindle **44** and seat **50** that is mounted onto and selectively positionable on seat support **48**. Figure 17B shows a side view of the pedal assembly and Figure 17C shows a front view of the pedal assembly comprising pedal assembly mount **18** having mount lock **20**, and chain guides **26**, with sprocket **22**, crank **28** and pedals **32** enabling the user to adjust the distance between the pedal assembly and their leg length.

Referring to Figure 18, shown is a partial front view of the tricycle of the present invention. Shown is the front frame **16** having pedal assembly **17** mounted thereon. Front frame **16** has shock absorbers **34** fastened to the front wheel spindle having cogset **38** and wheel **36** mounted thereto. Also shown is mount **18** having latch **20** for fixedly attaching the pedal assembly in a desired location and chain guides **18** enable the mount to slide along front frame **16**.

It will be understood that each of the elements described above, or two or more together may also find a useful application in other types of methods differing from the type described above.

While certain novel features of this invention have been shown and described and are pointed out in the annexed claims, it is not intended to be limited to the details above, since it will be understood that various omissions, modifications, substitutions and changes in the forms and details of the device illustrated and in its operation can be made by those skilled in the art without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

CLAIMS

What is claimed is new and desired to be protected by letters patent and is set forth in the appended claims.

1. A foldable three wheel land vehicle comprising:

a) a curvilinear front wheel frame forming a rail having a front end and a back end having a spindle tangentially projecting therefrom with said front end having a slidable pedal assembly mounted thereon and fixedly positionable thereto;

b) said pedal assembly fixedly attached to a respective shock absorber with the shock absorbers terminal end fixedly attached to a front wheel axle;

c) a rear wheels frame having a front end and a back end with said front end having a bearing whereby said front frame is pivotally fastened by said spindle to said rear frame; and

d) said rear wheels frame back end having a hinged rear axle with wheels mounted on its terminal ends that is movable between a folded state where said rear axle is beneath the rear wheels frame and a deployed state where said rear axle extends from said rear wheels frame.

2. The foldable three wheel land vehicle of Claim 1, wherein said rear axle comprises a superjacent axle portion and a subjacent axle portion with a pair of spacers and springs positioned between said axle portions so that the superjacent axle portion can linearly move left and right relative to the subjacent axle portion.

3. The foldable three wheel land vehicle of Claim 2, wherein each of said rear axle portions has a hinged section with opposing ends having pivotal strut sections extending therefrom that are fastened to respective wheel brackets having superjacent and subjacent apertures for securing a corresponding superjacent and subjacent strut section to a respective wheel bracket aperture having a wheel attached thereto.

4. The foldable three wheel land vehicle of Claim 3, further providing a seat assembly having a seat support fastened to said spindle that angularly extends to a rail with a seat mountable thereon so that an operator steers the tricycle by shifting their weight either left or right causing the steering rail segment and curvilinear rail-like segment to pivot in tandem.

5. The foldable three wheel land vehicle of Claim 4, further providing said rear wheels frame with a handlebar bushing having a handlebar shaft therein with its distal ends having pivots fastened thereto with attached handlebar pivot linkage terminating in a handlebar fastener with handlebars extending therefrom.
6. The foldable three wheel land vehicle of Claim 5, further providing said handlebar shaft with a pair of axle extension struts fastened to a respective side of said handlebar shaft with a struts shaft therebetween with each extension strut pivotally fastened to a pivot strut that is pivotally fastened to a respective subjacent pivotal strut section.
7. The foldable three wheel land vehicle of Claim 6, further providing said rear wheels frame with a rotative steering linkage post having a channel therethrough.
8. The foldable three wheel land vehicle of Claim 7, further providing said seat support with a steering linkage fastener downwardly extending from said seat support.
9. The foldable three wheel land vehicle of Claim 8, further providing steering linkage extending between said steering linkage fastener through said rotative steering linkage post to the superjacent hinged section whereby pivoting the seat support moves the superjacent axle portion linearly left or right relative to the subjacent axle portion thereby changing the wheels camber simultaneously.
10. The foldable three wheel land vehicle of Claim 9, wherein said steering linkage has a split rail with the stationary subjacent rail portion having longitudinal tracks thereon and the superjacent rail portion having track mating channels thereon extends when the rear axle is moved to a folded state with the mating tracks and channels maintaining guideway engagement between a folded and deployed position.
11. The foldable three wheel land vehicle of Claim 10, further providing said rear wheels frame with latching for said axle extension linkage comprising a pivotal shaft having a pair of cavities that engage the struts shaft when in the folded position and again when in the deployed position with the pivotal shaft pivotally fastened to the rear wheels frame and a pivotal bar with a pivot therebetween with the pivot bar having a handle for raising the pivotal shaft disengaging the struts shaft thereby enabling use of the axle extension linkage.

12. The foldable three wheel land vehicle of Claim 11, further providing shock absorbers pivotally fastened at one end to the superjacent hinged section and fixedly attached to a respective superjacent pivotal strut section.

13. The foldable three wheel land vehicle of Claim 1, wherein said pedal assembly comprises pedal assembly mount having a throughbore for slidably mounting onto the front wheel frame; mount lock for securing the mount to a desired position on the front wheel frame; pedals and cranks driving a pedal assembly sprocket having and chain forming drive means for the front wheel.

14. The foldable three wheel land vehicle of Claim 1, wherein said front wheel has a hub with a cogset mounted thereon and a derailleur mounted thereto with said chain extending through said derailleur engaging a desired sprocket of said cogset.

15. The foldable three wheel land vehicle of Claim 1, further providing a front wheel electric hub motor and a battery providing a tricycle that can be manually operated through said pedal assembly or motor driven.

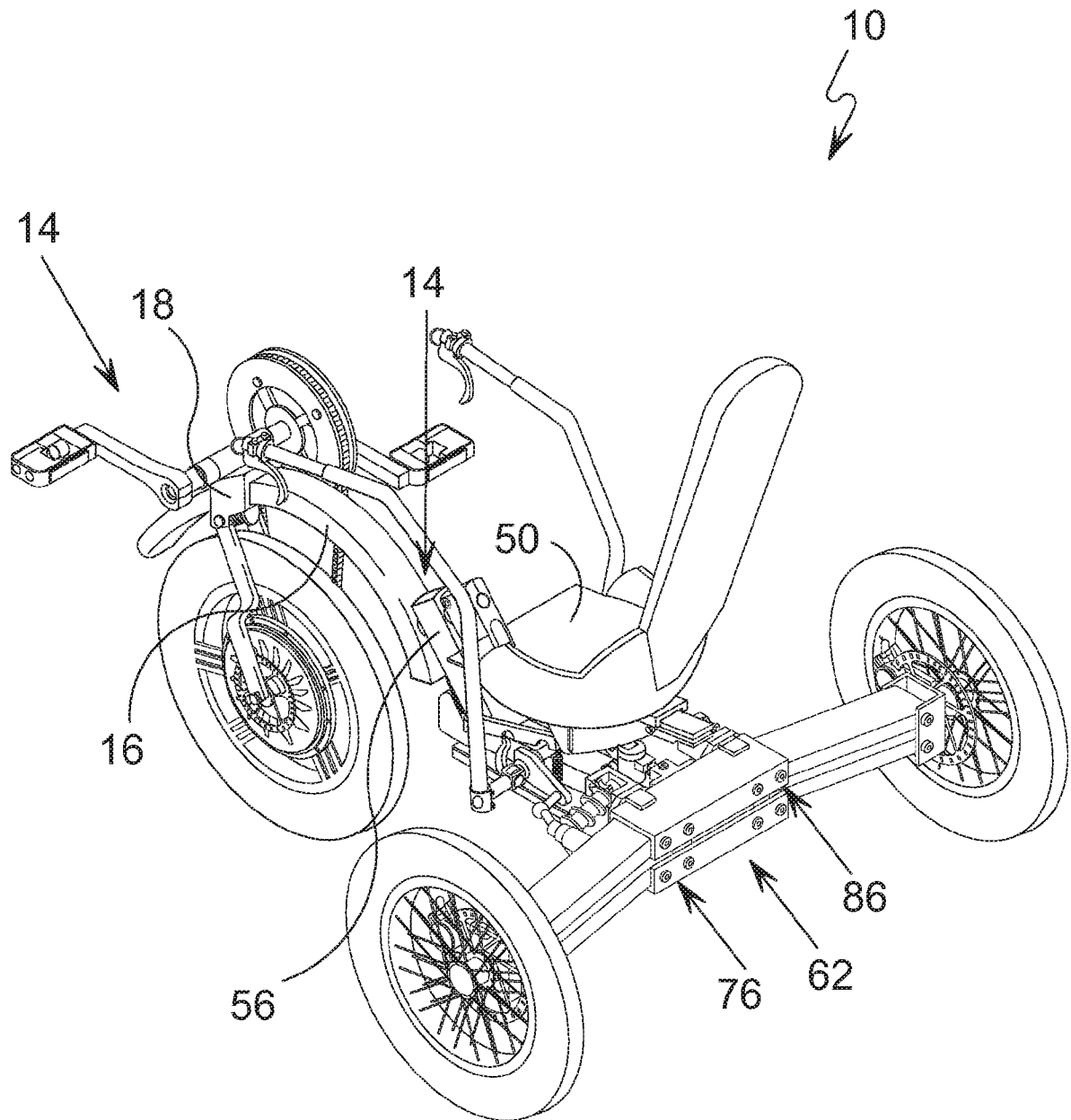


FIG. 1

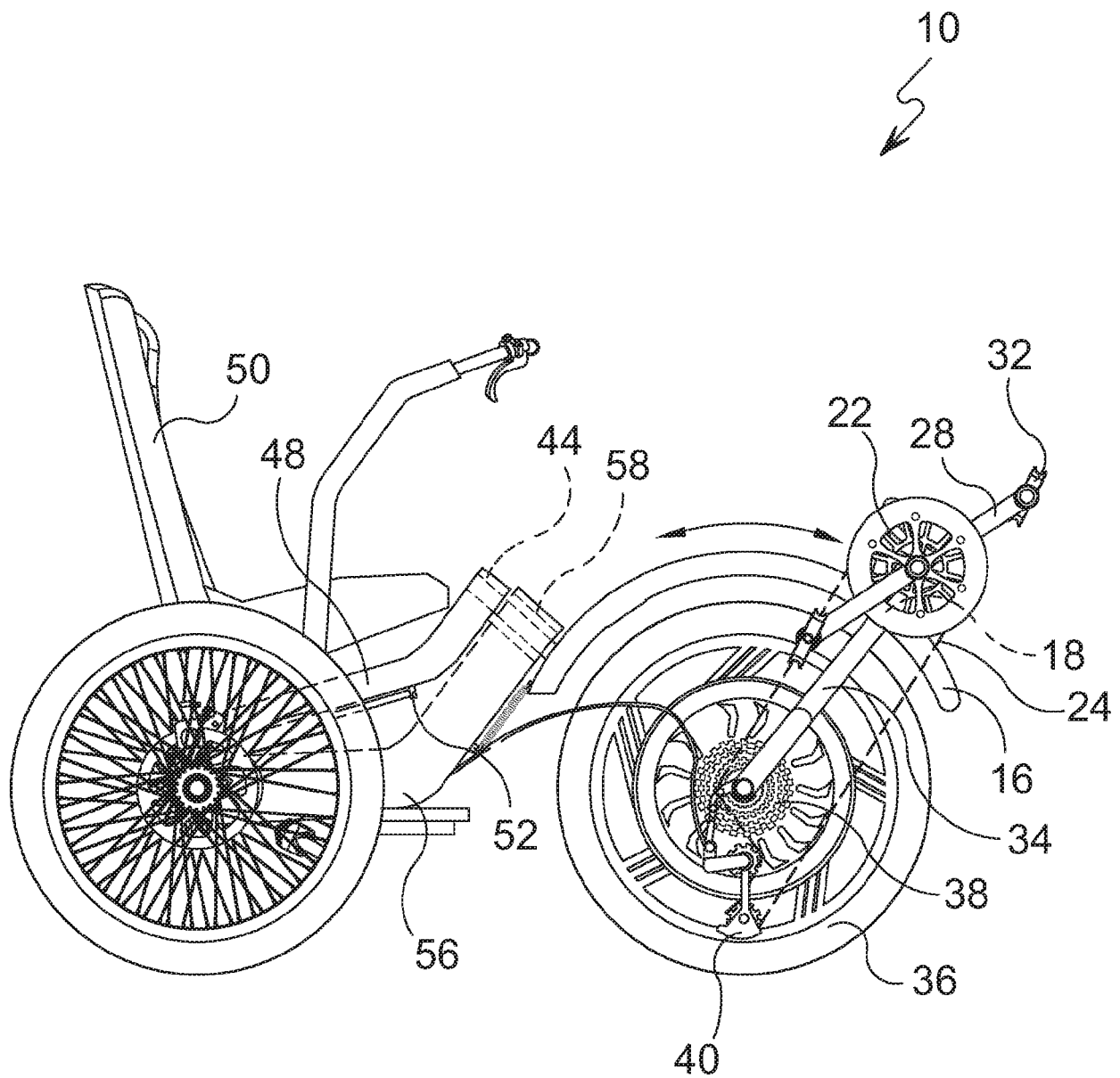
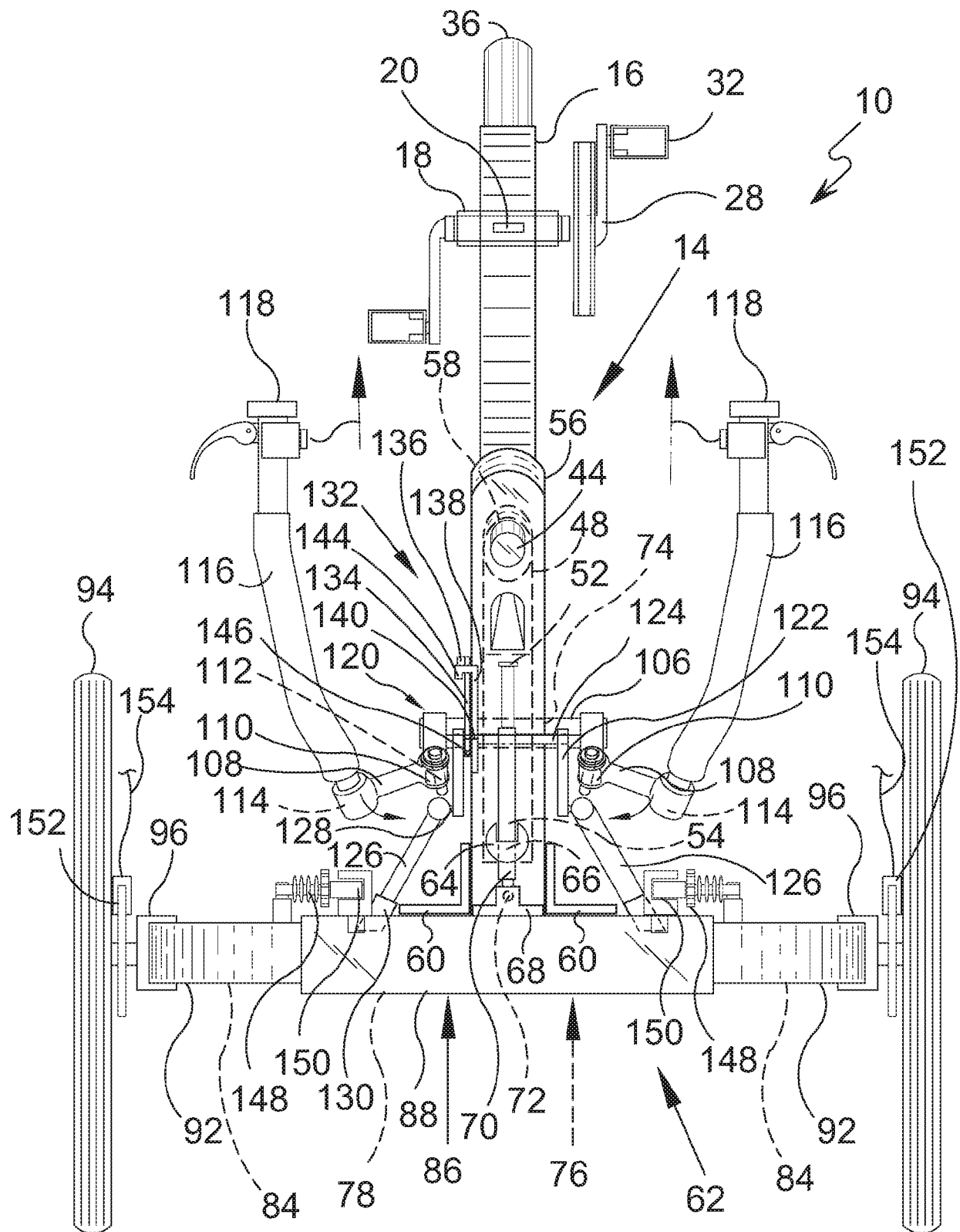
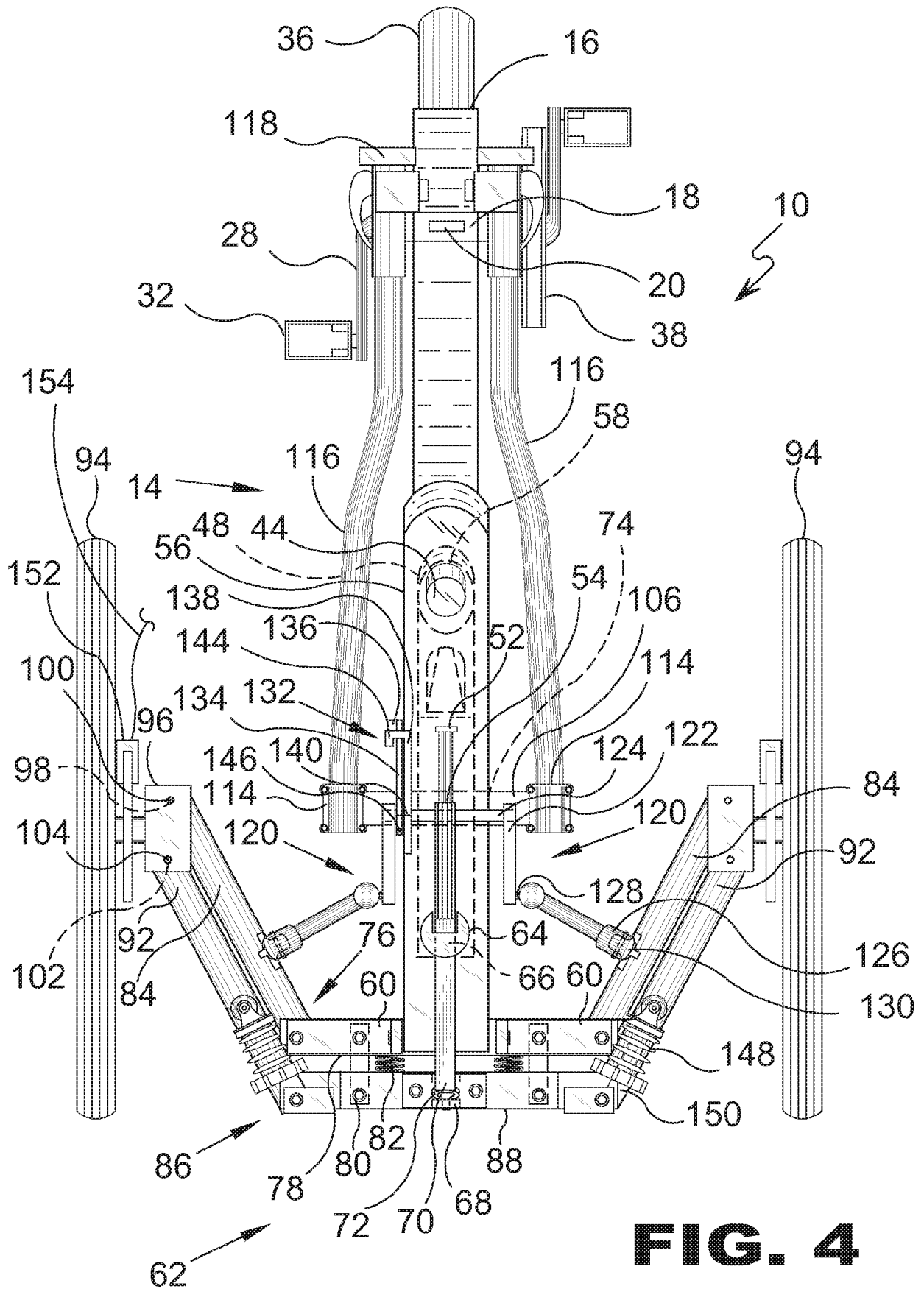
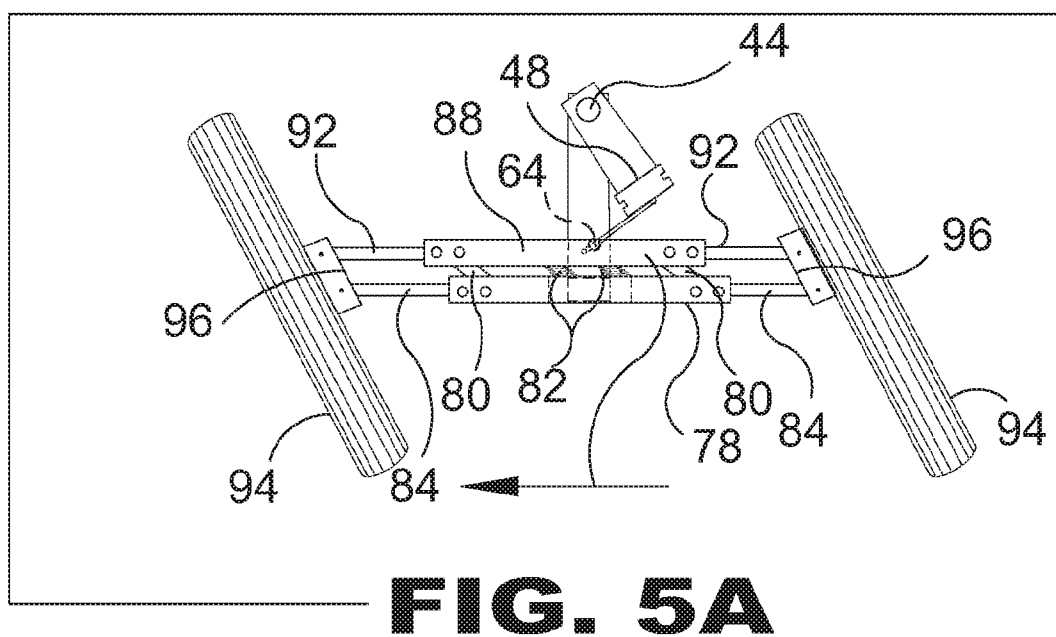
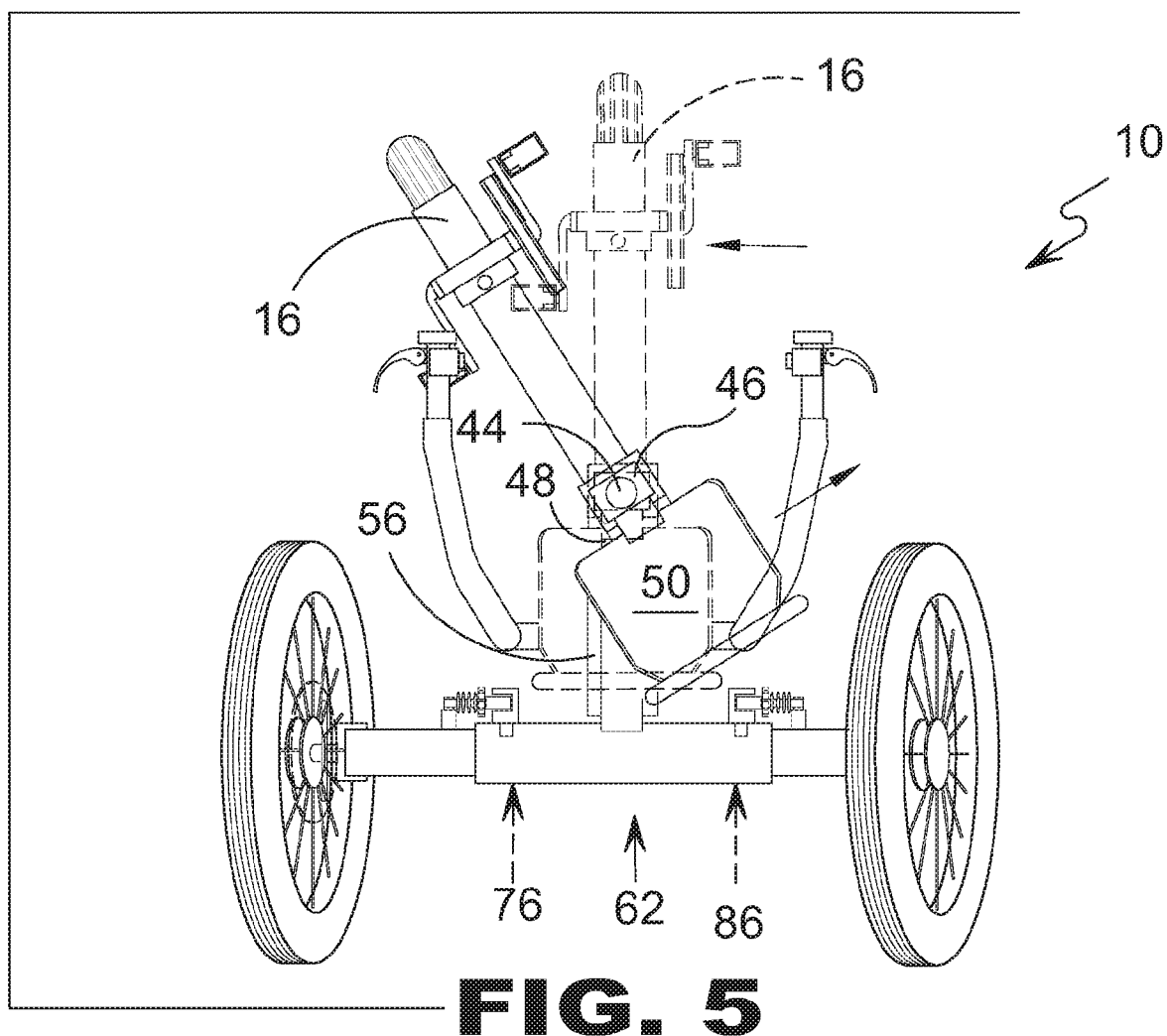


FIG. 2

**FIG. 3**

**FIG. 4**



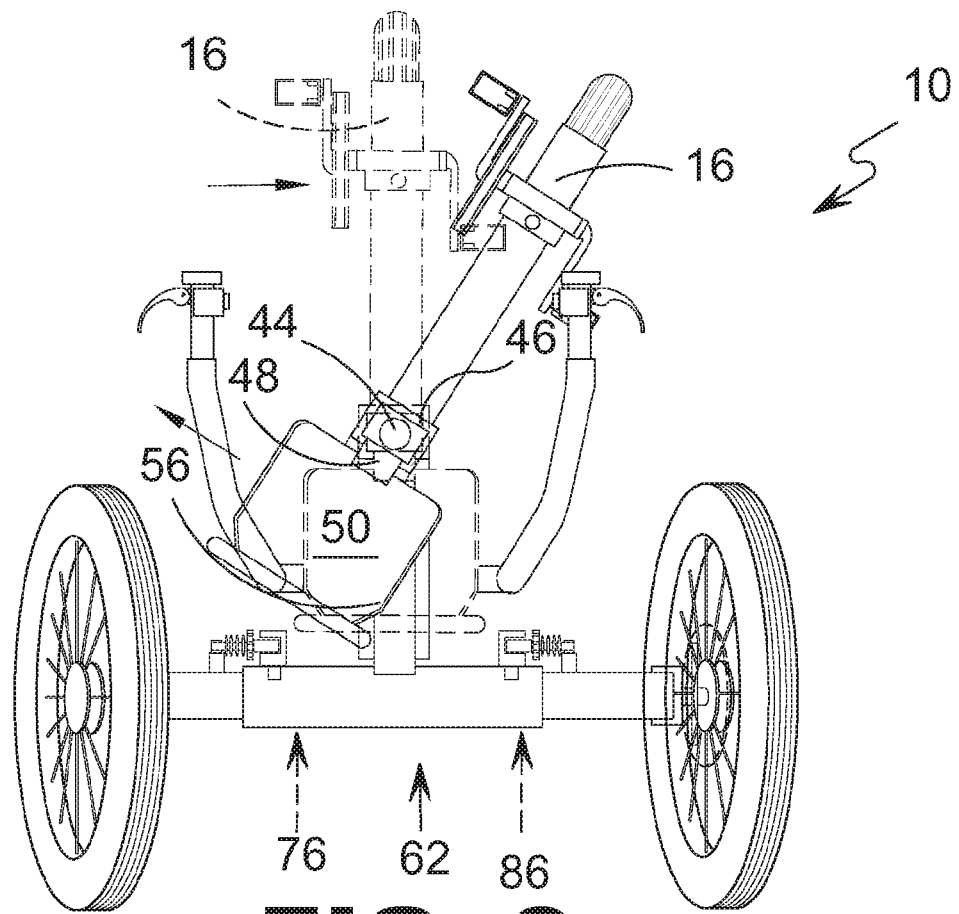


FIG. 6

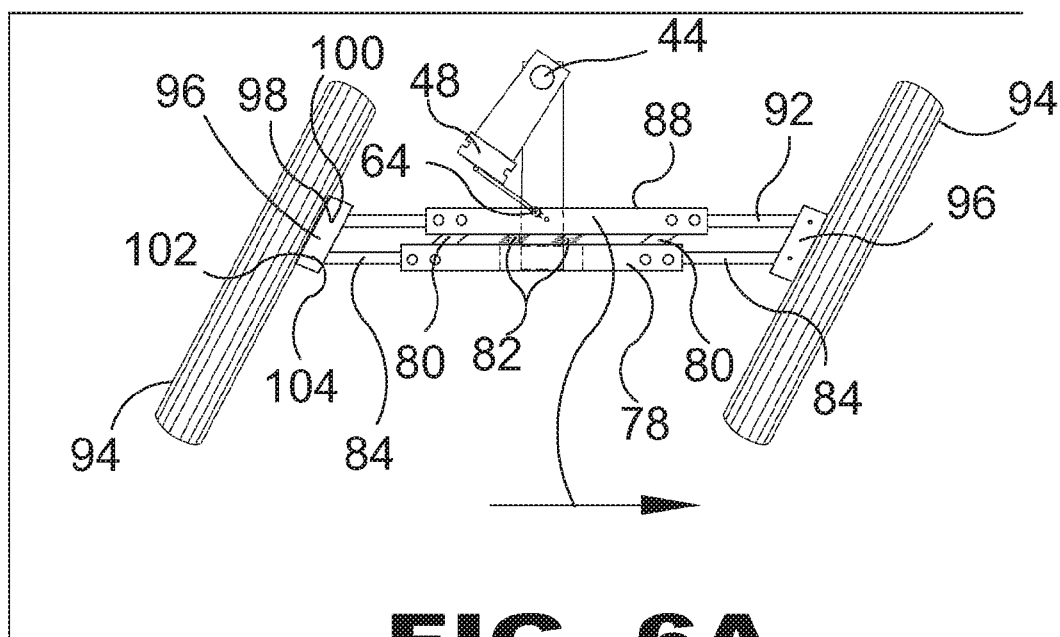


FIG. 6A

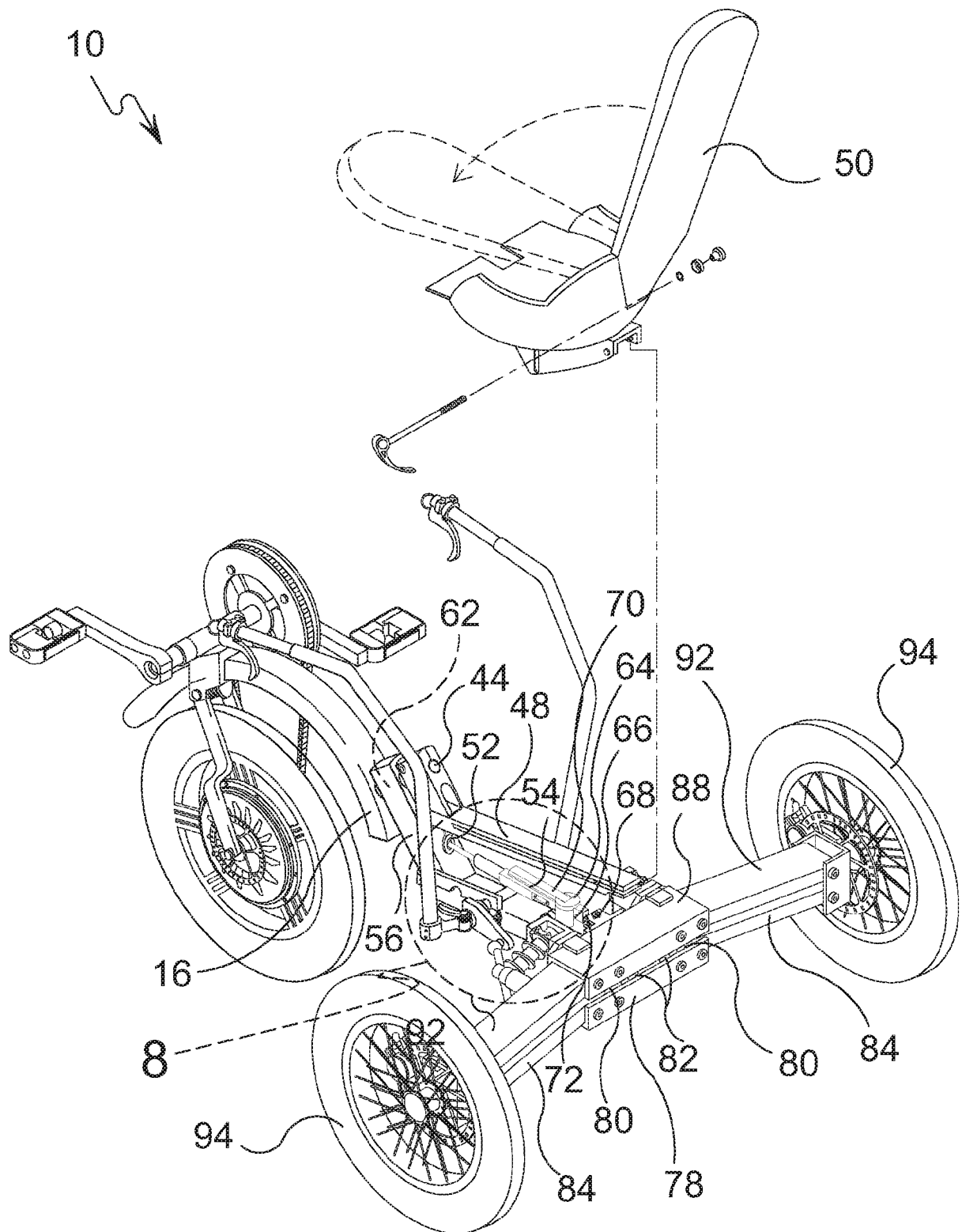
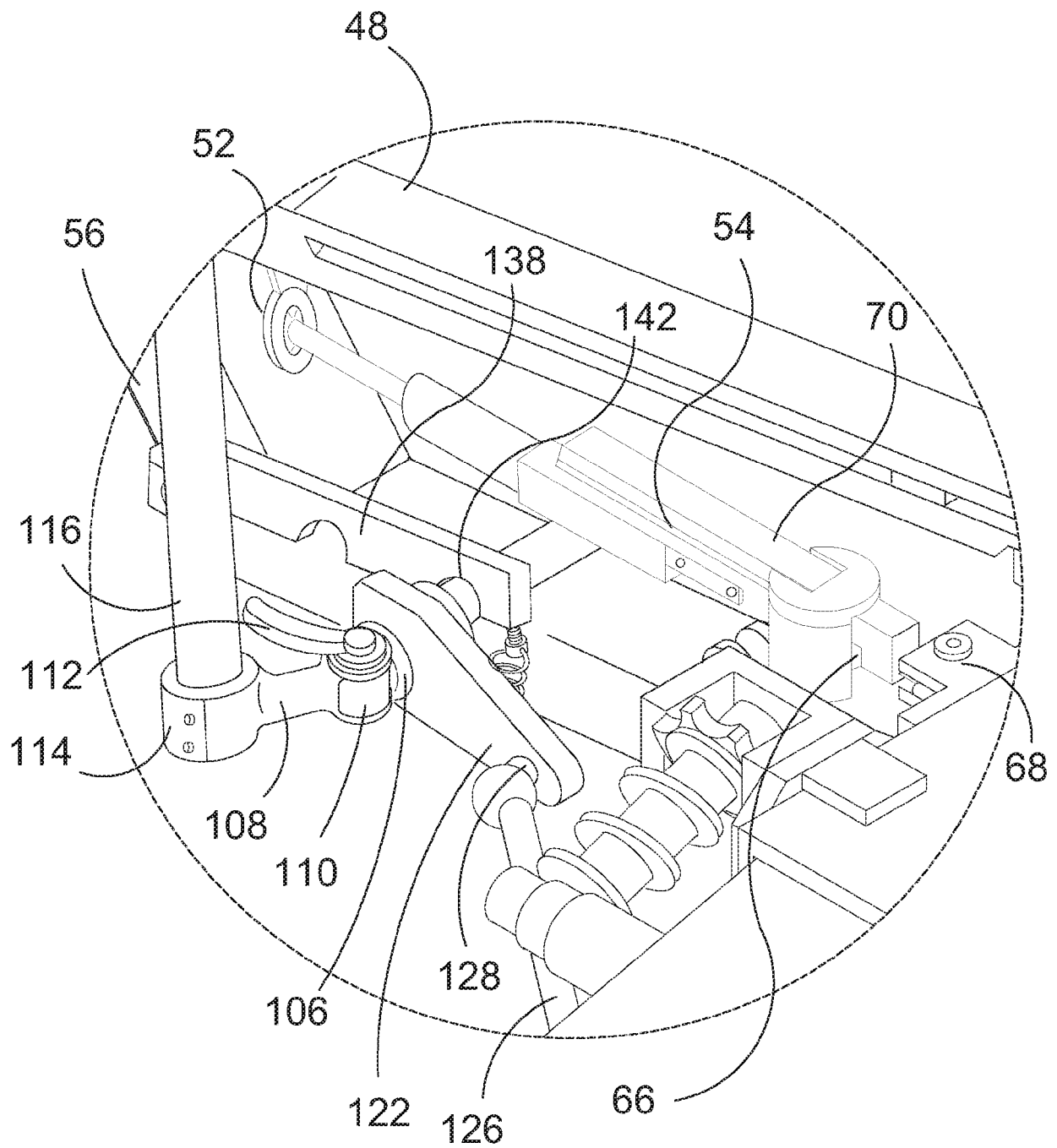


FIG. 7

**FIG. 8**

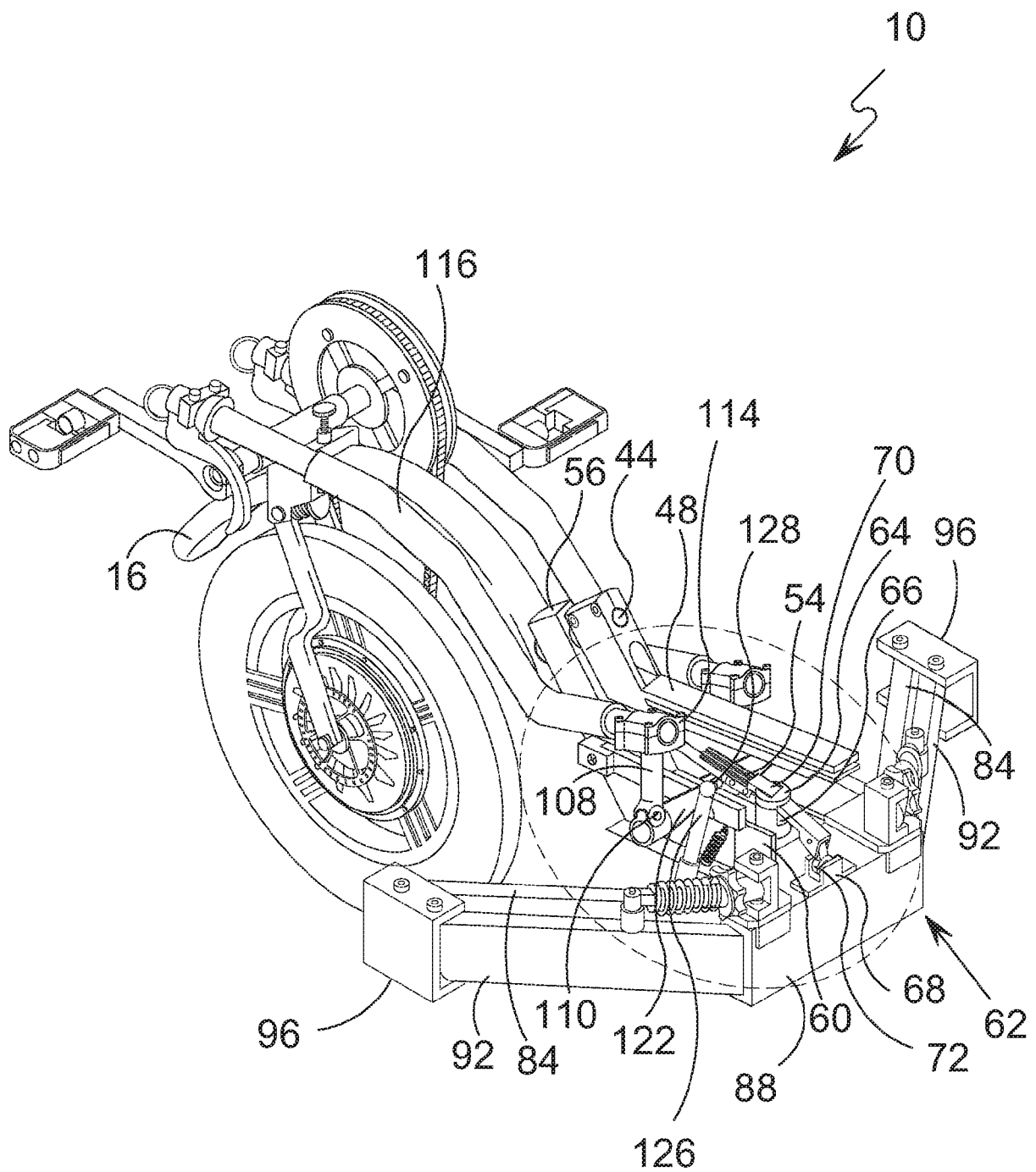


FIG. 9

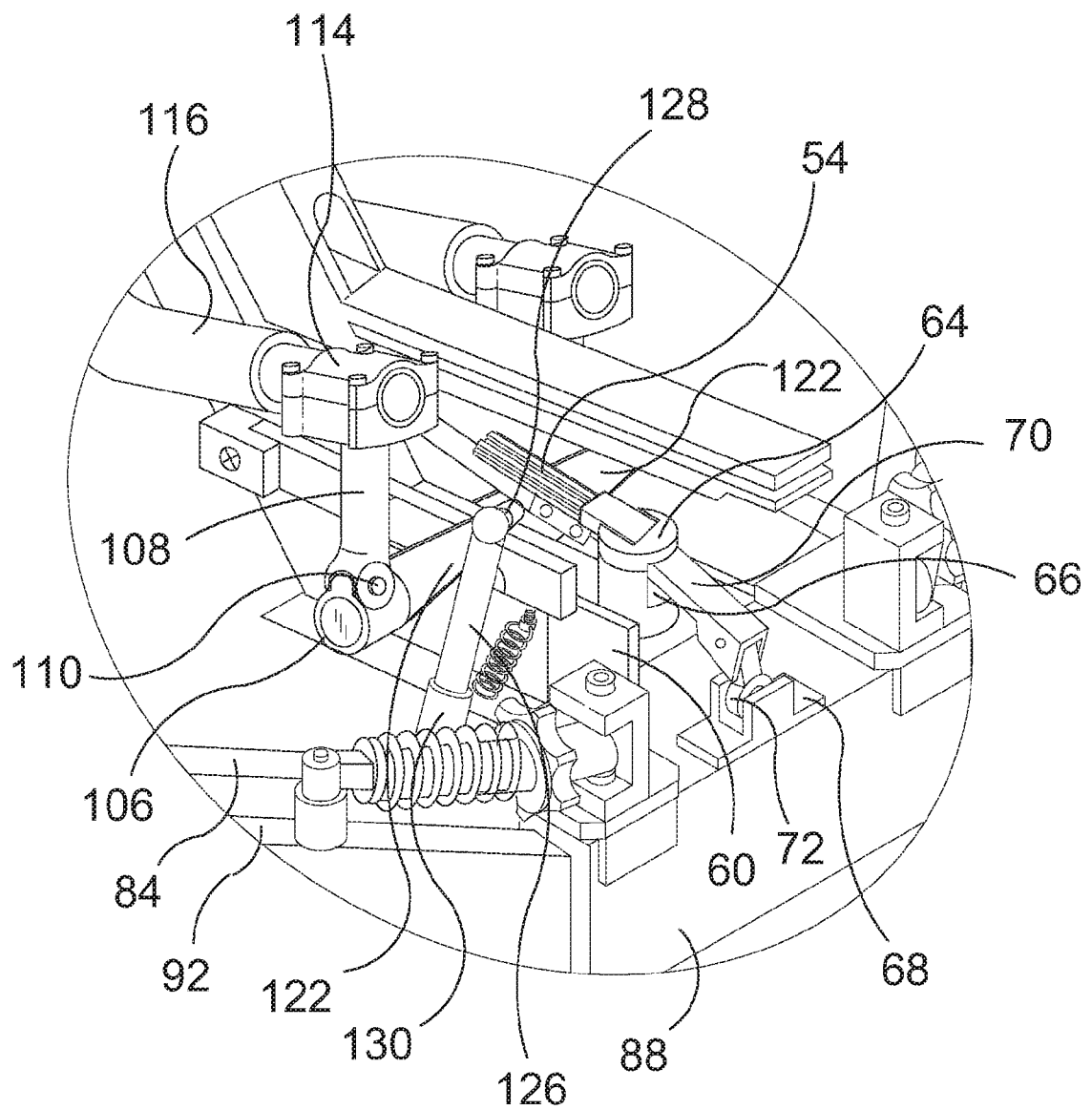


FIG. 10

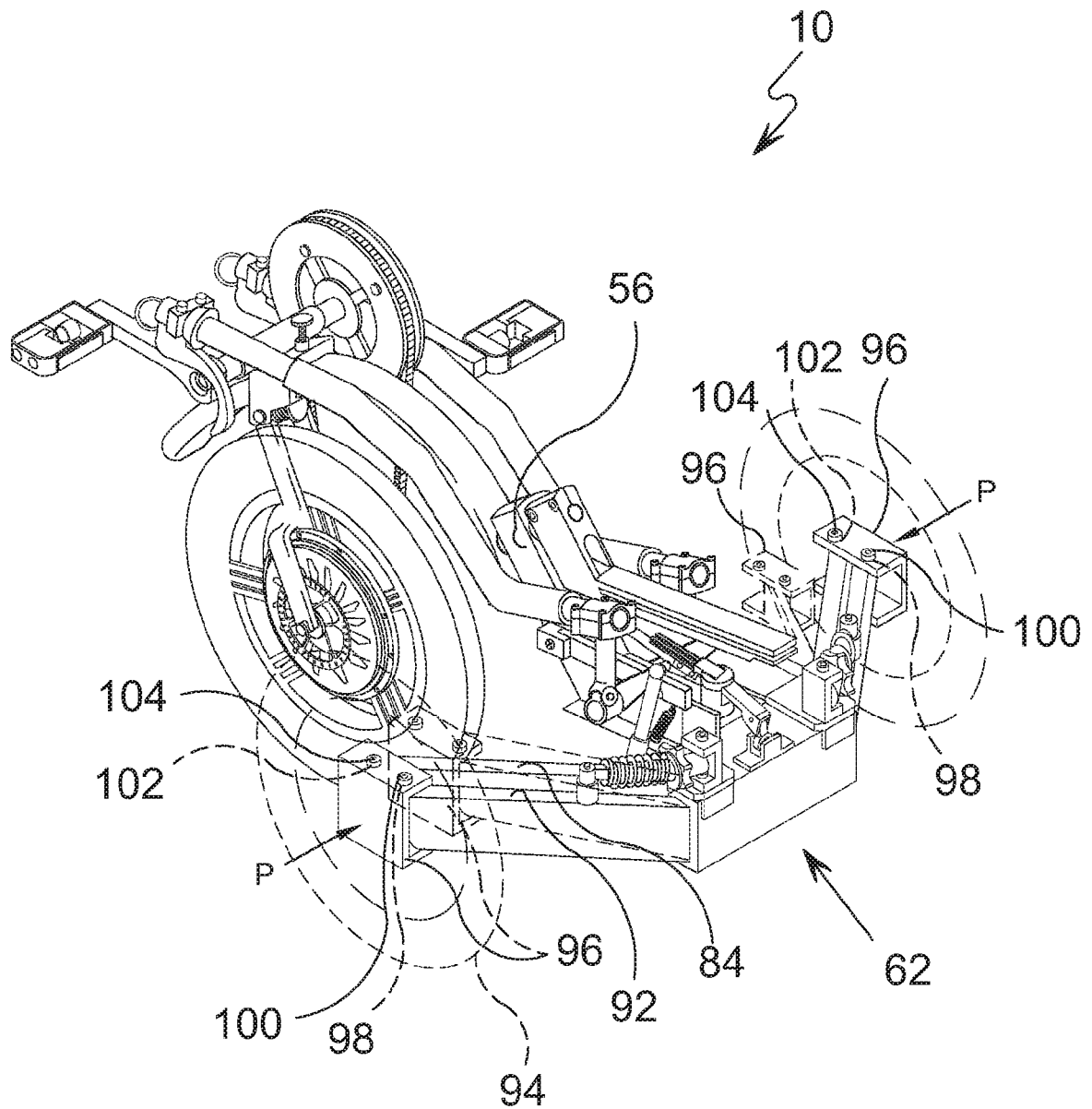


FIG. 11

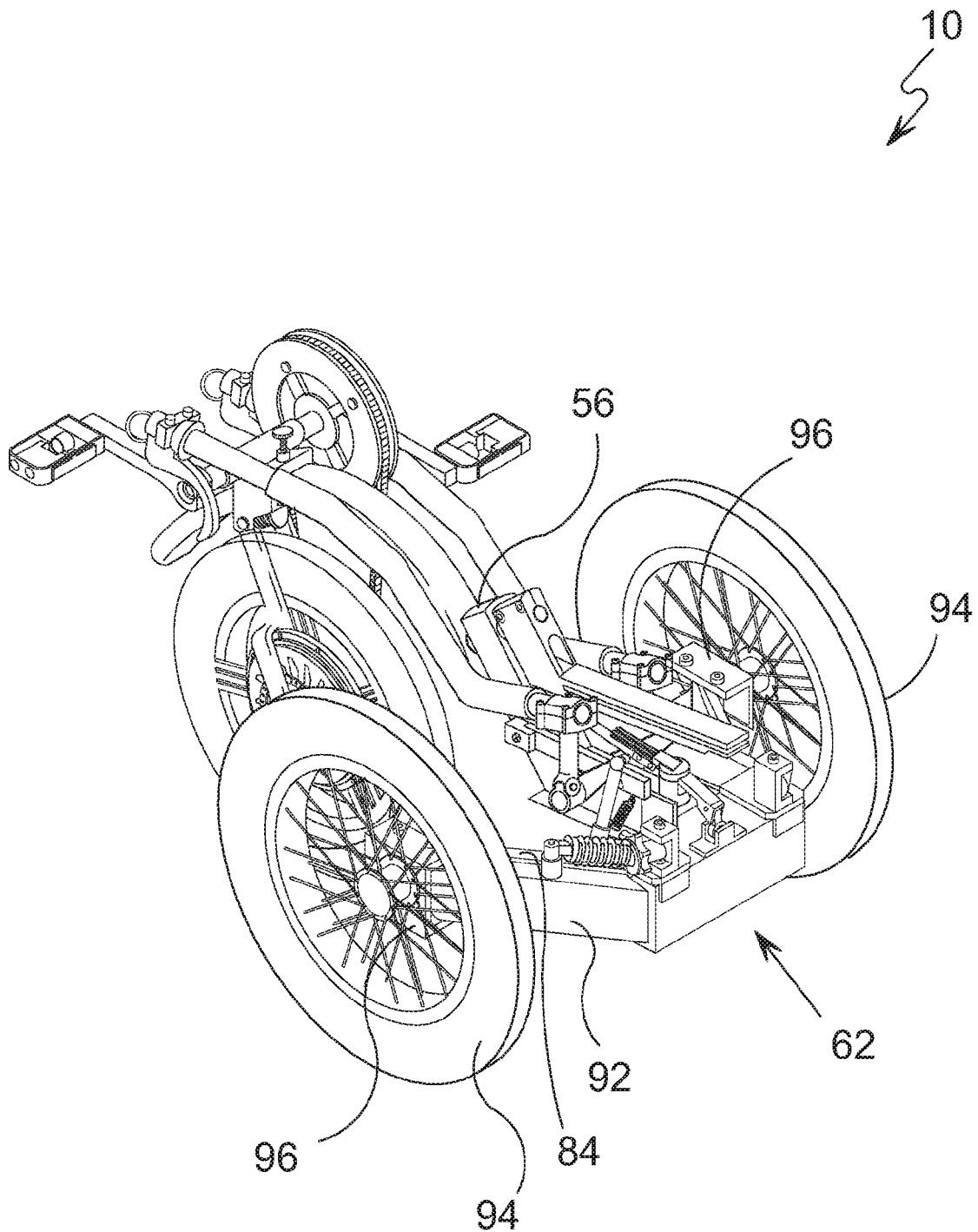
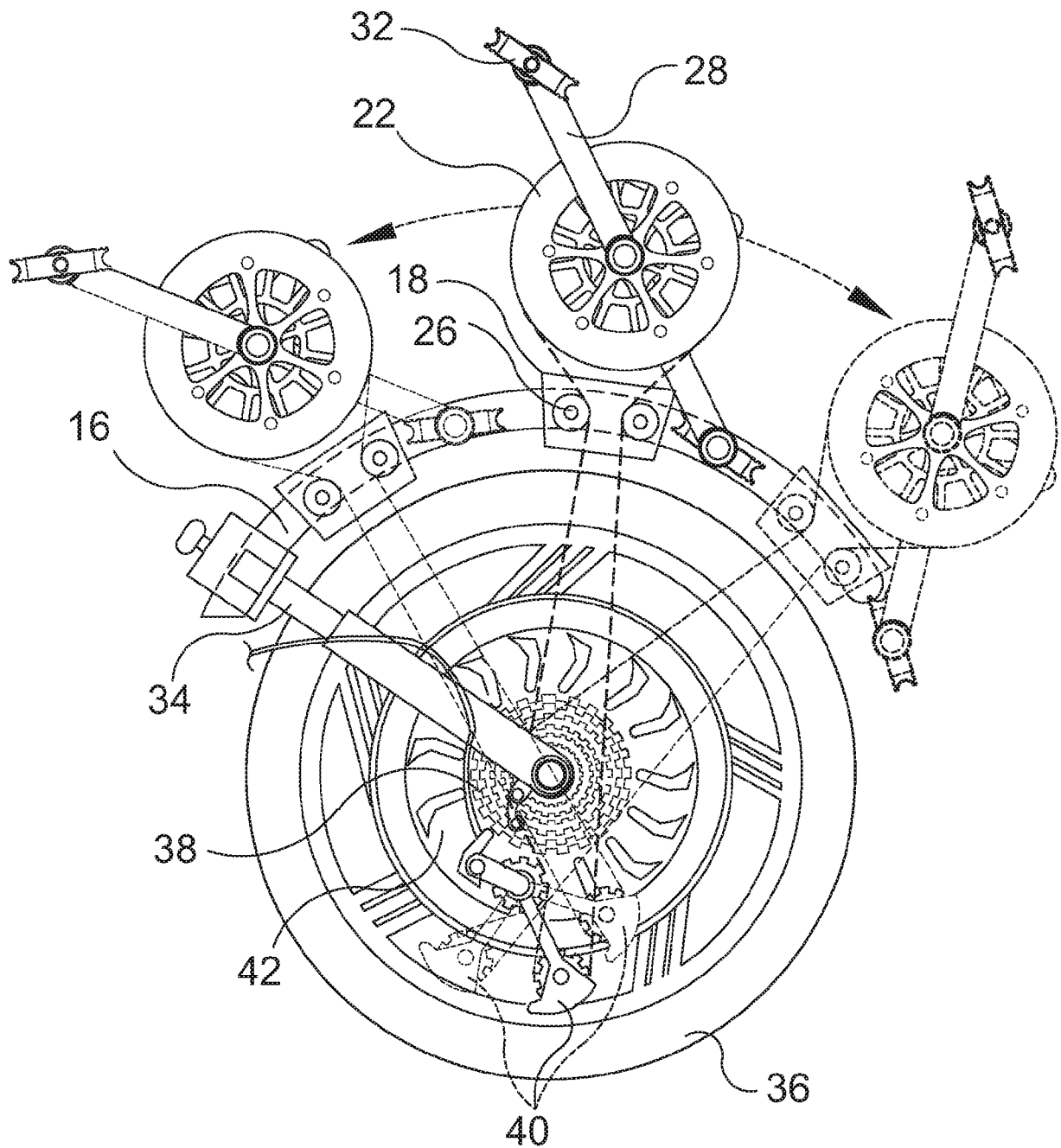


FIG. 12

**FIG. 13A**

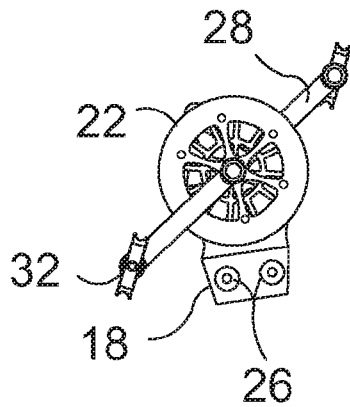


FIG. 13C

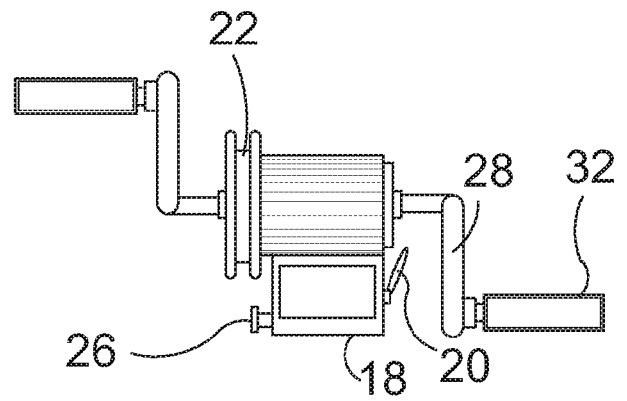


FIG. 13D

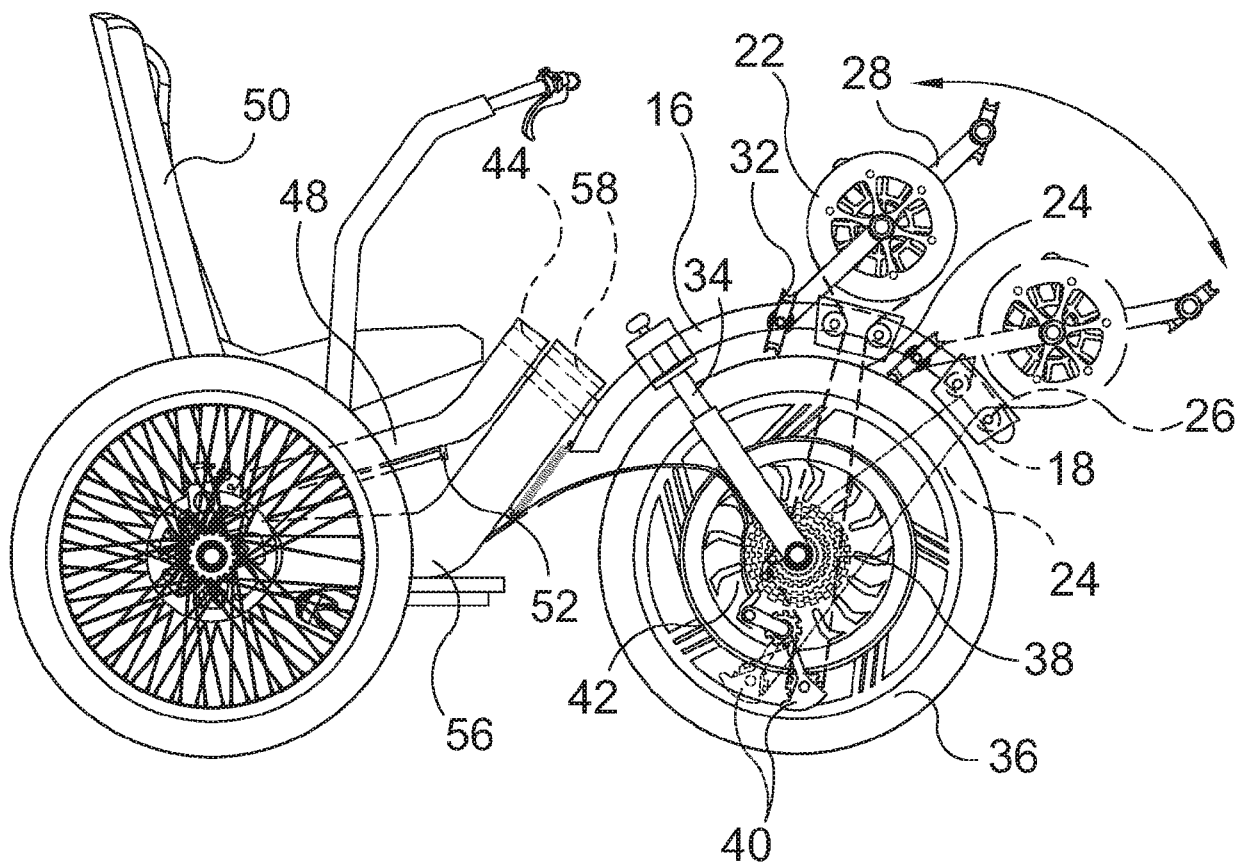


FIG. 13B

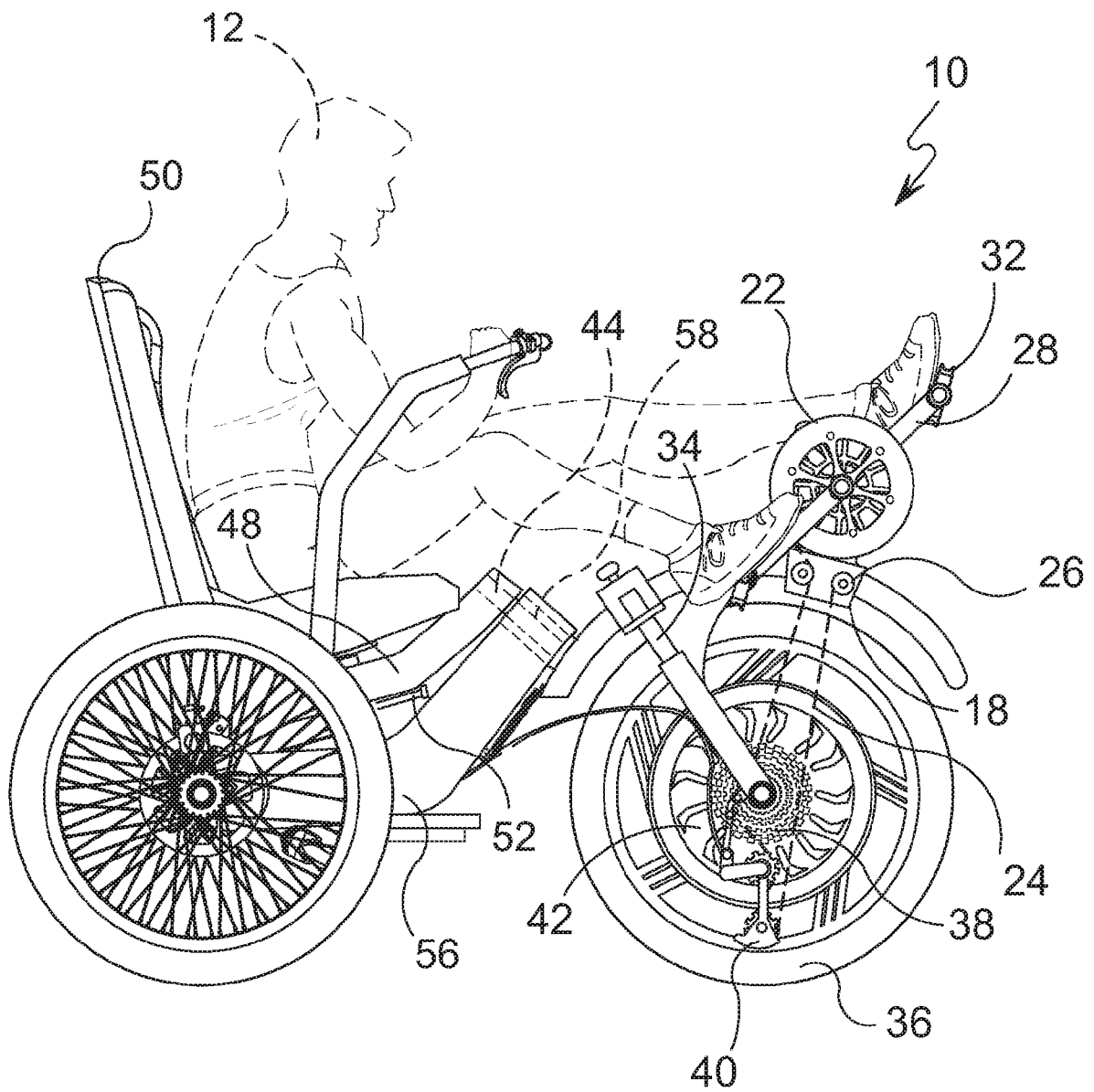
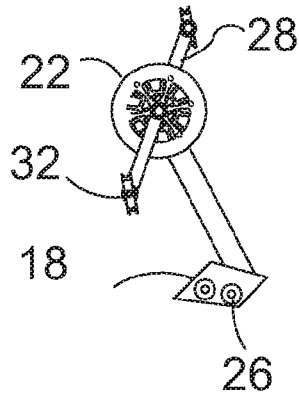
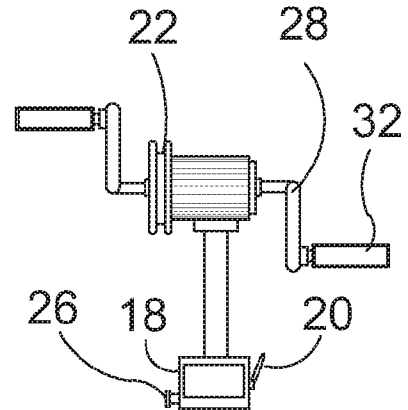
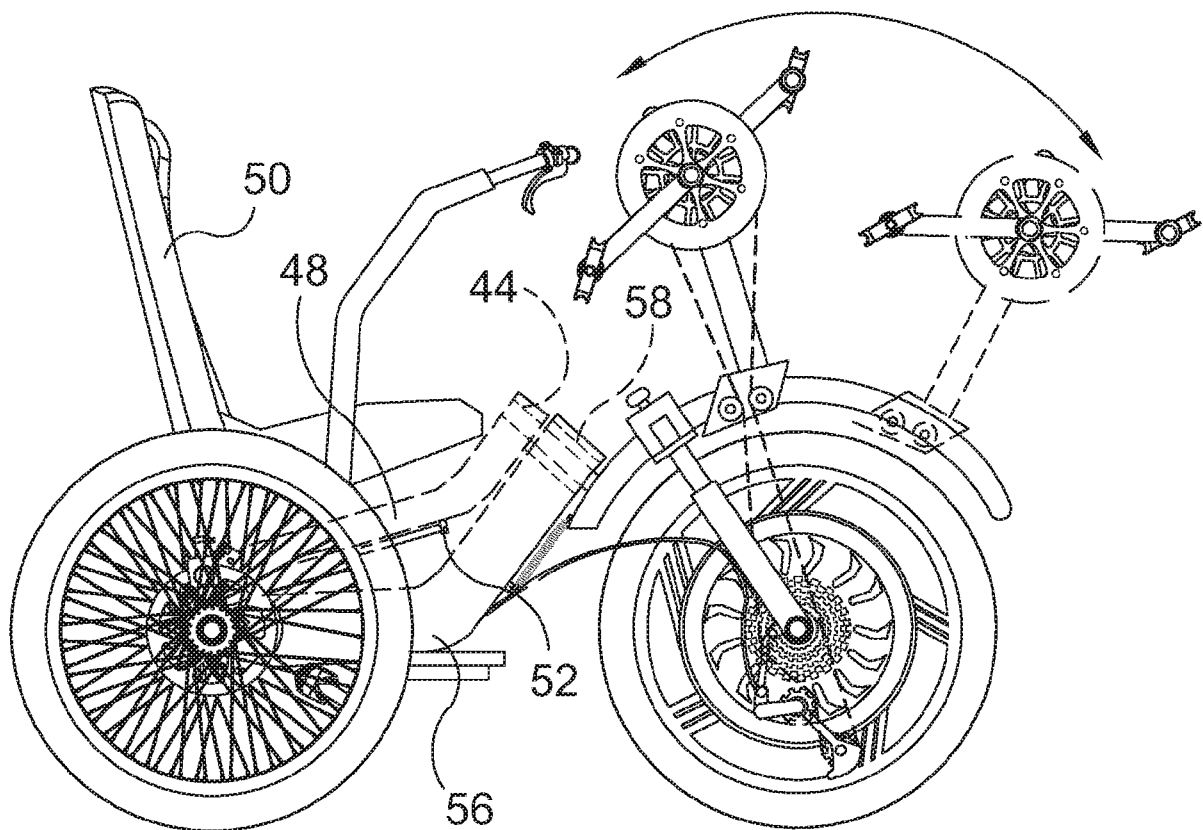
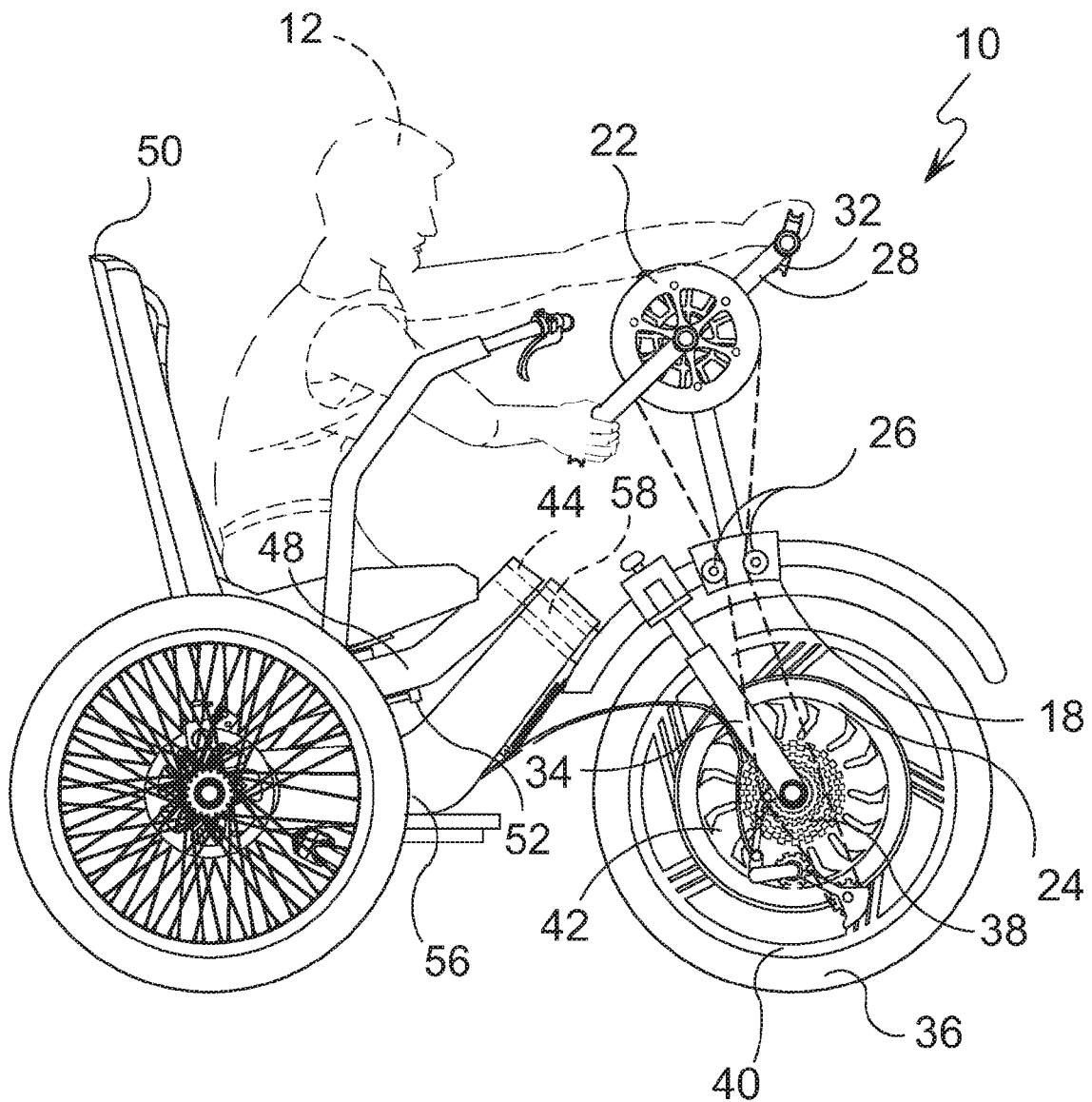


FIG. 14

**FIG. 15B****FIG. 15C****FIG. 15A**

**FIG. 16**

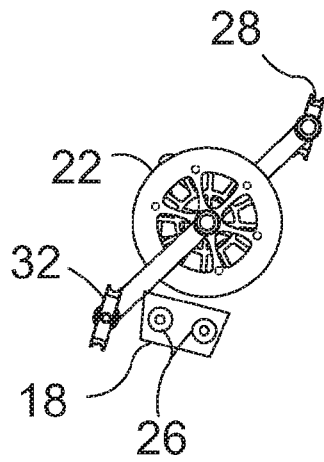


FIG. 17B

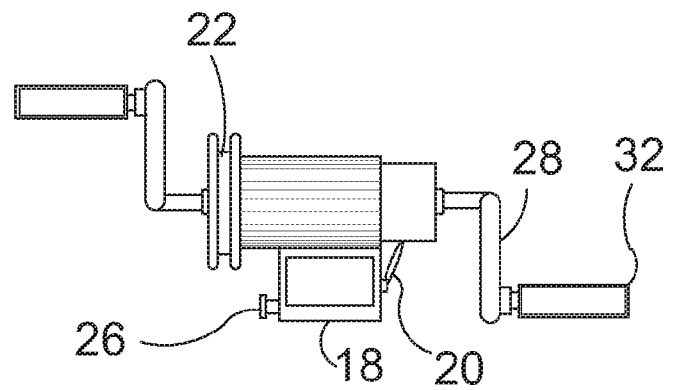


FIG. 17c

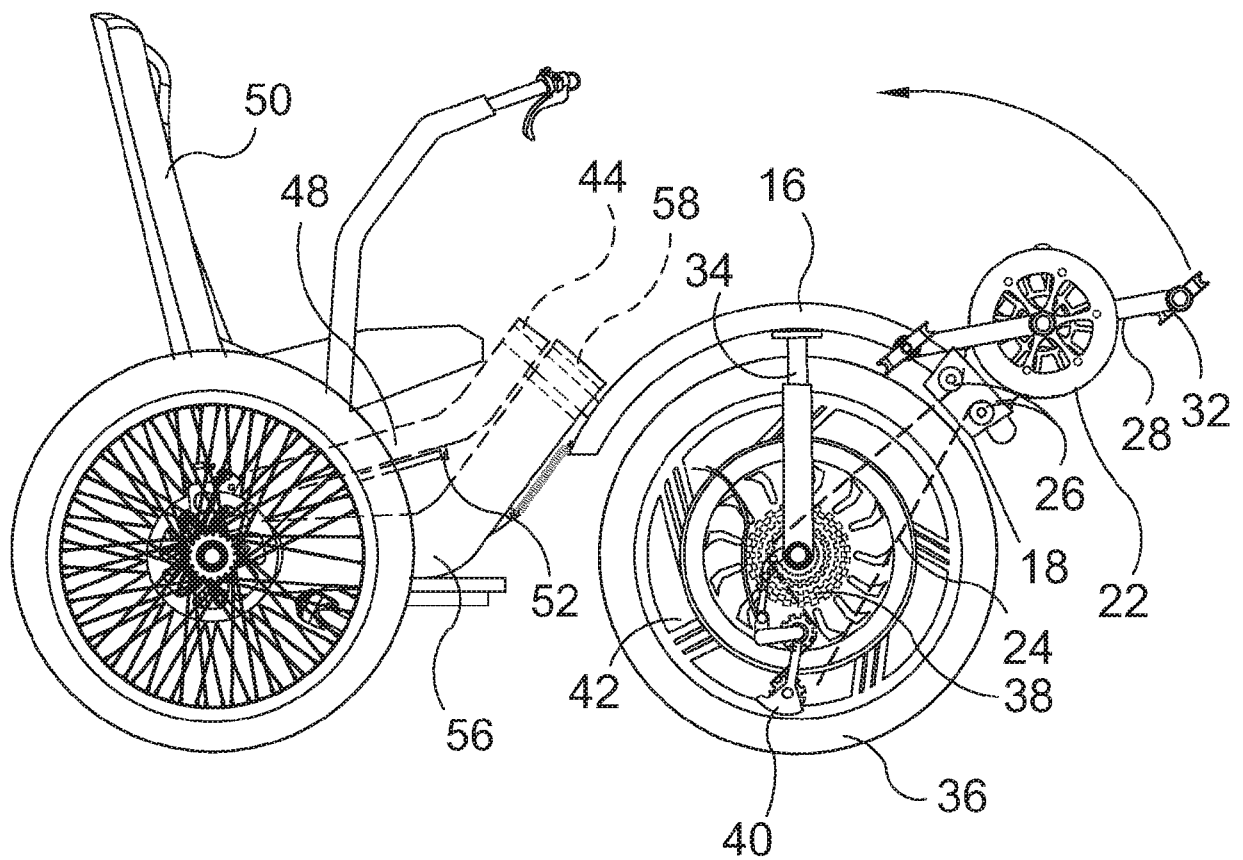
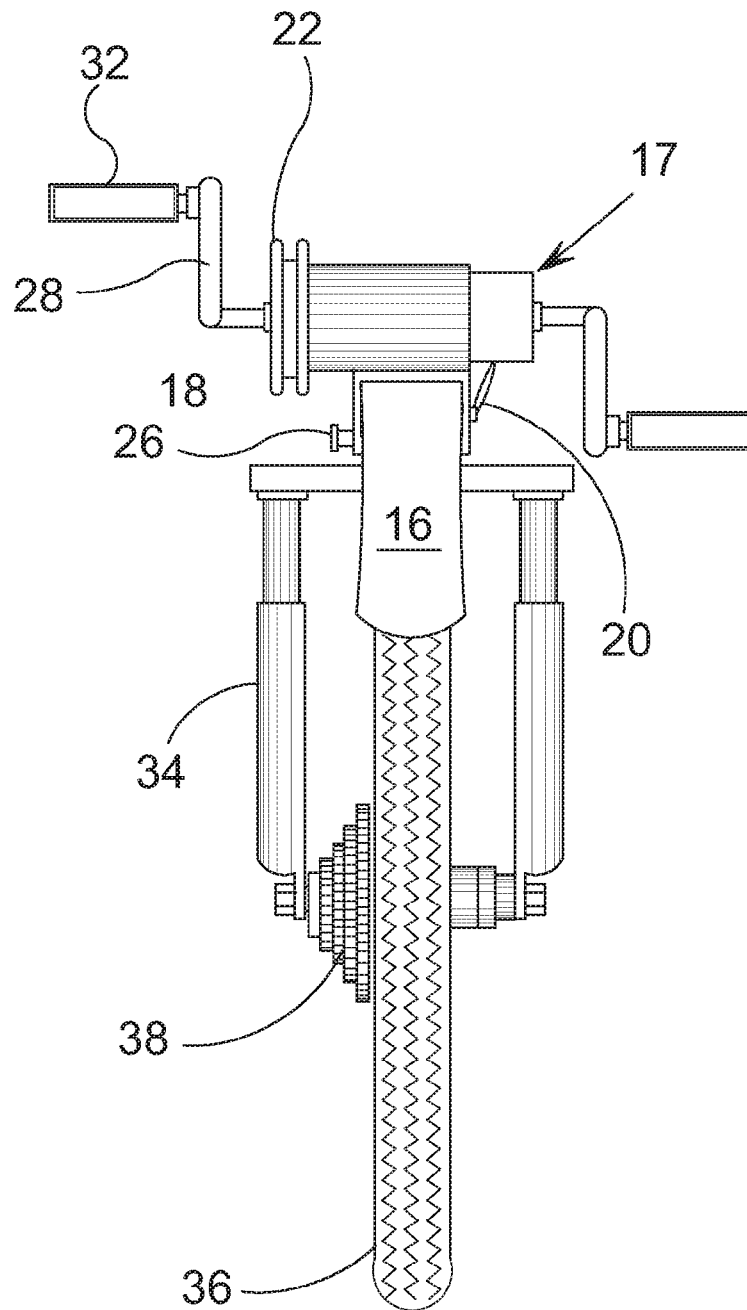


FIG. 17A

**FIG. 18**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/054959**A. CLASSIFICATION OF SUBJECT MATTER****B62K 15/00(2006.01)i, B62K 5/06(2006.01)i, B62M 1/36(2013.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B62K 15/00; B62K 5/04; B62M 1/02; B62M 1/36; B62K 5/02; B62K 5/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: tricycle, three wheel, foldable, collapsible, frame, sildable, pedal and axle

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2004-0090039 A1 (BOROCHOV et al.) 13 May 2004 See paragraphs [0066]-[0113] and figures 1-40.	1-15
A	US 2010-0237582 A1 (BELENKOV et al.) 23 September 2010 See paragraphs [0036]-[0068] and figures 1-18.	1-15
A	US 4789173 A (LOFGREN et al.) 06 December 1988 See column 2, line 25 - column 4, line 64 and figures 1-4.	1-15
A	KR 10-0790313 B1 (CHOI, JIN MAN) 02 January 2008 See paragraphs [0038]-[0050] and figures 1-8.	1-15
A	US 2013-0093157 A1 (BALL et al.) 18 April 2013 See paragraphs [0073]-[0231] and figures 1-21.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

22 November 2016 (22.11.2016)

Date of mailing of the international search report

22 November 2016 (22.11.2016)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

LEE, Jong Kyung

Telephone No. +82-42-481-3360



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/IB2016/054959

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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(71) Applicant: MOOV ELECTRIC VEHICLES [DE/DE];
Gröningerstr. 1, 39444 Hecklingen (DE).

(72) Inventor: DU TOIT, Arnold; Gröningerstr. 1, 39444 Hecklingen (DE).

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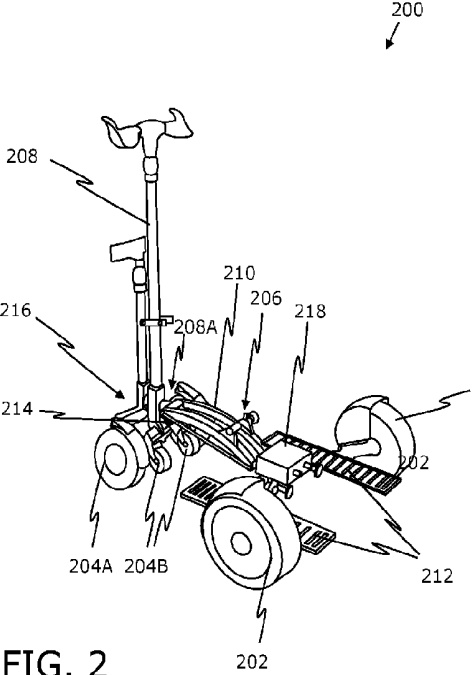


FIG. 2

(57) Abstract: Disclosed is a compact electric vehicle (200, 400, 500) comprising one set of rear wheels (202, 402, 502) configured to be rotated by one or more electric motors, a first set of front wheels (204A, 304A, 404A, 504A) and a second set of front wheels (204B, 304B, 404B, 504B); a steering column (208, 408, 508) with a single linkage steering mechanism (208A) for manoeuvring the compact electric vehicle (200, 300, 400, 500), wherein the steering column (208, 408, 508) is moveable to switch the vehicle (200, 300, 400, 500) between a first mode of operation and a second mode of operation; a frame (210, 410, 510) configured to connect the rear wheels (202, 402, 502) and the one or more electric motors with the first set of front wheels (204A, 304A, 404A, 504A) and the second set of front wheels (204B, 304B, 404B, 504B) and the single linkage steering mechanism (208A); wherein the steering column (208, 408, 508) is configured to be tiltable relative to the frame (210, 410, 510) to control, when in use, a direction of travel of the compact electric vehicle (200, 300, 400, 500); and comprising moreover a pivot mechanism configured to engage the first set of front wheels (204A, 304A, 404A, 504A) in the first mode of operation and to engage the second set of front wheels (204B, 304B, 404B, 504B) in the second mode of operation.

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COMPACT ELECTRIC VEHICLE HAVING A STEERING COLUMN WITH A SINGLE LINKAGE STEERING MECHANISM

TECHNICAL FIELD

The present disclosure relates to compact electric vehicles (EVs), and in particular to a multi-purpose stand-and-ride electric vehicle.

BACKGROUND

Electric vehicles (EVs) have gained significant prominence in different industries due to numerous advantages over conventional automobile vehicles. However, there are several technical challenges that still need to be addressed in the EVs (especially stand-and-ride electric vehicles or hoverboards), such as restricted functionality, instability, and the like. Typically, the conventional EVs are designed for a single purpose, limiting the corresponding adaptability for other uses. As a result, the load-carrying ability of the conventional EVs fails to meet the requirements of different users, which is not desirable. Furthermore, the conventional EVs suffer from issues of stability, versatility, manoeuvring, energy utilisation, and the like, particularly when transporting heavy loads over uneven terrain.

One of the crucial aspects related to EV manoeuvring is the ability of an operator to control the direction, the EV needs to be steered or manoeuvred with ease-of-use. However, the conventional EVs suffer from certain limitations in terms of manoeuvring. For example, the operator is restricted to adjust the position of the EV in accordance with specific driving conditions that do not lead the operator to drive the EV in the desired direction, which can cause safety and comfortability issues.

In addition, in certain unpredictable scenarios, the conventional EVs fail to move in the desired direction and as a result, the operator may get injured. Moreover, a new operator requires a significant amount of time and effort in order to learn how to turn left, right, stop, and accelerate the EV, which is not desirable. Furthermore, the conventional EVs are heavy in weight, which makes manoeuvring more difficult.

Therefore, in light of the foregoing discussion, there exists a need to overcome the aforementioned drawbacks.

SUMMARY

The aim of the present disclosure is to provide a compact electric vehicle having a steering column with a single linkage steering mechanism to ensure the safe, comfortable, and user-friendly manoeuvring of the compact electric vehicle with reduced

time and effort. The aim of the present disclosure is achieved by the compact electric vehicle as defined in the appended independent claims to which reference is made to. Advantageous features are set out in the appended dependent claims.

Throughout the description and claims of this specification, the words "comprise", "include", "have", and "contain" and variations of these words, for example, "comprising" and "comprises", mean "including but not limited to", and do not exclude other components, items, integers or steps not explicitly disclosed also to be present. Moreover, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of a schematic diagram that depicts a compact electric vehicle, in accordance with an embodiment of the present disclosure;

FIG. 2 is a perspective view of a compact electric vehicle, in accordance with an embodiment of the present disclosure;

FIG. 3 is an enlarged view two sets of front wheels, in accordance with an embodiment of the present disclosure;

FIG. 4A and 4B are perspective views of a compact electric vehicle, in accordance with an embodiment of the present disclosure; and

FIG. 5A, 5B and 5C, are perspective views of a compact electric vehicle, in accordance with another embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

The following detailed description illustrates embodiments of the present disclosure and ways in which they can be implemented. Although some modes of carrying out the present disclosure have been disclosed, those skilled in the art would recognize that other embodiments for carrying out or practising the present disclosure are also possible.

In a first aspect, the present disclosure provides a compact electric vehicle comprising:

- at least one set of rear wheels configured to be rotated in use by one or more electric motors;
- a first set of front wheels and a second set of front wheels;
- a steering column with a single linkage steering mechanism for manoeuvring the compact electric vehicle, wherein the steering column is moveable to switch the

vehicle between a first mode of operation and a second mode of operation;

- a frame configured to connect the rear wheels and the one or more electric motors with the first set of front wheels and the second set of front wheels and the single linkage steering mechanism;
- wherein the steering column is configured to be tiltable relative to the frame to control, when in use, a direction of travel of the compact electric vehicle; and comprising moreover
- a pivot mechanism configured to engage the first set of front wheels in the first mode of operation and to engage the second set of front wheels in the second mode of operation.

According to the first aspect of the present disclosure, the compact electric vehicle is a multi-purpose but compact electric vehicle, which has a capability to seamlessly transition between different modes, for example, a ride mode and a walk mode, catering to various use cases. Advantageously, the steering column with the single linkage steering mechanism allows for improved control and balance, even at high and low speeds and when carrying heavy loads. The steering column is moveable to switch the vehicle between different modes of operation, such as the first mode of operation (e.g., walk mode) and the second mode of operation (e.g., ride mode or storage mode). This improves the versatility of the compact electric vehicle. Additionally, the combination of following features, i.e., the single linkage steering mechanism of the steering column, the frame connected the rear wheels and the one or more electric motors with the front wheels and the single linkage steering mechanism, and the control of the direction of travel of the compact electric vehicle by tilting the steering column relative to the frame,

provides a synergistic effect of significantly improving the stability and control of the compact electric vehicle as compared to conventional electric vehicle (e.g., conventional stand-and-ride electric vehicle). By virtue of the aforementioned combination of features, it is experimentally observed that the control and balance is improved even when traversing uneven terrains while carrying load. Furthermore, the control of the direction of travel of the compact electric vehicle is simplified with significantly improved ease-of-use because such control can be done just by tilting the steering column relative to the frame irrespective of any mode of operation of the compact electric vehicle. The same compact vehicle may be used for different purposes with ease-of-use, for example, can be used as a stand-and-ride electric golf cart, where the mode of operation may be switched between ride and walk with smooth transition of modes. In another example, the compact electric vehicle can be used as a compact delivery vehicle with high manoeuvrability for last mile delivery. In yet another example, the compact electric vehicle may also be used as a warehouse transportation electric vehicle for moving goods not only indoors but also outdoors due to its capability to handle uneven terrain, versatility, and compact storage.

Throughout the present disclosure the term "electric vehicle" refers to a type of vehicle

that is propelled by electric motors (e.g., DC motors) by using electrical energy stored in rechargeable batteries. Moreover, the compact electric vehicle refers to a small-sized electric vehicle that is designed to enhance the manoeuvrability and versatility of the electric vehicle to allow the electric vehicle to move in congested areas easily. Furthermore, the compact electric vehicle has a compact form factor as compared to conventional electric vehicle and further is less heavy as compared to the conventional electric vehicles, which contributes to an improved energy efficiency and manoeuvrability in congested city streets and parking spaces. In an implementation, the compact electric vehicle is configured to be operated autonomously and remotely. In an implementation, the compact electric vehicle is configured to be operated autonomously. In such an implementation, the technical effect of operating the compact electric vehicle autonomously is that the compact electric vehicle can be used to navigate, make decisions, and execute manoeuvres, such as based on built-in sensors, algorithms, or artificial intelligence capabilities without affecting the scope of the present disclosure. Beneficially, as compared to conventional approaches, the compact electric vehicle can be operated without direct human intervention, allowing for increased convenience and efficiency. In another implementation, the compact electric vehicle is configured to be operated remotely. In such an implementation, the technical effect of operating the compact electric vehicle remotely is that the compact electric vehicle can be operated from a distance by a user or through a central control system, without affecting the scope of the present disclosure. Additionally, the ability of the compact electric vehicle to be operated remotely provides flexibility and convenience to the user. For example, the user can easily control and manage the different operations of the compact electric vehicle. As a result, the compact electric vehicle is configured to enhance the safety of the compact electric vehicle, such as by minimising the risk associated with mechanical as well as human error.

Throughout the present disclosure the term "set of wheels" typically refers to a pair of wheels. The at least one set of rear wheels are the pair of wheels that are located at the rear side of the compact electric vehicle. Moreover, the at least one set of rear wheels is configured to rotate, which enables the aforementioned compact electric vehicle to move in a forward direction. In addition, the at least one set of rear wheels is located at the rear side of the compact electric vehicle and must be behind the centre of gravity of the compact electric vehicle. The centre of gravity is the point at which the weight of the vehicle is evenly distributed. Herein, the compact electric vehicle includes at least one set of rear wheels. In an embodiment, the compact electric vehicle may comprise two sets of rear wheels. The at least one set of rear wheels is configured to be rotated in use by the one or more electric motors. The one or more electric motors are able to turn the at least one set of rear wheels, which will cause the compact electric vehicle to move in a forward direction. The term "electric motor" refers to the propulsion system of the compact electric vehicle that utilises motors for generating mechanical power and driving the at least one set of rear wheels. The one or more electric motors are configured to provide the required torque and rotational force to propel the compact electric vehicle. In particular, the one or more electric motors are operated based on the principle of electromagnetism by utilising the interaction between magnetic fields and

electric currents to generate the rotational motion. Firstly, an electric current flows through a wire coil placed within a magnetic field. Thereafter a force is produced that causes the coil to rotate, resulting in the mechanical working of the compact electric vehicle. Optionally, the one or more electric motors may be selected from at least one of: brushless DC (BLDC) motors, permanent magnet synchronous motors (PMSMs), induction motors and the like without affecting the scope of the present disclosure. Optionally, each of the one or more electric motors has a power rating of 2000 Watts. The power rating of each of the one or more electric motors determines the maximum power delivered by the corresponding electric motor during operation. Beneficially, each of the one or more electric motors in the compact electric vehicle having the power rating of 2000 Watts provides driving motion to the compact electric vehicle along with heavy loads on the load-carrying assembly. The technical effect of the 2000 Watts power rating of the one or more electric motors is to provide sufficient propulsion to effectively move on various terrains and carry out intended functions. Optionally, the compact electric vehicle is configured to excite the one or more electric motors with power in a range of 200 to 800 Watts, more optionally 500 Watts. During the operation of the compact electric vehicle, the power supplied by the one or more electric motors is adjusted between 200 to 800 Watts based on the load over the load-carrying assembly. In an implementation, the compact electric vehicle includes a control unit, which is configured to adjust the power supplied to the one or more electric motors according to the requirements of an application. The technical effect of the range of 200 to 800 Watts is to operate the compact electric vehicle within a specific energy consumption threshold, ensuring efficient use of electrical power. Beneficially, the one or more electric motors are configured to provide instant torque and smooth acceleration. In an embodiment, the one or more electric motors may utilise regenerative braking, where the motor acts as a generator to recover and store energy during deceleration, thus increasing the overall efficiency and range of the compact electric vehicle. Optionally, the at least one set of rear wheels may be mounted on a single axle or on multiple axles. In this regard, the at least one set of rear wheels of the compact electric vehicle can be attached to either the single axle or multiple axles. Notably, the axle is a structural component that connects and supports the wheels on either end. The axles may be used to distribute the weight and provide stability.

The compact electric vehicle includes at least two sets of front wheels. The at least two sets of front wheels improve traction and handling to provide an improved traction, enabling more power to be efficiently transferred to the road surface. Moreover, the at least two sets of front wheels enhance the acceleration, stability, and cornering capabilities, which allow the compact electric vehicle to handle challenging terrain (i.e., an uneven terrain) or demanding driving conditions with an improved controlling capability. Furthermore, the at least two sets of front wheels are also utilised to enhance braking performance and brake distribution thereby reducing stopping distance at higher speeds or during emergency braking situations. In an implementation, each set of wheels is independently driven by the one or more electric motors.

Optionally, the compact electric vehicle further includes one or more backup disc brakes

for enhancing the stopping performance of the compact electric vehicle. In an example, the one or more backup disc brakes are based on a hydraulic braking system. In an implementation, the one or more backup disc brakes include one or more braking callipers and one or more discs are arranged with each of the at least one set of rear wheels and the at least two sets of front wheels. Upon actuation of the one or more backup disc brakes, the one or more braking callipers apply pressure on corresponding discs to stop the compact electric vehicle. The technical effect of the one or more backup disc brakes is to provide a quick and reliable response through an efficient braking functionality. Further, the one or more backup disc brakes provide emergency stopping of the compact electric vehicle and enhance the stopping power of the compact electric vehicle. Advantageously, the at least two sets of front wheels allow the vehicle to have better manoeuvrability and stability, in tight turns and on slippery surfaces. Optionally, the at least two sets of front wheels include a first set of front wheels that is larger than a second set of front wheels. In this regard, the larger first set of front wheels provides an improved stability through an increased contact area of the compact electric vehicle with the road to provide better traction and grip, particularly during cornering and high-speed manoeuvres. The technical effect of larger wheels is that it allows for more lateral force to be exerted on the road surface, enhancing the ability of the compact electric vehicle to maintain control and stability while navigating curves or challenging driving conditions. Moreover, the larger first set of front wheels can enhance the braking performance of the compact electric vehicle. The increased contact patch between the larger wheels and the road improves the braking efficiency, allowing for better deceleration and shorter stopping distances. The at least two sets of front wheels help optimise weight distribution and balance. The larger first set of front wheels can carry a greater portion of the weight of the compact electric vehicle, contributing to a more balanced distribution between the axles.

Optionally, the compact electric vehicle further includes an electric drivetrain including an electronic differential enabling one or more sets of wheels to turn independently of each other, and an advanced electronic braking system to prevent abrupt stopping of the vehicle. For example, when the compact electric vehicle turns, the rear wheel positioned on the inner edge of the turn requires a lower magnitude of rotational motion compared to the rear wheel positioned on the outer edge of the turn. In such a scenario, the electronic differential provides more power to the electric motor connected to the rear wheel positioned at the outer edge of the turn than the electric motor connected to the rear wheel positioned at the inner edge of the turn. In an implementation, the advanced electronic braking system includes one or more sensors to detect the rotational motion of the at least two sets of front wheels and the at least one set of rear wheels, a microcontroller and braking actuators connected to each of the at least two sets of front wheels and the at least one set of rear wheels. The microcontroller directs the braking actuators to stop the at least two sets of front wheels and the at least one set of rear wheels based on the rotational speed measured by the one or more sensors. The technical effect of the electronic differential is to improve the manoeuvrability of the compact electric vehicle while driving over the turn. The technical effect of the advanced electronic braking system is to avoid slipping of the compact electric vehicle on the

application of brakes.

The compact electric vehicle includes the steering column with the single linkage steering mechanism for manoeuvring the compact electric vehicle. The steering column with the single linkage steering mechanism refers to a configuration in which the steering column is connected to the at least two sets of front wheels through a single linkage system. The steering column with the single linkage steering mechanism converts the user's input from the steering into a rotational movement of the at least two sets of front wheels, allowing for controlled steering and manoeuvring. The steering column serves as a connection between the steering handle and the steering mechanism. The steering handle is arranged centrally perpendicular to the steering column and provides a space for the user to operate and control the compact electric vehicle. The steering column consists of a shaft or tube that extends from the steering handle down through the compact electric vehicle and connects to the at least two sets of front wheels through a single set of linkages.

Furthermore, the steering column is movable to switch the vehicle between a first mode of operation and a second mode of operation. The single linkage mechanism can provide direct and responsive steering feedback, allowing for precise control over the compact electric vehicle direction. The steering column is moveable to switch the compact electric vehicle between the first mode of operation and the second mode of operation. Optionally, the first mode of operation is a riding mode, and the second mode of operation is a walking mode. Moreover, the first mode of operation and the second mode of operation allows the user to flexibly select the mode of operation based on specific needs and preferences. Typically, in the first mode of operation, the first set of front wheels from the at least two sets of front wheels are in direct contact with the ground and the second set of front wheels from the at least two sets of front wheels are not in direct contact with the ground. Moreover, the first mode of operation allows the user to ride the compact electric vehicle by standing on a platform (i.e., footplates as described below) provided to stand on the compact electric vehicle to move the user along with the compact electric vehicle in the forward direction. In particular, in the first mode of operation, the steering column is perpendicular to the ground. However, in the second mode of operation, the second set of front wheels from the at least two sets of front wheels are in contact with the ground and the first set of front wheels from the at least two sets of front wheels are not in contact with the ground. The first mode of operation allows the user to use the compact electric vehicle as a cart to allow the compact electric vehicle to lift heavyweights, such as to carry golf equipment or parcels for last-mile delivery. Thus, the technical effect of switching between the first mode of operation and the second mode of operation is that the compact electric vehicle provides an improved versatility to further allow smooth transitions between both the first mode of operation and the second mode of operation based on the user's requirements.

Optionally, the compact electric vehicle further comprises a load-carrying assembly configured to move independently of the steering column for enabling a weight distribution to be supported across the front wheels. The load carrying assembly

includes a supporting bar and a supporting plate arranged at an end of the supporting bar. When any goods are placed over the load carrying assembly, the goods are placed over the supporting plate and the supporting bar provides a vertical support to the goods. In an implementation, the supporting bar is adjustable along its height and the supporting plate is adjustable along its width to accommodate goods of varying dimensions, thereby providing versatility to the compact electric vehicle in terms of load carrying capacity.

Optionally, the compact electric vehicle further includes a modular spacer arrangement for a front axle of the at least two sets of front wheels to accommodate varying load sizes. The modular spacer arrangement in the front axle of the compact electric vehicle allows for the adjustment of the spacing between the at least two sets of front wheels. The technical effect of the modular spacer arrangement is to enable the compact electric vehicle to adapt to different sizes and loads, such as by accommodating variations in weight or dimensions.

Optionally, the compact electric vehicle has a load capacity of at least 500 kg.

In an example, the compact electric vehicle has a load capacity of 500 kg. In another example, the compact electric vehicle has a load capacity of 1000 kg. Similarly, the compact electric vehicle can have the load capacity of 1500 kg or more without affecting the scope of the present disclosure. As a result, the technical effect of storing the at least 500 kg in the compact electric vehicle is that the versatility and utility of the compact electric vehicle can be improved to meet the requirements of diverse industries and effectively address the challenges associated with transporting heavy loads. Beneficially, the single linkage steering mechanism is reliable and involves fewer components compared to more complex steering systems like rack and pinion.

Optionally, the compact electric vehicle is configured to be stored in a compact storage mode when not in use. For example, in the compact storage mode, the pair of footplates along with the at least one set of rear wheels are folded towards the steering column until the pair of footplates is in contact with the steering column. The technical effect of the compact storage mode is to offer the convenience of easy transportation by a user, allowing the compact electric vehicle to be carried effortlessly between different locations. Further, the compact storage mode ensures efficient utilisation of space when the compact electric vehicle is not in use.

Optionally, the compact electric vehicle is configured to fold into the compact storage mode by the steering column folding towards the at least one set of rear wheels. In other words, the steering column can be folded down in such a manner that the steering column is parallel to the ground. The technical effect of folding the compact electric vehicle into the compact storage mode is that the compact electric vehicle can be stored in small spaces and effortlessly transported when not in use.

Optionally, the compact electric vehicle further comprises a pivot mechanism configured to engage the first set of front wheels in the first mode of operation and to engage the second set of front wheels in the second mode of operation. In this regard, the pivot

mechanism is configured to switch the steering column in the first mode and second mode of operation. The term "pivot mechanism" refers to a mechanical system that enables rotational movement around a fixed point, known as a pivot or fulcrum. A technical effect of the pivot mechanism is that it allows the steering column to rotate or swing smoothly, either partially or completely. Typically, the pivot point or fulcrum acts as the central axis of rotation allowing the steering column to move freely in a rotational manner. Optionally, the pivot mechanism includes supporting structures, such as bearings or bushings, to reduce friction and enable smooth movement. The pivot mechanism includes a hinge where a pivot mechanism allows for smooth opening and closing motions. When the user pushes or pulls the hinge the steering column collapses and can be set by the user to the predefined position such as in the first mode and second mode. The user is configured to move the steering column from the first mode of operation to the second mode of operation by using the pivot mechanism and moving the steering column towards the at least one set of rear wheels.

The compact electric vehicle includes the frame. The frame is configured to connect the rear wheels and the one or more electric motors with the front wheels and the single linkage steering mechanism. The frame provides support, strength, and stability to the compact electric vehicle. The frame is configured to maintain the integrity of the compact electric vehicle and ensure efficient power transmission, weight distribution, and handling characteristics. Optionally, the frame is curved along part of its length. The frame acts as a connecting link between the at least two sets of front wheels and the at least one set of rear wheels. The technical effect of the curved structure of the frame is to provide increased bending stiffness due to curvature effect, thereby providing a rigid connection between the at least two sets of front wheels and the at least one set of rear wheels and preventing failure of the frame due to repeated switching between the first mode of operation and the second mode of operation.

Furthermore, the steering column is configured to be tiltable relative to the frame to control, when in use, a direction of travel of the compact electric vehicle. The steering column is connected with the at least two sets of front wheels to allow the user to steer and navigate the compact electric vehicle, such as through the steering column that is configured to be tiltable relative to the frame. Moreover, the steering column is configured to be tiltable relative to the frame to control the direction of the compact electric vehicle, such as by adjusting the direction of the steering column. In an implementation, the steering column is configured to be tiltable relative to the frame to control the direction of travel of the compact electric vehicle based on the direction in which the steering column is tilted, such as left, right, back and forth. In another implementation, the steering column is configured to be tiltable relative to the frame to control the direction of travel of the compact electric vehicle based on the degree of angle at which the steering column is tilted, such as 45-degrees, 90-degrees, and the like. For example, if the steering column is tilted towards the left side, then, then in that case, the compact electric vehicle is configured to move towards the left side, such as through the at least two sets of the front wheels. Similarly, if the steering column is tilted towards the right side, then, then in that case, the compact electric vehicle is configured

to move towards the right side, such as through the at least two sets of the front wheels.

Furthermore, the steering column is configured to be tiltable relative to the frame to control the direction of travel of the compact electric vehicle in different undesired scenarios, such as in uneven terrain, congested areas and the like. For example, if in any unforeseen situation, the user is required move or stop the compact electric vehicle quickly (e.g., in a sharp turn) in a fraction of time, then, in that case, the steering column is configured to turn the compact electric vehicle smoothly and safely without affecting the comfort level of the user. In addition, the steering column is also configured to allow the compact electric vehicle to turn precisely and accurately to prevent any undesired movement of the compact electric vehicle even if the compact electric vehicle is moving at a high speed. In an implementation, the degree of turn of the compact electric vehicle depends directly on the degree of turn of the steering column. Therefore, the steering column improves the stability, control and balance of the user, even at high or low speeds or when carrying heavy loads, or in the uneven terrain or congested spaces with an improved manoeuvrability.

Optionally, the steering column is configured to be tiltable relative to the frame to control, when in use, the power provided to excite the one or more electric motors. In other words, the steering column is configured to control the power that is delivered by the one or more electric motors that can be further used to control the movement of the compact electric vehicle. In an implementation, the tilt mechanism can be operated manually or automatically. Moreover, the steering column is configured to monitor the speed (or the movement) of the compact electric vehicle and the amount of torque that is required to turn the at least one set of rear wheels. The technical effect of controlling the power that is provided to excite the one or more electric motors is to ensure that the compact electric vehicle is operating at its most efficient speed that improves the overall efficiency and the performance of the compact electric vehicle. In addition, the steering column that is configured to be tiltable relative to the frame to control the power provided to excite the one or more electric motors enables the compact electric vehicle to operate in uneven terrains, congested areas, and the like.

Optionally, the compact electric vehicle further includes a pair of footplates positioned below an axle level and towards a front region of the rear wheels, to reduce a height of a centre of gravity of the vehicle when ridden by a user, for increasing stability of the compact electric vehicle when in use. In an example, the pair of footplates are flat surfaces on which the user can stand while riding the compact electric vehicle. In the first mode of operation, the plane of the pair of footplates is parallel to the ground and in the second mode of operation, the plane of the pair of footplates is at an angle lesser than 90-degrees from the ground.

Optionally, the compact electric vehicle further includes a torsion bar, linked to the steering column. Moreover, the torsion bar is configured to articulate the footplates such that the user remains in balance when the compact electric vehicle is traversing an uneven terrain. The torsion bar is a type of mechanical component used to provide resistance to torsional or twisting forces generated during passage of the vehicle over

uneven terrain. The torsion bar includes a first end and a second end. The first end of the torsion bar is connected with the at least two sets of front wheels and the second end of the torsion bar is connected with the at least one set of rear wheels. The torsion bar possesses a substantial torsional stiffness, which sustains torsional loads while steering and traversing over the uneven terrain. Further, the torsion bar supports the substantial loads on the compact electric vehicle (due to rider and/or goods) while maintaining balance of the user while riding the compact electric vehicle.

Typically, at least one set of rear wheels is typically mounted on an axle that is attached to the frame. The frame provides a foundation for the axle, allowing it to withstand the forces and torque generated by the one or more electric motors. By securely connecting the at least one set of rear wheels to the frame, the frame ensures that power from the one or more electric motors is efficiently transmitted thereto, enabling propulsion and movement of the compact electric vehicle.

The one or more electric motors are arranged on the frame. The one or more electric motors are strategically positioned within the frame to optimise weight distribution and maximise performance. The frame must provide adequate support and mounting points for the one or more electric motors, ensuring their stability and alignment. Optionally, the one or more electric motors are attached to the frame using mounting brackets and fasteners. The at least two sets of front wheels are attached to the frame through the mounting brackets and fasteners. The frame provides the structural support to withstand the forces encountered during steering, braking, and acceleration and helps to maintain the alignment and stability of the at least two sets of front wheels, allowing for precise steering control and responsive handling. Furthermore, the frame ensures that the weight of the compact electric vehicle is properly distributed between the at least one set of rear wheels and at least two sets of front wheels. Optionally, the frame is fabricated from different materials such as steel, aluminium, or carbon fibre composites and the like.

Optionally, the compact electric vehicle is configurable for carrying golf equipment in a golf course. In other words, the compact electric vehicle provides load-carrying capacity that enables the compact electric vehicle to carry a full set of golf clubs, golf balls, and other golf equipment. As a result, the technical effect of carrying the golf equipment in the golf course is that the compact electric vehicle is used to provide an improved user experience as well as easy transportation of the golf equipment. Optionally, the compact electric vehicle is configured for carrying parcels for implementing last-mile delivery. In an implementation, the last-mile delivery refers to a final stage of the delivery process in which goods are transported from a distribution centre or a local hub to their ultimate destination such as a residential or a commercial address. Moreover, the compact electric vehicle that is configured for last-mile delivery can be used to drive in congested areas. Therefore, the technical effect of carrying parcels for implementing last-mile delivery by the compact electric vehicle is to provide time-efficient and cost-effective delivery of the parcels.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to FIG. 1, illustrated is a schematic diagram that depicts a compact electric vehicle, in accordance with an embodiment of the present disclosure. As shown in FIG 1, the compact electric vehicle **100** includes the at least one set of rear wheels, such as a first rear wheel **104A** and a second rear wheel **104B** that are configured to be rotated in use by one or more electric motors. In an example, the first rear wheel **104A** is configured to be rotated by using the corresponding electric motor. Furthermore, the compact electric vehicle **100** includes the at least two sets of front wheels, such as a first front wheel **102A** and a second front wheel **102B**. It will be appreciated that the compact electric vehicle **100** that is shown in the FIG.1 includes one set of front wheels, such as the first front wheel **102A** and the second front wheel **102B**, for easy reference. However, the compact electric vehicle **100** includes at least two sets of front wheels as further shown and described in detail in FIG.2. Furthermore, the compact electric vehicle **100** includes a steering column **106** with a single linkage steering mechanism for manoeuvring the compact electric vehicle **100**. The steering column **106** is moveable to switch the vehicle between a first mode of operation (i.e., a riding mode) and a second mode (i.e., a walking mode) of operation. The steering column **106** is connected with the at least two sets of front wheels, such as the first front wheel **102A** and the second front wheel **102B** to allow the user to steer and navigate the compact electric vehicle **100**, such as through the steering column **106** that is configured to be tiltable relative to a frame **108**. Furthermore, the compact electric vehicle **100** includes the frame **108** that is configured to connect the rear wheels and the one or more electric motors with the front wheels and the single linkage steering mechanism. For example, the compact electric vehicle **100** includes the frame **108** that is configured to connect the first rear wheel **104A** and the corresponding electric motor with the first front wheel **102A** and the single linkage steering mechanism. Similarly, the compact electric vehicle **100** includes the frame **108** that is configured to connect the second rear wheel **104B** and the corresponding electric motor with the second front wheel **102B** and the single linkage steering mechanism. Furthermore, the steering column **106** is configured to be tiltable relative to the frame **108** to control the direction of travel of the compact electric vehicle **100**. In an exemplary scenario, if the steering column **106** is tilted towards left side **P1** as shown in FIG. 1, then, in that case, the compact electric vehicle **100** is configured to move towards the left side **D1**. Similarly, if the steering column is tilted towards right side **P2**, then, then in that case, the compact electric vehicle **100** is configured to move towards the right side **D2**, such as through the at least two set of the front wheels (i.e., the first front wheel **102A** and the second front wheel **102B**). Therefore, the steering column improves the stability, control and balance of the user, even at high or low speeds or when carrying heavy loads, or in the uneven terrain or congested spaces with an improved manoeuvrability.

Referring to FIG. 2, illustrated is a perspective view of a compact electric vehicle **200**, in accordance with an embodiment of the present disclosure. The compact electric vehicle **200** comprises at least one set of rear wheels **202** configured to be rotated in use by one or more electric motors. The compact electric vehicle **200** includes at least two sets

of front wheels: a first set of front wheels **204A** and a second set of front wheels **204B**. The at least two sets of front wheels **204A**, **204B** are arranged to rotate in conjunction with the at least one set of rear wheels **202**. The compact electric vehicle **200** also includes a pivot mechanism **206** configured to engage the first set of front wheels **204A** from at least two sets of front wheels **204A**, **204B** in the first mode of operation. The compact electric vehicle **200** includes a steering column **208** with a single linkage steering mechanism for manoeuvring the compact electric vehicle **200**.

The compact electric vehicle **200** includes a frame **210** configured to connect the at least one set of rear wheels **202** and the one or more electric motors with at least two sets of front wheels **204A**, **204B** and the single linkage steering mechanism **208A**. The compact electric vehicle **200** also includes a pair of footplates **212** positioned below an axle level (not shown) and towards a front region of the at least one set of rear wheels **202**, to keep reduce a height of a centre of gravity of the vehicle when ridden by a user, for increasing stability of the vehicle when in use. The compact electric vehicle **200** is a stand and ride electric vehicle that can enable the user to a stand-and-ride the compact electric vehicle **200**. The compact electric vehicle **200** also includes a torsion bar **214**, linked to the steering column. The compact electric vehicle **200** also includes a load-carrying assembly **216** configured to move independently of the steering column **208** for enabling a weight distribution to be supported across at least two sets of front wheels **204A**, **204B**. The compact electric vehicle **200** also includes an electric drivetrain including an electronic differential **218** enabling one or more sets of wheels to turn independently of each other.

Referring to FIG. 3, illustrated is an enlarged view of two sets of front wheels, in accordance with an embodiment of the present disclosure. As shown, the at least two sets of front wheels include a first set of front wheels **304A** that is larger than a second set of front wheels **304B**. The single linkage steering mechanism (as shown in FIG. 2) is connected with the first set of front wheels **304A** and the second set of front wheels **304B** such that when the steering column is configured to be tiltable relative to the frame it in conjunction moves the two sets of front wheels **304A**, **304B**. During the riding mode, the second set of front wheels **304B** will not be in contact with the surface. During the walking mode, the first set of front wheels **304A** will not be in contact with the surface.

Referring to FIG. 4A and 4B, illustrated are perspective views of compact electric vehicle **400**, in accordance with an embodiment of the present disclosure. As shown in FIG. 4A, the compact electric vehicle **400** is in first mode of operation. The first mode of operation is a riding mode in which the user is operable to ride the compact electric vehicle **400**. The compact electric vehicle **400** comprises at least one set of rear wheels **402** configured to be rotated in use by one or more electric motors (not shown). The one or more electric motors is configured to power the at least one set of rear wheels **402** to drive the compact electric vehicle **400**.

The compact electric vehicle **400** includes at least two sets of front wheels: a first set of front wheels **404A** and a second set of front wheels **404B**. The at least two sets of front

wheels **404A**, **404B** are arranged to rotate in conjunction with the at least one set of rear wheels **402**. The at least two sets of front wheels **404A**, **404B** include a first set of front wheels **404A** that is larger than a second set of front wheels **404B**. As shown in FIG. 4A, the compact electric vehicle **400** also includes a pivot mechanism **406** configured to engage the first set of front wheels **404A** from at least two sets of front wheels **404A**, **404B** in the first mode of operation. The compact electric vehicle **400** includes a steering column **408** with a single linkage steering mechanism for manoeuvring the compact electric vehicle **400**.

The compact electric vehicle **400** includes a frame **410** configured to connect the at least one set of rear wheels **402** and the one or more electric motors with at least two sets of front wheels **404A**, **404B** and the single linkage steering mechanism. The frame **410** is a structural framework that provides support, stability and forms the basic structure.

As shown, the frame **410** is curved along part of its length. The compact electric vehicle **400** also includes a pair of footplates **412** positioned below an axle level (not shown) and towards a front region of the at least one set of rear wheels **402**, to keep reduce a height of a centre of gravity of the vehicle when ridden by a user, for increasing stability of the vehicle when in use. The pair of footplates **412** provides two flat surfaces designed for the placement of the user feet in the compact electric vehicle **400**. The compact electric vehicle **400** also includes a torsion bar **414**, linked to the steering column. The torsion bar **414** is configured to articulate the footplates **412** such that the user remains in balance when the company electric vehicle is traversing an uneven terrain.

The compact electric vehicle **400** also includes a load-carrying assembly **416** configured to move independently of the steering column **408** for enabling a weight distribution to be supported across at least two sets of front wheels **404A**, **404B**. The compact electric vehicle **400** also includes an electric drivetrain including an electronic differential **418** enabling one or more sets of wheels to turn independently of each other, and an advanced electronic braking system to prevent abrupt stopping of the vehicle.

As shown in FIG. 4B, the compact electric vehicle **400** is in second mode of operation. The second mode of operation is a walking mode in which the user is operable to move the compact electric vehicle **400** without riding thereon. The steering column **408** is moveable to switch the compact electric vehicle **400** between the first mode of operation and the second mode of operation. In the second mode of operation the compact electric vehicle **400** is configurable for carrying golf equipment in a golf course or for carrying parcels for implementing last-mile delivery.

Referring to FIG. 5A, 5B and 5C illustrated are perspective views of compact electric vehicle **500**, in accordance with another of the present disclosure. As shown in FIG. 5A, the compact electric vehicle **500** is in first mode of operation. The first mode of operation is a riding mode in which the user is operable to ride the compact electric vehicle **500**. The compact electric vehicle **500** comprises at least one set of rear wheels

502 configured to be rotated in use by one or more electric motors (not shown). The one or more electric motors is configured to power the at least one set of rear wheels **502** to drive the compact electric vehicle **500**.

The compact electric vehicle **500** includes at least two sets of front wheels **504A**, **504B**. The at least two sets of front wheels: a first set of front wheels **504A** and a second set of front wheels **504B** are arranged to rotate in conjunction with the at least one set of rear wheels **502**. The at least two sets of front wheels **504A**, **504B** include a first set of front wheels **504A** that is larger than a second set of front wheels **504B**. As shown in FIG. 4A, the compact electric vehicle **500** also includes a pivot mechanism **506** configured to engage the first set of front wheels **504A** from at least two sets of front wheels **504A**, **504B** in the first mode of operation. The compact electric vehicle **500** includes a steering column **508** with a single linkage steering mechanism for manoeuvring the compact electric vehicle **500**.

The compact electric vehicle **500** includes a frame **410** configured to connect the at least one set of rear wheels **502** and the one or more electric motors with at least two sets of front wheels **504A**, **504B** and the single linkage steering mechanism. The frame **510** is a structural framework that provides support, stability and forms the basic structure. As shown, the frame **510** is curved along part of its length. The compact electric vehicle **500** also includes a pair of footplates **512** positioned below an axle level (not shown) and towards a front region of the at least one set of rear wheels **502**, to keep reduce a height of a centre of gravity of the vehicle when ridden by a user, for increasing stability of the vehicle when in use. The pair of footplates **512** provides two flat surfaces designed for the placement of the user feet in the compact electric vehicle **500**. The compact electric vehicle **500** also includes a torsion bar **514**, linked to the steering column. The torsion bar **514** is configured to articulate the footplates **512** such that the user remains in balance when the compact electric vehicle is traversing an uneven terrain.

The compact electric vehicle **500** also includes a load-carrying assembly **516** configured to move independently of the steering column **508** for enabling a weight distribution to be supported across at least two sets of front wheels **504A**, **504B**. The compact electric vehicle **500** also includes an electric drivetrain including an electronic differential **518** enabling one or more sets of wheels to turn independently of each other, and an advanced electronic braking system to prevent abrupt stopping of the vehicle.

As shown in FIG. 5B, the compact electric vehicle **500** is in second mode of operation. The second mode of operation is a walking mode in which the user is operable to move the compact electric vehicle **500** without riding thereon. A load **520** is placed on the load-carrying assembly **516**. The steering column **508** is moveable to switch the compact electric vehicle **500** between the first mode of operation and the second mode of operation. In second mode of operation the compact electric vehicle **500** is configurable for carrying golf equipment in a golf course or for carrying parcels for implementing last-mile delivery. As shown in FIG. 5C, the compact electric vehicle **500** is configured to be stored in a compact storage mode when not in use. In the compact

storage mode by the steering column **508** folding towards the at least one set of rear wheels **502**.

CLAIMS

1. A compact electric vehicle (200, 300, 400, 500), comprising:

at least one set of rear wheels (202, 402, 502) configured to be rotated in use by one or more electric motors;

a first set of front wheels (204A, 304A, 404A, 504A) and a second set of front wheels (204B, 304B, 404B, 504B);

a steering column (208, 408, 508) with a single linkage steering mechanism (208A) for manoeuvring the compact electric vehicle (200, 300, 400, 500), wherein the steering column (208, 408, 508) is moveable to switch the vehicle (200, 300, 400, 500) between a first mode of operation and a second mode of operation;

a frame (210, 410, 510) configured to connect the rear wheels (202, 402, 502) and the one or more electric motors with the first set of front wheels (204A, 304A, 404A, 504A) and the second set of front wheels (204B, 304B, 404B, 504B) and the single linkage steering mechanism (208A);

wherein the steering column (208, 408, 508) is configured to be tiltable relative to the frame (210, 410, 510) to control, when in use, a direction of travel of the compact electric vehicle (200, 300, 400, 500); and comprising moreover

a pivot mechanism configured to engage the first set of front wheels (204A, 304A, 404A, 504A) in the first mode of operation and to engage the second set of front wheels (204B, 304B, 404B, 504B) in the second mode of operation.

2. The compact electric vehicle (200, 300, 400, 500) of claim 1, wherein the steering column (208, 408, 508) is configured to be tiltable relative to the frame (210, 410, 510) to control, when in use, power provided to excite the one or more electric motors.

3. The compact electric vehicle (200, 300, 400, 500) of claim 1 or 2, wherein the frame (210, 410) is curved along part of its length.

4. The compact electric vehicle (200, 300, 400, 500) of claim 1, 2 or 3, wherein the first set of front wheels (204A, 304A, 404A, 504A) is larger than the second set of front wheels (204B, 304B, 404B, 504B).

5. The compact electric vehicle (200, 300, 400, 500) of claim 1, 2, 3 or 4, further comprising a pair of footplates positioned below an axle level and towards a front region of the rear wheels, to reduce a height of a centre of gravity of the vehicle when ridden by a user, for increasing stability of the compact electric vehicle (200, 300, 400, 500) when in use.

6. The compact electric vehicle (200, 300, 400, 500) of claim 5, further comprising a torsion bar, linked to the steering column (208, 408, 508), wherein the torsion bar is

configured to articulate the footplates such that user remains in balance when the compact electric vehicle (200, 300, 400, 500) is traversing an uneven terrain.

7. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, further comprising a load-carrying assembly configured to move independently of the steering column (208, 408, 508) for enabling a weight distribution to be supported across the first set of front wheels (204A, 304A, 404A, 504A) and the second set of front wheels (204B, 304B, 404B, 504B).

8. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, wherein each of the one or more electric motors has a power rating of 2000 Watts.

9. The compact electric vehicle (200, 300, 400, 500) of claim 8, wherein, in use, the compact electric vehicle (200, 300, 400, 500) is configured to excite the one or more electric motors with power in a range of 200 to 800 Watts.

10. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, further comprising an electric drivetrain including an electronic differential enabling one or more sets of wheels to turn independently of each other, and an advanced electronic braking system to prevent abrupt stopping of the compact electric vehicle (200, 300, 400, 500).

11. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, further comprising a modular spacer arrangement for a front axle of the first set of front wheels (204A, 304A, 404A, 504A) the second set of front wheels (204B, 304B, 404B, 504B) to accommodate varying load sizes.

12. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, further comprising one or more backup disc brakes for enhancing a stopping performance of the compact electric vehicle (200, 400, 500).

13. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, wherein the compact electric vehicle (200, 300, 400, 500) is configured to be stored in a compact storage mode when not in use.

14. The compact electric vehicle (200, 300, 400, 500) of claim 13, wherein the compact electric vehicle (200, 300, 400, 500) is configured to fold into the compact storage mode by the steering column (208, 408, 508) folding towards the at least one set of rear wheels (202, 402, 502).

15. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, wherein the first mode of operation is a riding mode, and the second mode of operation is a walking mode.

16. The compact electric vehicle (200, 400, 500) of any preceding claim, wherein the compact electric vehicle (200, 400, 500) is configured to be operated autonomously and remotely.

17. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, wherein the compact electric vehicle (200, 400, 500) has a load capacity of at least 500 kg.

18. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, wherein the compact electric vehicle (200, 300, 400, 500) is configurable for carrying golf equipment in a golf course.

19. The compact electric vehicle (200, 300, 400, 500) of any preceding claim, wherein the compact electric vehicle (200, 300, 400, 500) is configured for carrying parcels for implementing last-mile delivery.

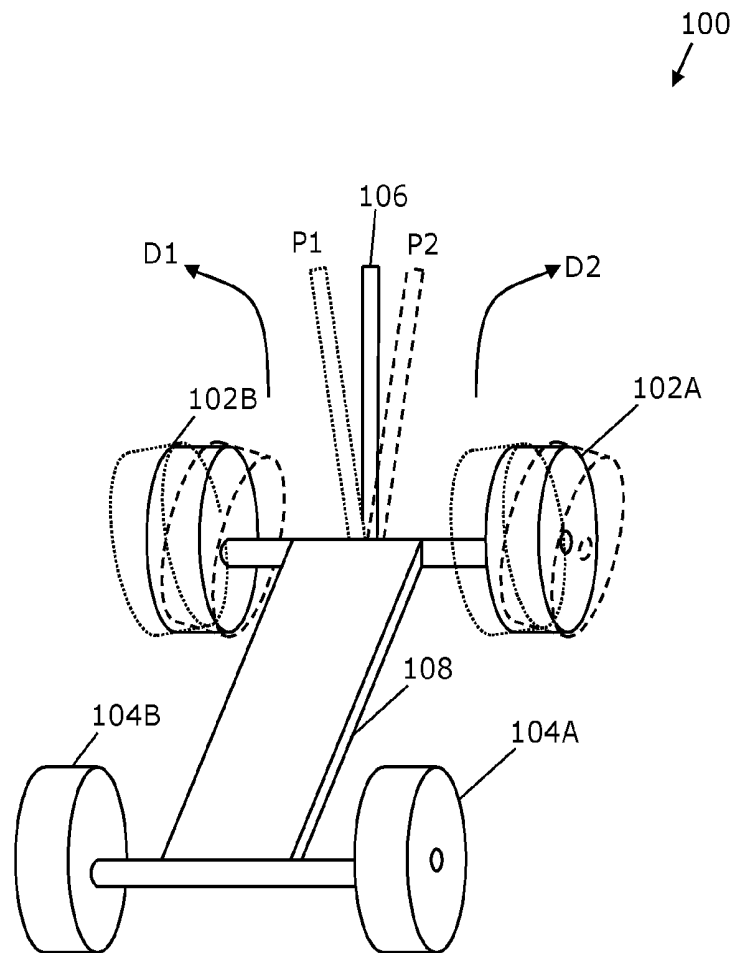


FIG. 1

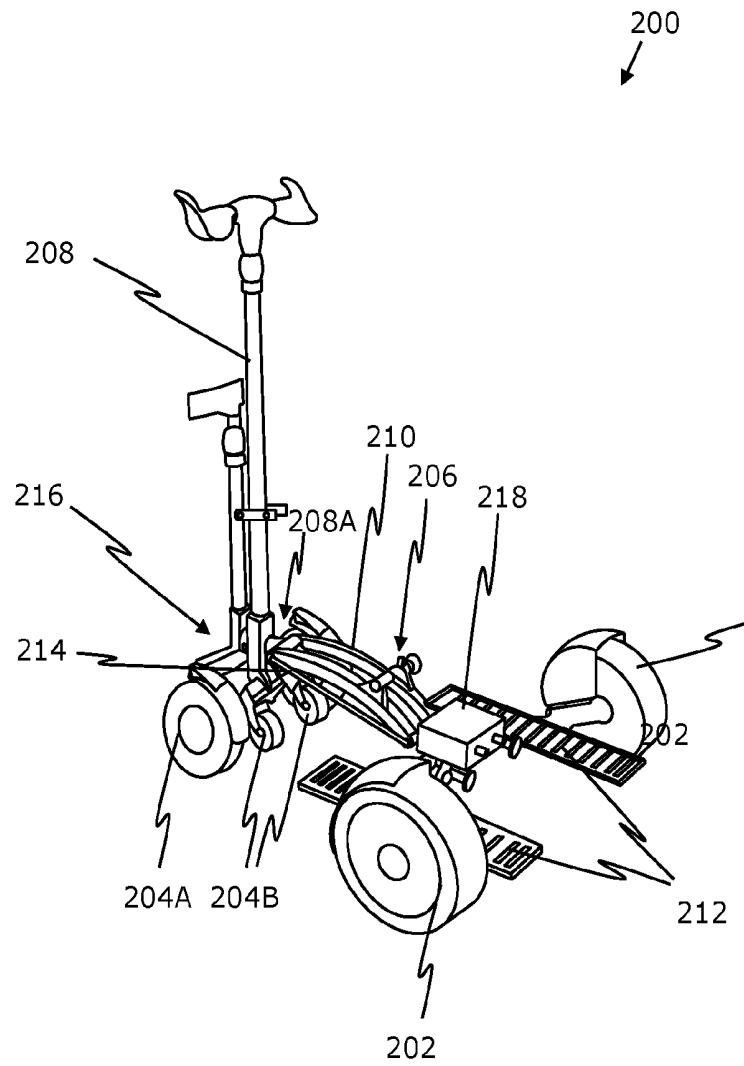


FIG. 2

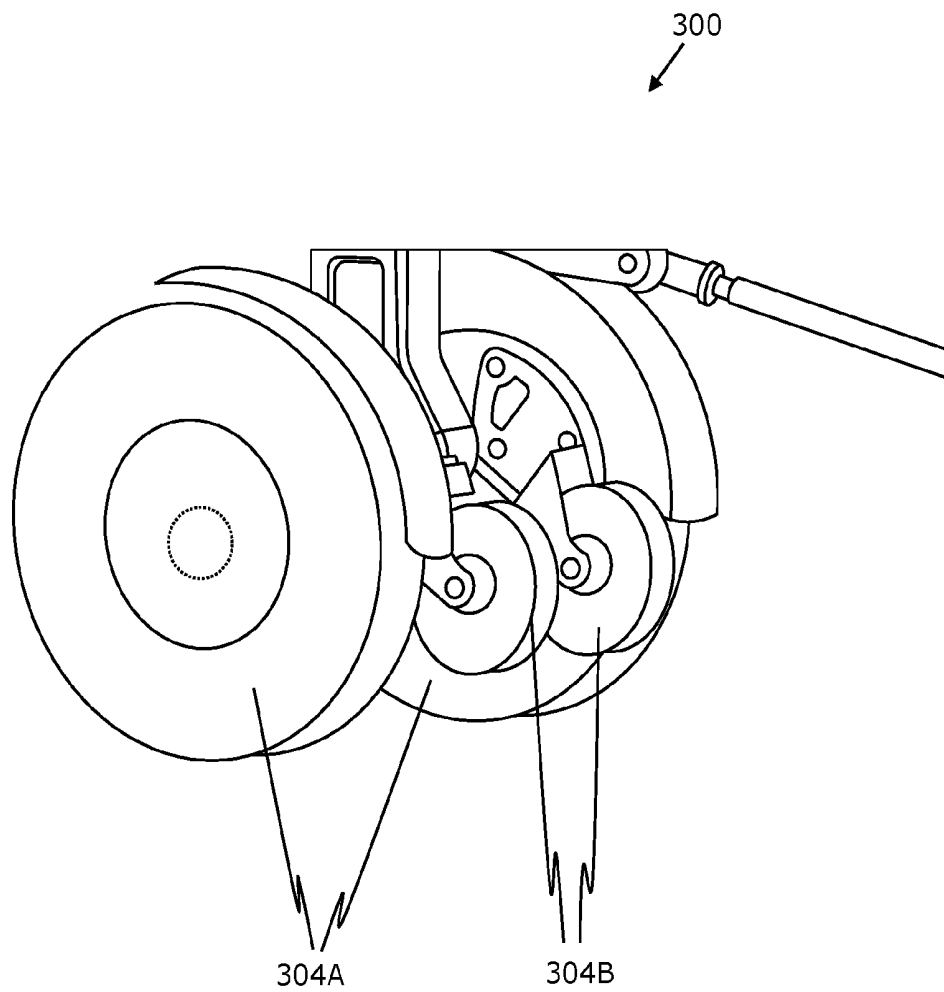


FIG. 3

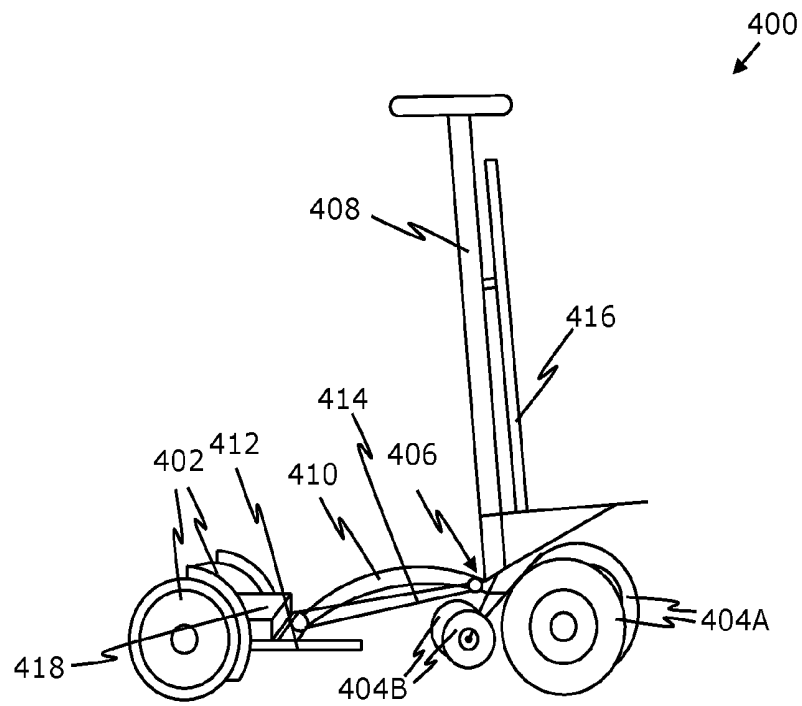


FIG. 4A

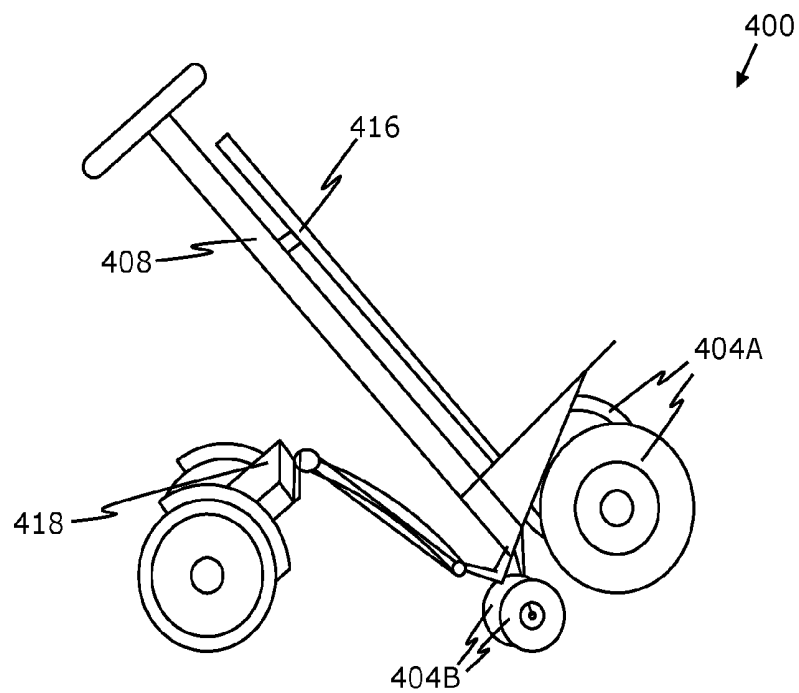


FIG. 4B

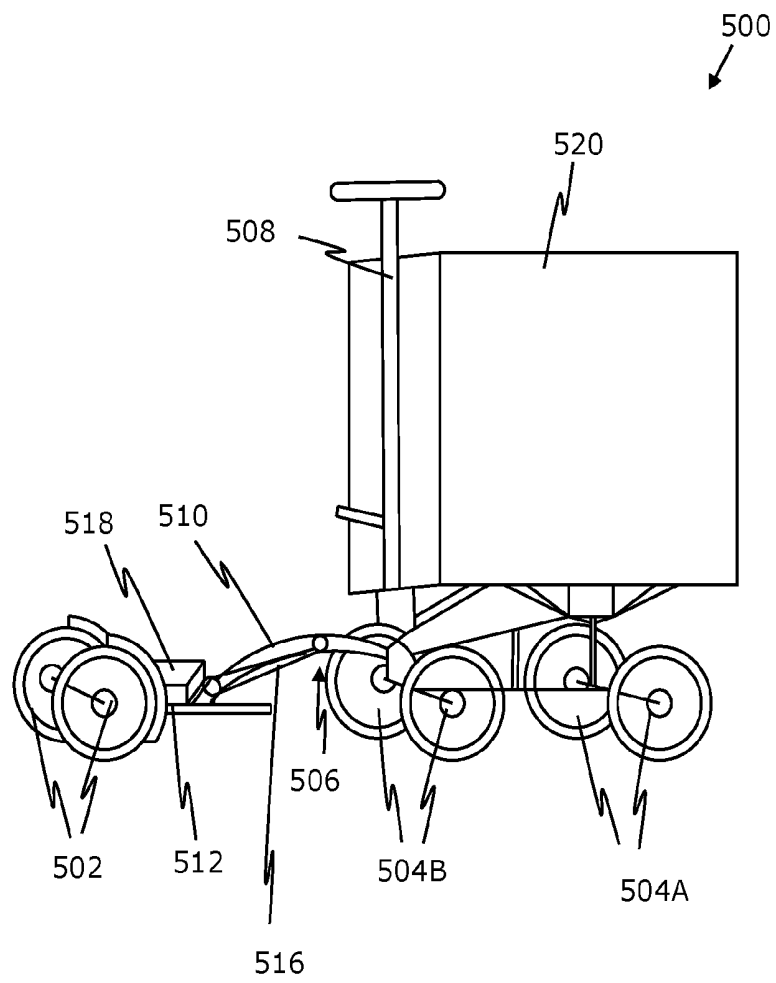


FIG. 5A

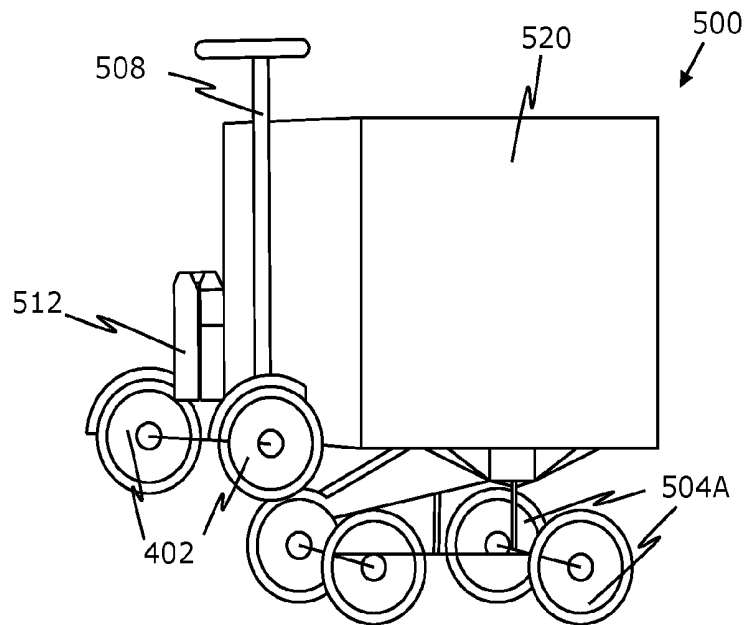


FIG. 5B

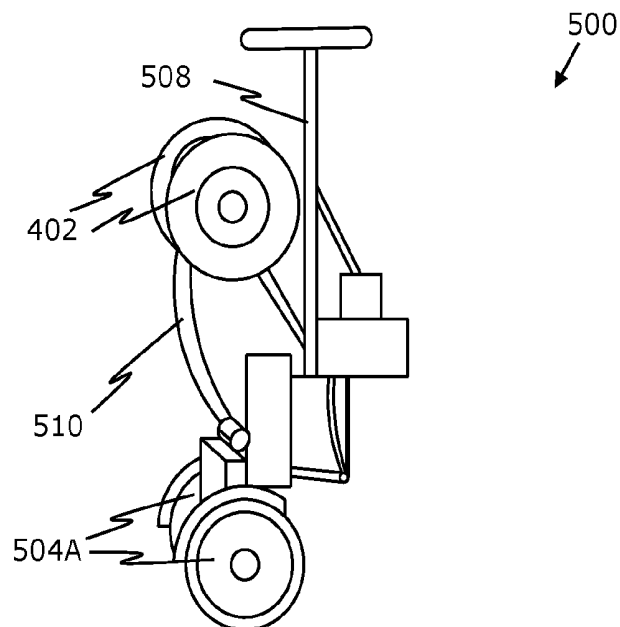


FIG. 5C

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2024/055269

A. CLASSIFICATION OF SUBJECT MATTER

INV. B62K5/08 B62K5/01 B62K13/00 B62K15/00 B62K3/00
B62K21/00 B62K23/02 B62J7/06 B62J25/04 A63B55/60
B62B3/00 B62B3/02 B62B5/00 B62B5/08 B62D9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B62J A63B B62D B62B B62K B60L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014/125021 A1 (DU TOIT ARNOLD [GB]) 8 May 2014 (2014-05-08) the whole document -----	1-19
A	US 2012/118657 A1 (LIAO GORDON [TW]) 17 May 2012 (2012-05-17) the whole document -----	1-19
A	US 2022/266105 A1 (ROSZHART TIMOTHY J [US]) 25 August 2022 (2022-08-25) the whole document -----	1-19
A	KR 101 516 744 B1 (JOEN CO LTD [KR]) 4 May 2015 (2015-05-04) figures 1-4 ----- - / - -	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

3 September 2024

Date of mailing of the international search report

23/09/2024

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Truchot, Alexandre

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/055269

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 962 106 A (BURNSIDE WALTER M ET AL) 29 November 1960 (1960-11-29) the whole document -----	1-19
A	CN 108 382 426 A (GUO HAO) 10 August 2018 (2018-08-10) figures 1,2 -----	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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US 2962106 A	29-11-1960	NONE	
CN 108382426 A	10-08-2018	NONE	



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(71) 申请人 下一代汽车(河北)有限公司

地址 056004 河北省邯郸市丛台区丛台路
495号中道大厦商业208号

(72) 发明人 请求不公布姓名 请求不公布姓名
请求不公布姓名

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B62J 27/00 (2020.01)

B62H 1/12 (2006.01)

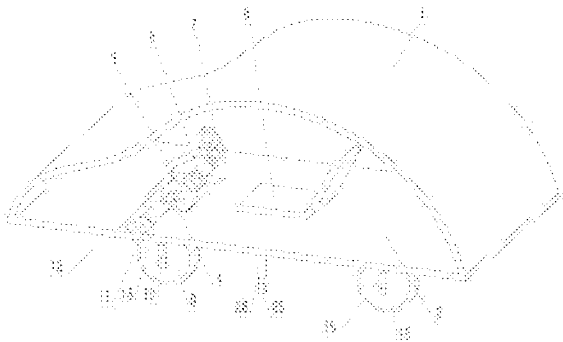
权利要求书1页 说明书7页 附图4页

(54) 发明名称

一种自平衡车辆

(57) 摘要

本发明公开了一种自平衡车辆,涉及交通工具技术领域,包括底盘和平衡结构;所述底盘上固定安装有水平仪;所述平衡结构固定安装在所述底盘内,所述平衡结构通过所述水平仪的倾角进行调节。不采用传统的机械陀螺仪保持平衡,避免了机械陀螺仪带来的潜在人身威胁和能量消耗,本申请采用电机带动前轮或后轮左右移动来保持车辆运动时的平衡,安全性高的同时降低能耗。车辆安装水平仪,可实时测试车辆运动时的倾斜角度,给控制电机信号,使移动轮与车辆倾斜状态联动,使车辆保持平衡。在静止或低速运动时,使用辅助结构保持平衡,实现了车辆全时全状态下的稳定平衡。



1. 一种自平衡车辆,其特征在于,包括底盘(2)和平衡结构;所述底盘(2)上固定安装有水平仪(3);所述平衡结构固定安装在所述底盘(2)内,所述平衡结构通过所述水平仪(3)的倾角进行调节;所述底盘(2)下方安装有前轮(9)和后轮(15);所述平衡结构可控制移动轮进行沿底盘(2)的宽度方向进行移动。

2. 根据权利要求1中所述的自平衡车辆,其特征在于:所述移动轮为前轮(9),所述平衡结构包括驱动结构和连接杆(6);所述连接杆(6)的下方安装有前轮(9);所述连接杆(6)远离所述前轮(9)的一端固定安装有方向盘(7),方向盘(7)与前轮(9)为软连接,所述连接杆(6)可传递转动,不影响左右移动。

3. 根据权利要求2中所述的自平衡车辆,其特征在于:所述连接杆(6)采用扭矩传递软管,方向盘(7)与前轮(9)为软连接,可传递转动,不影响左右移动;方向盘(7)与所述扭矩传递软管同步转动实现前轮(9)的转动控制。

4. 根据权利要求2中所述的自平衡车辆,其特征在于:所述方向盘(7)与前轮(9)之间设置有线控EPS系统;方向盘(7)通过所述线控EPS系统实现对车辆的方向控制。

5. 根据权利要求2中所述的自平衡车辆,其特征在于:所述底盘(2)下方固定安装有第二连接臂(16),所述第二连接臂(16)的下方安装有后轮(15)。

6. 根据权利要求1中所述的自平衡车辆,其特征在于:所述移动轮为后轮(15),所述前轮(9)负责转向。

7. 根据权利要求6中所述的自平衡车辆,其特征在于:所述底盘(2)上活动安装有连接杆(6),所述连接杆(6)的下方固定安装有第一连接臂(10),所述第一连接臂(10)的下方安装有前轮(9);所述连接杆(6)远离所述前轮(9)的一端固定安装有方向盘(7),所述方向盘(7)的转动带动所述前轮(9)进行转动。

8. 根据权利要求6中所述的自平衡车辆,其特征在于:所述底盘(2)上安装有第二安装座(19);所述第二安装座(19)安装在所述底盘(2)对应所述后轮(15)的位置;所述第一安装座(13)和第二安装座(19)分别设置为两个;两个所述第二安装座(19)之间设置有第二通槽(17);所述第二安装座(19)为中空结构;

所述平衡结构包括驱动结构,所述驱动结构包括第二丝杠(20),所述第二丝杠(20)的两侧分别可转动得插接在两个所述第二安装座(19)内部;所述第二丝杠(20)的一端安装有第二电机(18);所述第二电机(18)的工作带动所述第二丝杠(20)进行转动;所述第二丝杠(20)上活动安装有第二安装块(14)。

9. 根据权利要求8中所述的自平衡车辆,其特征在于:所述第二安装块(14)下方固定安装有第二连接臂(16),所述第二连接臂(16)的下方安装有后轮(15)。

10. 根据权利要求1-9任一项所述的自平衡车辆,其特征在于:所述车辆底部安装有辅助结构。

一种自平衡车辆

技术领域

[0001] 本发明涉及交通工具技术领域,具体而言,尤其涉及一种自平衡车辆。

背景技术

[0002] 中国市场每年汽车产销三千万余辆,全球每年汽车产销近亿辆,其中大量车辆为四轮车辆;随着四轮车辆数量的增加,给城市市政建设提出挑战,然而在城市中,车辆往往作为代步工具使用,形成了大量资源浪费。

[0003] 经过大量调研发现,作为代步工具来说,二轮车辆相较于四轮车辆具有大量优势:

二轮车辆的重心在直线,四轮车辆重心在平面上,二轮车辆天生稳定性优于传统四轮车辆,所有二轮车辆在行驶中均存在微小的左右摆动,这种动态调整通过产生向心力抵消重心偏移。实验表明,即使以直线行驶时,车把仍会通过高频抖动实现动态平衡。当车体发生倾斜时,前轮会自然向倾斜方向偏转,通过调整行进轨迹使重心回归支撑面,而四轮车辆不具有上述优势。

[0004] 同时,二轮全封闭车体和传统四轮车体相比,在发生碰撞或翻滚时,由于受力面减半,车体刚性大幅提升,车体不易变形,乘员更加安全。

[0005] 另外,在驾驶过程中,驾驶员的视野更开阔,特别是右侧视野。

[0006] 电动二轮车辆可以使用轮毂电机来驱动,电动四轮汽车如果使用轮毂电机来驱动,则会遇到四轮协同配合技术难题,轮毂电机可以省去传动部分,系统更加简单但是效率会更高。并且操作更加灵活,反应更灵敏,更加有驾驶乐趣。

[0007] 其次,占用空间小,二轮车辆的全封闭车体和传统四轮车辆的车体相比,占地面积缩小约占50%,相同的道路可以容纳更多的车辆,对解决交通拥堵有重要意义,同时相同的停车位可以容纳更多的车辆,对解决停车难问题有重要意义。

[0008] 四轮车辆存在严重的空间浪费常态化问题:5座车型日均使用中,单车单人出行比例超50%,整车空间利用率不足20%。即便满载场景仅占全年出行频次的15%以下。这使得四轮车辆存在能耗效率倒置问题:单人驾驶状态下,5座车每百公里需消耗1.2吨金属框架的无效运力,能量转换效率比满载时低42%。

[0009] 同时二轮车辆缓解城市配套失衡问题:单车单人出行模式使停车位日均使用时长压缩至1.5小时,但每个标准车位仍持续占用10m²城市用地资源。高峰期单车道路资源承载效率仅为设计载荷的20%。

[0010] 因此,基于大量优势,二轮车辆亟需发展。然而中国的二轮车辆目前局限于电动自行车和摩托车,随着而来的就是电动自行车和摩托车的安全问题,由于电动自行车和摩托车使用者的身体置于车辆上方,当车辆倾倒,会使得使用者的身体置于危险环境,因此研究如何使二轮车辆保持平衡迫在眉睫;

福特上世纪60年代研发过两轮汽车,2012年,美国加州的LitMotors公司研发一款代号为C-1的全封闭两轮“不倒翁”电动车,在中国只有北京凌云智能科技有限公司2016年-2019年二轮概念车发布。

[0011] 然而上述诸多公司提出的二轮概念汽车为封闭结构,封闭结构驾驶员无法感知车辆平衡状态,无法像自行车一样通过车把转动可保持平衡,一般采用安装机械陀螺仪来保持平衡,但机械陀螺仪存在致命的缺陷,其中一个高速的机械陀螺仪转子对乘客来说是一个巨大的安全隐患,因机械陀螺仪在使用过程中转速调试(高达每分钟上万转),极易导致导致内部结构炸裂,飞溅金属块,产生严重后果。同时机械陀螺仪工作时,一部分能量消耗在机械陀螺仪转子上,机械陀螺仪在保持两轮车移动时,其依靠大型机械陀螺仪维持平衡,为维持机械陀螺仪高速旋转,需配合大功率发动机进行驱动,使得机械陀螺仪保持的两轮车辆存在巨大的弊端。

[0012] 综上所述,故现在迫切需要一种不使用机械陀螺仪的自平衡车辆,用来解决上述问题。

发明内容

[0013] 针对现有技术的不足,本发明提供了一种自平衡车辆,解决两轮车辆无法感知车辆平衡状态,难以控制平衡以及兼顾使用安全的技术问题。

[0014] 本发明提出了一种自平衡车辆,包括底盘和平衡结构;所述底盘上固定安装有水平仪;所述平衡结构固定安装在所述底盘内,所述平衡结构通过所述水平仪的倾角进行调节。

[0015] 所述底盘下方安装有前轮和后轮;所述平衡结构可控制所述前轮或后轮进行沿底盘的宽度方向进行移动。

[0016] 作为本发明一种优选的实施方式,所述底盘上安装有第一安装座;所述第一安装座安装在所述底盘对应所述前轮的位置;所述第一安装座和第二安装座分别设置为两个;两个所述第一安装座之间设置有第一通槽;所述第一安装座为中空结构;

所述平衡结构包括驱动结构和连接杆,所述驱动结构包括第一丝杠,所述第一丝杠的两侧分别可转动得插接在两个所述第一安装座内部;所述第一丝杠的一端安装有第一电机;所述第一电机的工作带动所述第一丝杠进行转动;所述第一丝杠上活动安装第一安装块。

[0017] 所述第一安装块上活动安装有连接杆,所述连接杆的下方固定安装有第一连接臂,所述第一连接臂的下方安装有前轮;所述连接杆远离所述前轮的一端固定安装有方向盘,所述方向盘的转动带动所述前轮进行转动,所述底盘下方固定安装有第二连接臂,所述第二连接臂的下方安装有后轮。

[0018] 作为本发明一种优选的实施方式,移动轮为前轮时,所述连接杆采用扭矩传递软管,扭矩传递软管(Torque Transmission Hose)是一种用于传递旋转动力的特殊软管,在机械系统中替代刚性轴实现柔性扭矩传输,尤其适用于需要弯曲、扭转或振动的复杂工况环境)或线控EPS系统;方向盘与所述扭矩传递软管同步转动实现前轮的转动控制,同时扭矩传递软管不影响所述第一电机控制第一安装块的移动不影响;当所述水平仪检测到车辆向一侧倾倒,根据倾倒角度,所述第一电机驱动所述前轮向倾倒方向移动,进而调整车辆恢复平衡。

[0019] 作为本发明一种优选的实施方式,移动轮为前轮时,所述方向盘与前轮之间设置有线控EPS系统;方向盘通过所述线控EPS系统实现前轮的转动控制,同时线控EPS不影响所

述第一电机控制第一安装块的移动不影响;当所述水平仪检测到车辆向一侧倾倒,根据倾倒角度,所述第一电机驱动所述前轮向倾倒方向移动,进而调整车辆恢复平衡。

[0020] 作为本发明一种优选的实施方式,所述底盘上安装有第二安装座;所述第二安装座安装在所述底盘对应所述后轮的位置;所述第一安装座和第二安装座分别设置为两个;两个所述第二安装座之间设置有第二通槽;所述第二安装座为中空结构;

所述平衡结构包括驱动结构,所述驱动结构包括第二丝杠,所述第二丝杠的两侧分别可转动得插接在两个所述第二安装座内部;所述第二丝杠的一端安装有第二电机;所述第二电机的工作带动所述第二丝杠进行转动;所述第二丝杠上活动安装有第二安装块。

[0021] 所述底盘上活动安装有连接杆,所述连接杆的下方固定安装有第一连接臂,所述第一连接臂的下方安装有前轮;所述连接杆远离所述前轮的一端固定安装有方向盘,所述方向盘的转动带动所述前轮进行转动。

[0022] 所述第二安装块下方固定安装有第二连接臂,所述第二连接臂的下方安装有后轮。

[0023] 作为本发明一种优选的实施方式,所述底盘顶部的中央设置固定安装有座椅,所述座椅设置在后轮的上方。

[0024] 作为本发明一种优选的实施方式,所述水平仪水平状态下,所述前轮和后轮设置在车辆轴对称面上。

[0025] 作为本发明一种优选的实施方式,移动轮为后轮时,方向盘控制转向角度;当所述水平仪检测到车辆向一侧倾倒,根据倾倒角度,所述第二电机驱动所述后轮向倾倒方向移动,进而调整车辆恢复平衡。

[0026] 作为本发明一种优选的实施方式,所述车辆底部安装有辅助结构;所述辅助结构包括固定块和支撑轮,所述支撑轮可进行收起和放下动作。

[0027] 作为本发明一种优选的实施方式,所述支撑轮的收起和放下动作为圆周式;所述固定块固定安装在所述底盘的底部,所述固定块的一端安装有第三电机,所述第三电机的输出端固定连接控制杆,所述控制杆沿所述固定块的轴向插接入所述固定块,所述控制杆上固定安装有两个支撑腿;两个所述支撑腿沿车辆轴对称面对称设置;所述支撑腿在所述第三电机作用下进行转动,所述支撑腿远离所述控制杆的一端固定连接支撑轮。

[0028] 作为本发明一种优选的实施方式,所述支撑轮的收起和放下动作为垂直伸缩;所述固定块固定安装在所述底盘的底部,所述固定块的下方固定安装有沿车辆轴对称面对称分布的伸缩杆,所述伸缩杆下方安装有支撑轮。

[0029] 作为本发明一种优选的实施方式,所述支撑轮的控制模式为:当车辆速度低于倾倒速度或静止时,支撑轮进行放下动作,当车辆正常行驶时,支撑轮进行收起动作。

[0030] 作为本发明一种优选的实施方式,所述车体为全封闭式,所述底盘上方安装有车体。

[0031] 与现有技术相比,本申请的技术方案具备以下有益效果:

本发明所展示的自平衡车辆,不采用传统的机械陀螺仪控制平衡,避免了机械陀螺仪带来的潜在人身威胁和能量消耗,本申请采用电机带动前轮或后轮左右移动来保持车辆运动时的平衡,安全性高的同时降低能耗。车辆安装水平仪,可实时测试车辆运动时的倾斜角度,给控制电机信号,使移动轮与车辆倾斜状态联动,使车辆保持平衡。在静止或低速

运动时,使用辅助结构保持平衡,实现了车辆全时全状态下的稳定平衡。

[0032] 同时本发明提供两种自平衡车辆,分别具备不同调节平衡方式:左右移动轮是前轮时,方向盘与前轮为可传递扭矩的软连接,可传递转动,不影响左右移动;左右移动轮为后轮,那前轮负责转向,方向盘与车轮不需要软连接,设置两种模式,满足不同使用环境和适用人群,适应性强。

附图说明

[0033] 图1为本发明一种自平衡车辆中实施例一的立体结构示意图;
图2为本发明一种自平衡车辆中实施例一的正视结构示意图;
图3为本发明一种自平衡车辆中实施例一的仰视结构示意图;
图4为本发明一种自平衡车辆中实施例二的立体结构示意图;
图5为本发明一种自平衡车辆中实施例二的正视结构示意图;
图6为本发明一种自平衡车辆中实施例三的正视结构示意图;
图7为本发明一种自平衡车辆中实施例三的仰视结构示意图。

[0034] 图中:1、车体;2、底盘;3、水平仪;4、第一丝杠;5、第一安装块;6、连接杆;7、方向盘;8、座椅;9、前轮;10、第一连接臂;11、第一电机;12、第一通槽;13、第一安装座;14、第二安装块;15、后轮;16、第二连接臂;17、第二通槽;18、第二电机;19、第二安装座;20、第二丝杠;21、第三电机;22、固定块;23、控制杆;24、连接腿;25、支撑轮;26、伸缩杆。

具体实施方式

[0035] 首先要指出,在不同描述的实施方式中,相同部件设有相同的附图标记或者说相同的构件名称,其中,在整个说明书中包含的公开内容能够按意义转用到具有相同的附图标记或者说相同的构件名称的相同部件上。在说明书中所选择的位置说明、例如上、下、侧向等等也参考直接描述的以及示出的附图并且在位置改变时按意义转用到新的位置上。

实施例一

[0036] 一种自平衡车辆,包括底盘2和平衡结构;不采用传统的机械陀螺仪保持平衡,避免了机械陀螺仪带来的潜在人身威胁和能量消耗,本申请采用第一电机11带动前轮9左右移动来保持车辆运动时的平衡,安全性高的同时降低能耗。

[0037] 如图3所示,所述底盘2上固定安装有水平仪3;所述平衡结构固定安装在所述底盘2内,所述平衡结构通过所述水平仪3的倾角进行调节;车辆安装水平仪3,可实时测试车辆运动时的倾斜角度,给控制电机信号,使移动轮与车辆倾斜状态联动,使车辆保持平衡。

[0038] 如图3所示,所述底盘2下方安装有前轮9和后轮15;所述平衡结构可控制所述前轮9进行沿底盘2的宽度方向进行移动。

[0039] 如图3所示,所述底盘2上安装有第一安装座13;所述第一安装座13安装在所述底盘2对应所述前轮9的位置;所述第一安装座13和第二安装座19分别设置为两个;两个所述第一安装座13之间设置有第一通槽12;所述第一安装座13为中空结构;

如图3所示,所述平衡结构包括驱动结构和连接杆6,所述驱动结构包括第一丝杠4,所述第一丝杠4的两侧分别可转动得插接在两个所述第一安装座13内部;所述第一丝杠4的一端安装有第一电机11;所述第一电机11的工作带动所述第一丝杠4进行转动;所述第一

丝杠4上活动安装第一安装块5。

[0040] 如图2所示,所述第一安装块5上活动安装有连接杆6,所述连接杆6的下方固定安装有第一连接臂10,所述第一连接臂10的下方安装有前轮9;所述连接杆6远离所述前轮9的一端固定安装有方向盘7,所述方向盘7的转动带动所述前轮9进行转动,所述底盘2下方固定安装有第二连接臂16,所述第二连接臂16的下方安装有后轮15。

[0041] 优选的,车辆可设置左右倾斜角度为正负15度,实时成比例对应可移动车轮左右移动正负15CM。

[0042] 优选的,当使用过程中,自平衡车辆的移动轮为前轮9,所述连接杆6采用扭矩传递软管,方向盘7与前轮9为软连接,原理同燃气管连接,可传递转动,不影响左右移动;方向盘7与所述扭矩传递软管同步转动实现前轮9的转动控制;当所述水平仪3检测到车辆向左侧倾倒15度时,所述第一电机11驱动所述前轮9向左移动15CM;当所述水平仪3检测到车辆向右侧倾倒15度时,所述第一电机11驱动所述前轮9向右移动15CM;如果车辆恢复平衡,则第一电机11驱动所述前轮9至中间位置。

[0043] 值得一提的是,扭矩传递软管(Torque Transmission Hose)是一种用于传递旋转动力的特殊软管,在机械系统中替代刚性轴实现柔性扭矩传输,尤其适用于需要弯曲、扭转或振动的复杂工况环境),其为现有技术,在此就不一一赘述;

优选的,所述自平衡车辆的移动轮为前轮9,所述方向盘7与前轮9之间设置有线控EPS系统;方向盘7通过所述线控EPS系统实现前轮9的转动控制,当所述水平仪3检测到车辆向左侧倾倒15度时,所述第一电机11驱动所述前轮9向左移动15CM;当所述水平仪3检测到车辆向右侧倾倒15度时,所述第一电机11驱动所述前轮9向右移动15CM;如果车辆恢复平衡,则第一电机11驱动所述前轮9至中间位置。

[0044] 值得一提的是,线控EPS系统,又称电动助力转向系统,是一种直接依靠电机提供辅助扭矩的动力转向系统。EPS主要由扭矩传感器、车速传感器、电动机、减速机构和电子控制单元(ECU)等组成,其为现有技术,在此就不一一赘述;

如图2所示,所述底盘2顶部的中央设置固定安装有座椅8,所述座椅8设置在后轮15的上方。

[0045] 如图3所示,所述水平仪3水平状态下,所述前轮9和后轮15设置在车辆轴对称面上。

[0046] 如图2所示,所述车辆底部安装有辅助结构;在静止或低速运动时,使用辅助结构保持平衡,实现了车辆全时全状态下的稳定平衡。

[0047] 所述辅助结构包括固定块22和支撑轮25,所述支撑轮25可进行收起和放下动作。

[0048] 如图3所示,所述支撑轮25的收起和放下动作为垂直伸缩;所述固定块22固定安装在所述底盘2的底部,所述固定块22的下方固定安装有沿车辆轴对称面对称分布的伸缩杆26,所述伸缩杆26下方安装有支撑轮25。

[0049] 在静止或低速运动时,使用辅助结构保持平衡,实现了车辆全时全状态下的稳定平衡。辅助结构使用状态时,所述支撑轮25可根据车辆速度和状态进行收起和放下动作:当车辆速度低于倾倒速度或静止时,支撑轮25进行放下动作,当车辆正常行驶时,支撑轮25进行收起动作。

[0050] 如图2所示,所述底盘2上方安装有车体1,优选的,所述车体1为全封闭式。

[0051] 同时自平衡车辆实现低碳节能:传统汽车能源主要消耗车轮转动摩擦上,汽车由4个车轮减少为两个车轮,并且二轮汽车可以做到极端轻量化,汽车能源消耗降低60%左右。

实施例二

[0052] 一种自平衡车辆,包括底盘2和平衡结构;与实施例一不同的是,采用第二电机18带动后轮15左右移动来保持车辆运动时的平衡,不采用传统的机械陀螺仪保持平衡,避免了机械陀螺仪带来的潜在人身威胁和能量消耗,安全性高的同时降低能耗。

[0053] 如图4所示,所述底盘2上安装有第二安装座19;所述第二安装座19安装在所述底盘2对应所述后轮15的位置;所述第一安装座13和第二安装座19分别设置为两个;两个所述第二安装座19之间设置有第二通槽17;所述第二安装座19为中空结构;

如图4所示,所述平衡结构包括驱动结构,所述驱动结构包括第二丝杠20,所述第二丝杠20的两侧分别可转动得插接在两个所述第二安装座19内部;所述第二丝杠20的一端安装有第二电机18;所述第二电机18的工作带动所述第二丝杠20进行转动;所述第二丝杠20上活动安装有第二安装块14。

[0054] 如图5所示,所述底盘2上活动安装有连接杆6,所述连接杆6的下方固定安装有第一连接臂10,所述第一连接臂10的下方安装有前轮9;所述连接杆6远离所述前轮9的一端固定安装有方向盘7,所述方向盘7的转动带动所述前轮9进行转动。

[0055] 如图5所示,所述第二安装块14下方固定安装有第二连接臂16,所述第二连接臂16的下方安装有后轮15。

[0056] 左右移动轮为后轮15,那前轮9负责转向,方向盘7与车轮不需要软连接;所述连接杆6采用不锈钢管;当所述水平仪3检测到车辆向左侧倾倒10度时,所述第二电机18驱动所述后轮15向左移动10CM;当所述水平仪3检测到车辆向右侧倾倒10度时,所述第二电机18驱动所述后轮15向右移动10CM;如果车辆恢复平衡,则第一电机11驱动所述前轮9至中间位置。

实施例三

[0057] 一种自平衡车辆,与实施例一不同的是,如图6-图7所示,所述支撑轮25的收起和放下动作为圆周式;所述固定块22固定安装在所述底盘2的底部,所述固定块22的一端安装有第三电机21,所述第三电机21的输出端固定连接控制杆23,所述控制杆23沿所述固定块22的轴向插接入所述固定块22,所述控制杆23上固定安装有两个支撑腿;两个所述支撑腿沿车辆轴对称面对称设置;所述支撑腿在所述第三电机21作用下进行转动,所述支撑腿远离所述控制杆23的一端固定连接有支撑轮25。

[0058] 需要说明的是,本发明的控制方式是通过控制器来自动控制,控制器的控制电路通过本领域的技术人员简单编程即可实现,电源的提供和前轮9、后轮15的驱动方式也属于本领域的公知常识,并且本发明主要用来保护机械装置,所以本发明不再详细解释控制方式和电路连接。

[0059] 需要说明的是,在本文中,诸如第一和第二等之类的关系术语仅仅用来将一个实体或者操作与另一个实体或操作区分开来,而不一定要求或者暗示这些实体或操作之间存在任何这种实际的关系或者顺序。而且,术语“包括”、“包含”或者其任何其他变体意在涵盖非排他性的包含,从而使得包括一系列要素的过程、方法、物品或者设备不仅包括那些要素,而且还包括没有明确列出的其他要素,或者是还包括为这种过程、方法、物品或者设备

所固有的要素。在没有更多限制的情况下,由语句“包括一个……”限定的要素,并不排除在包括所述要素的过程、方法、物品或者设备中还存在另外的相同要素。

[0060] 尽管已经示出和描述了本发明的实施例,对于本领域的普通技术人员而言,可以理解在不脱离本发明的原理和精神的情况下可以对这些实施例进行多种变化、修改、替换和变型,本发明的范围由所附权利要求及其等同物限定。

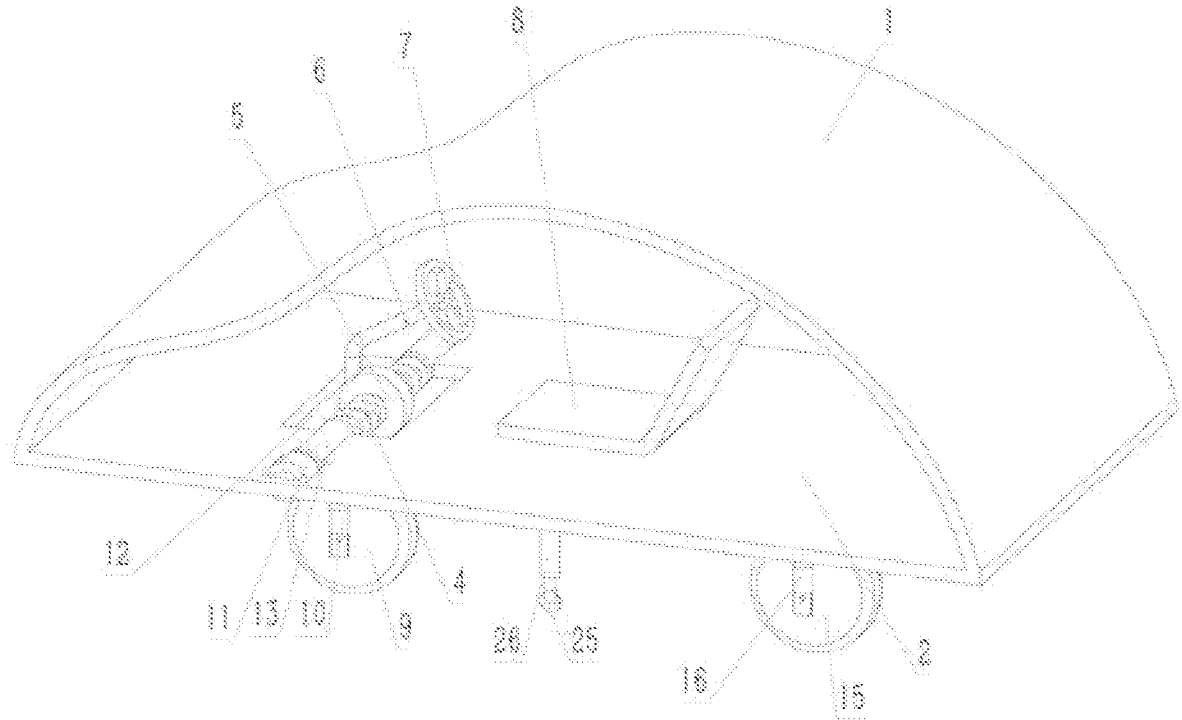


图 1

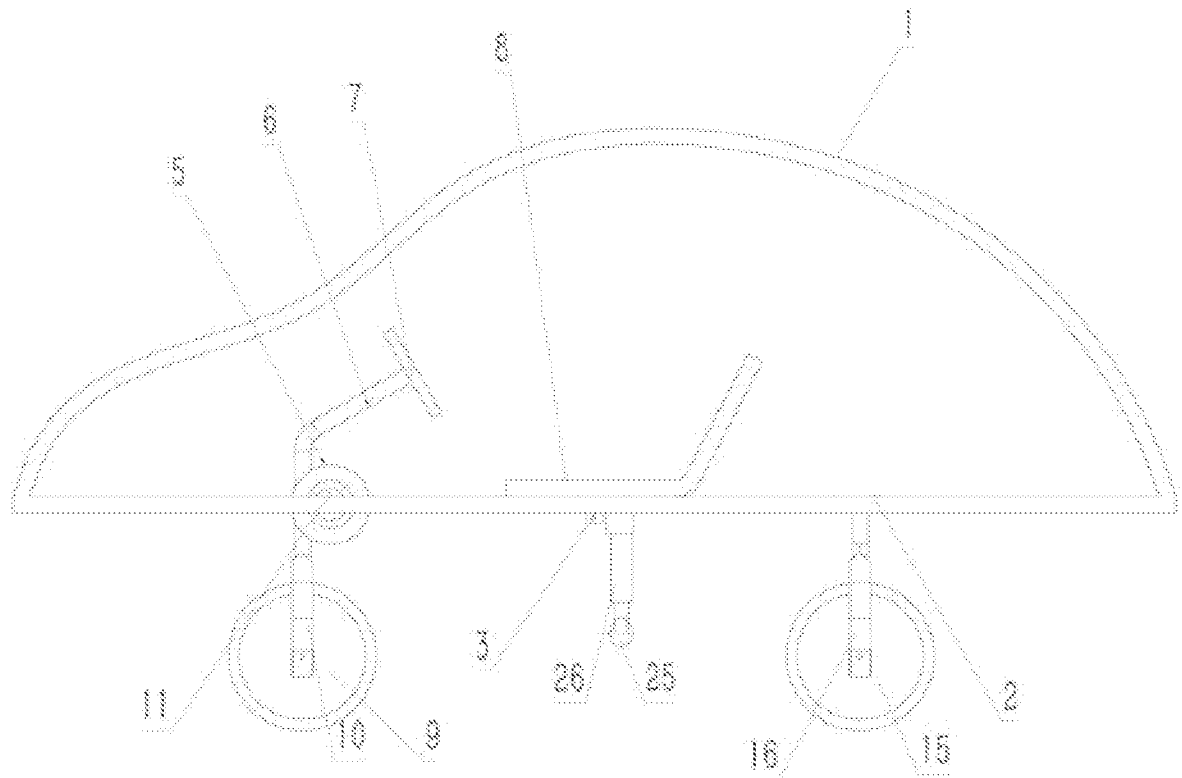


图 2

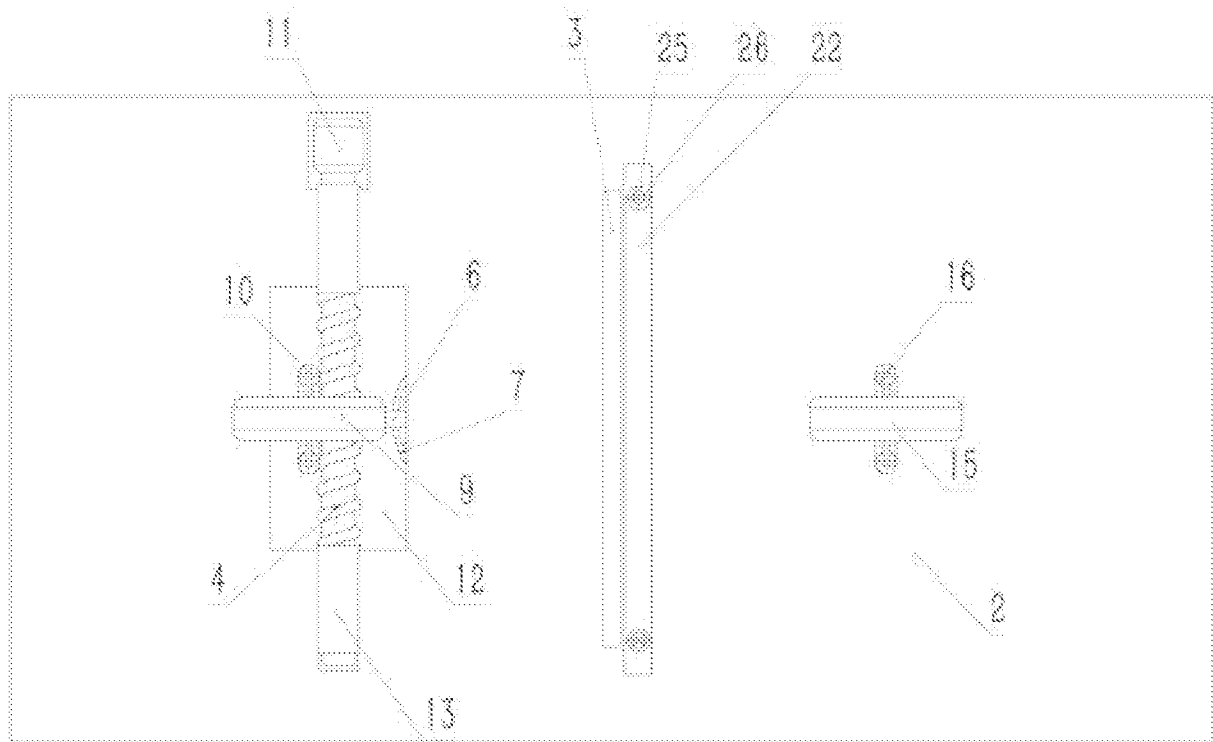


图 3

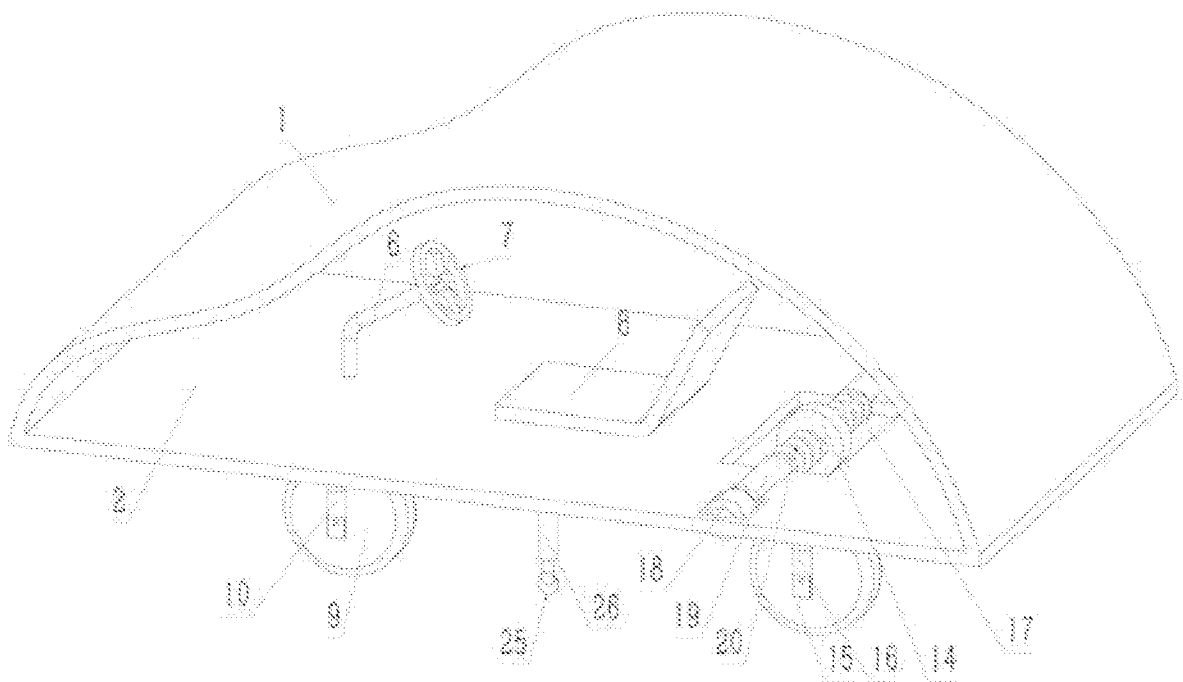


图 4

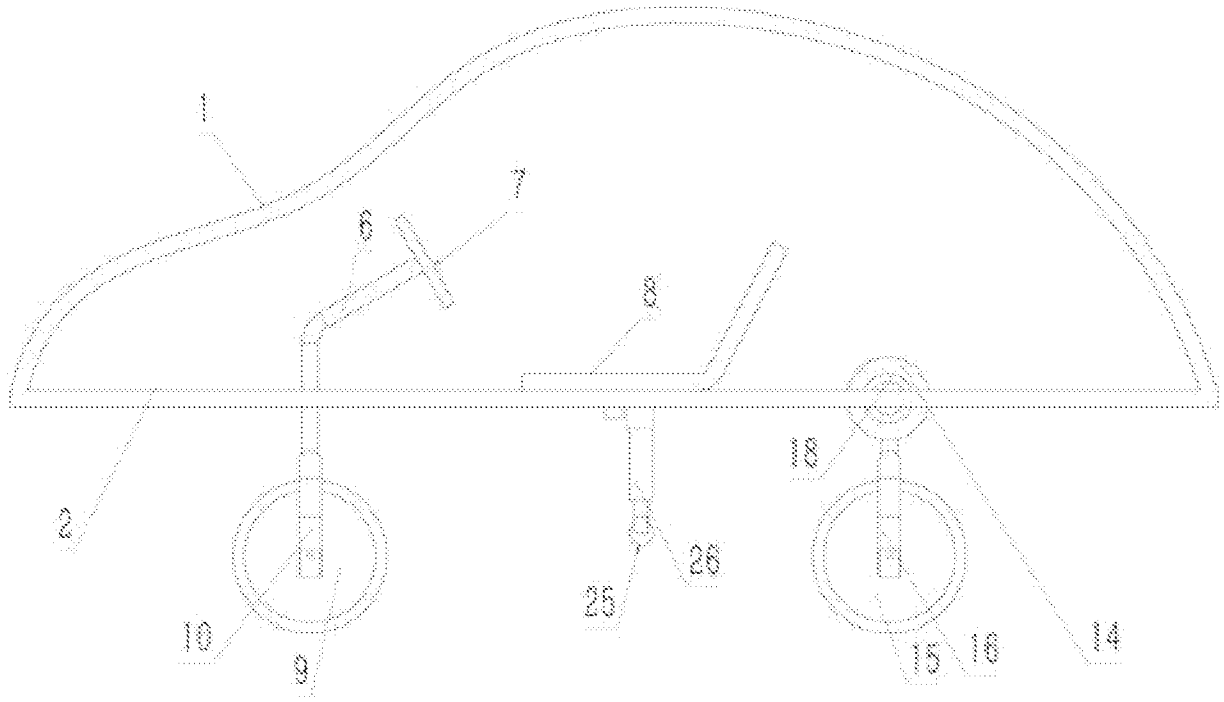


图 5

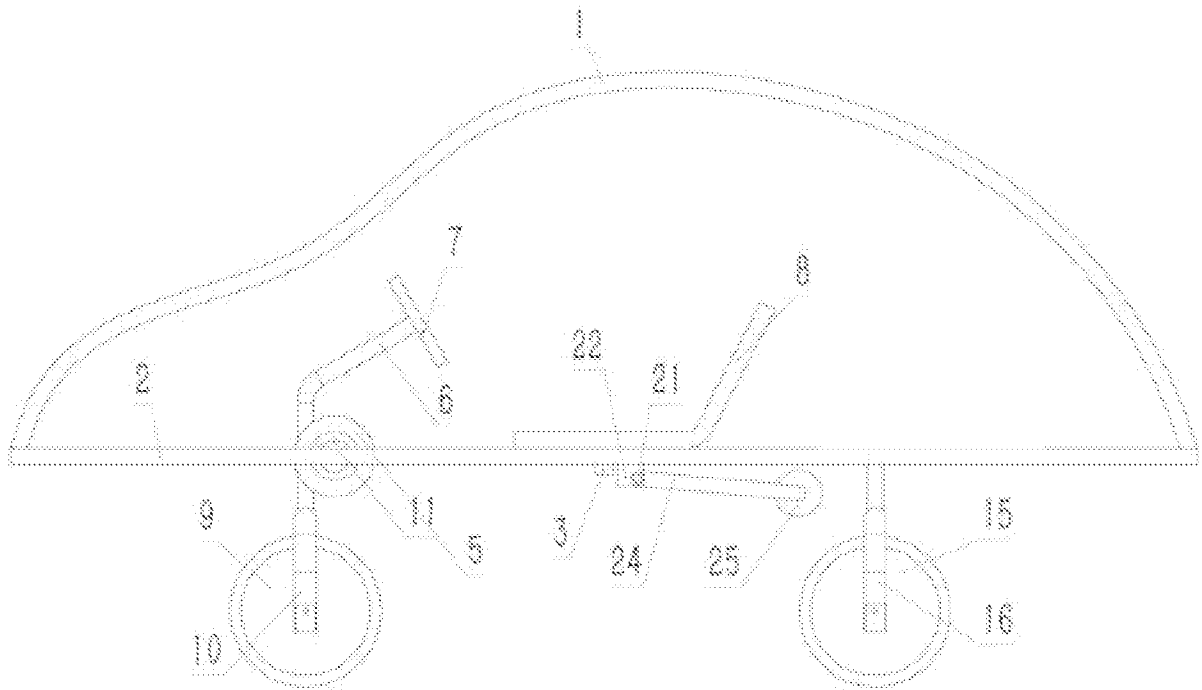


图 6

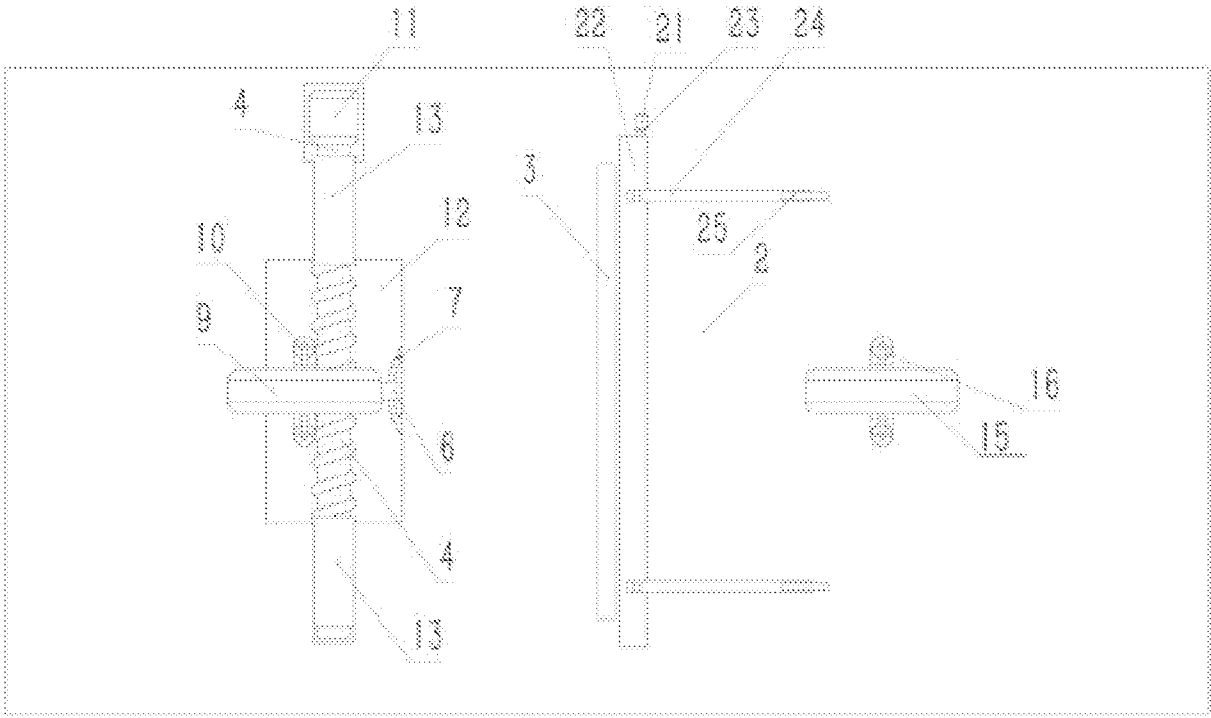


图 7



US 20210197919A1

(19) **United States**(12) **Patent Application Publication**
Casablancas(10) **Pub. No.: US 2021/0197919 A1**(43) **Pub. Date: Jul. 1, 2021**(54) **FOLDING BICYCLE AND METHOD OF USE**(52) **U.S. Cl.**(71) Applicant: **Julian Casablancas**, Ridgefield, CT
(US)CPC **B62K 15/008** (2013.01); **B62K 2015/001**
(2013.01); **B62K 21/16** (2013.01)(72) Inventor: **Julian Casablancas**, Ridgefield, CT
(US)

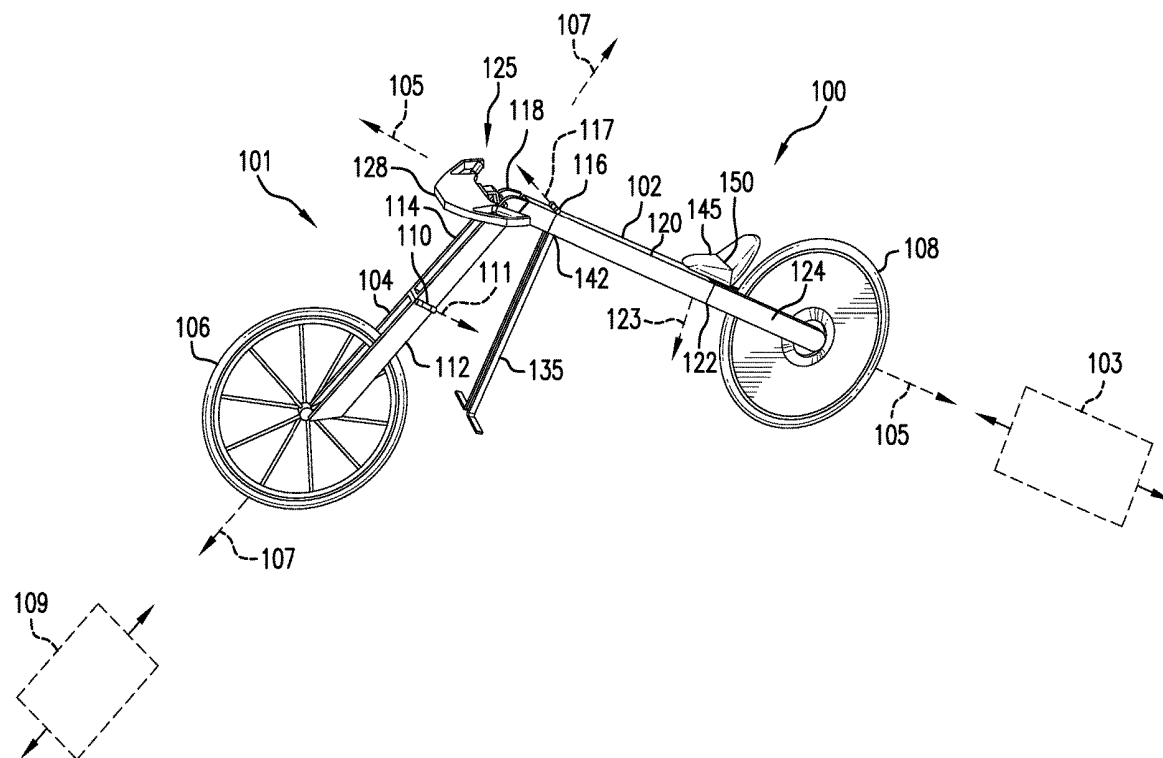
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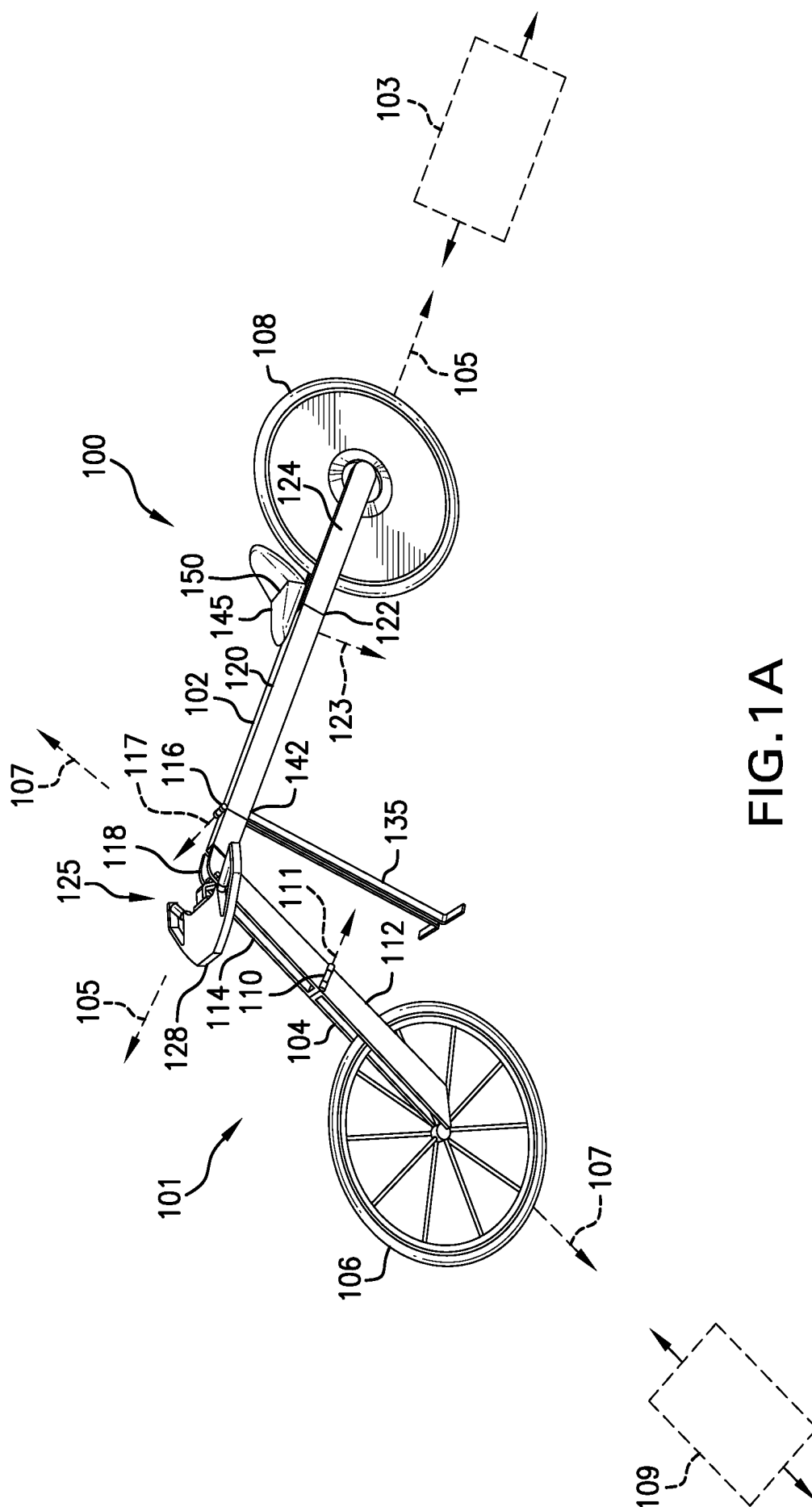
ABSTRACT(21) Appl. No.: **17/202,510**(22) Filed: **Mar. 16, 2021****Related U.S. Application Data**

(63) Continuation of application No. 15/907,255, filed on Feb. 27, 2018, now Pat. No. 10,946,924, which is a continuation of application No. 14/942,398, filed on Nov. 16, 2015, now Pat. No. 9,902,455, which is a continuation of application No. 14/444,249, filed on Jul. 28, 2014, now Pat. No. 9,187,145, which is a continuation of application No. 13/622,890, filed on Sep. 19, 2012, now Pat. No. 8,789,840.

Publication Classification(51) **Int. Cl.****B62K 15/00** (2006.01)**B62K 21/16** (2006.01)

A folding bicycle and method for folding the folding bicycle is provided. The folding bicycle comprises a frame having a first end and a second end; a first wheel connected to the second end of the frame, the first wheel and the frame being located in a first plane; a fork having a first end and a second end, the second end of the fork pivotally connected to the first end of the frame thereby allowing the fork to pivot about the first plane; a second wheel connected to the first end of the fork, the second wheel and the fork being located in a second plane; a first pivot member having a first pivot axis to allow the first end of the fork to pivot towards the second end of the fork about the first pivot axis; a second pivot member having a second pivot axis to allow the first end of the frame to pivot towards the second end of the frame about the second pivot axis; and a third pivot member having a third pivot axis to allow the second end of the frame to pivot towards the first end of the frame about the third pivot axis.





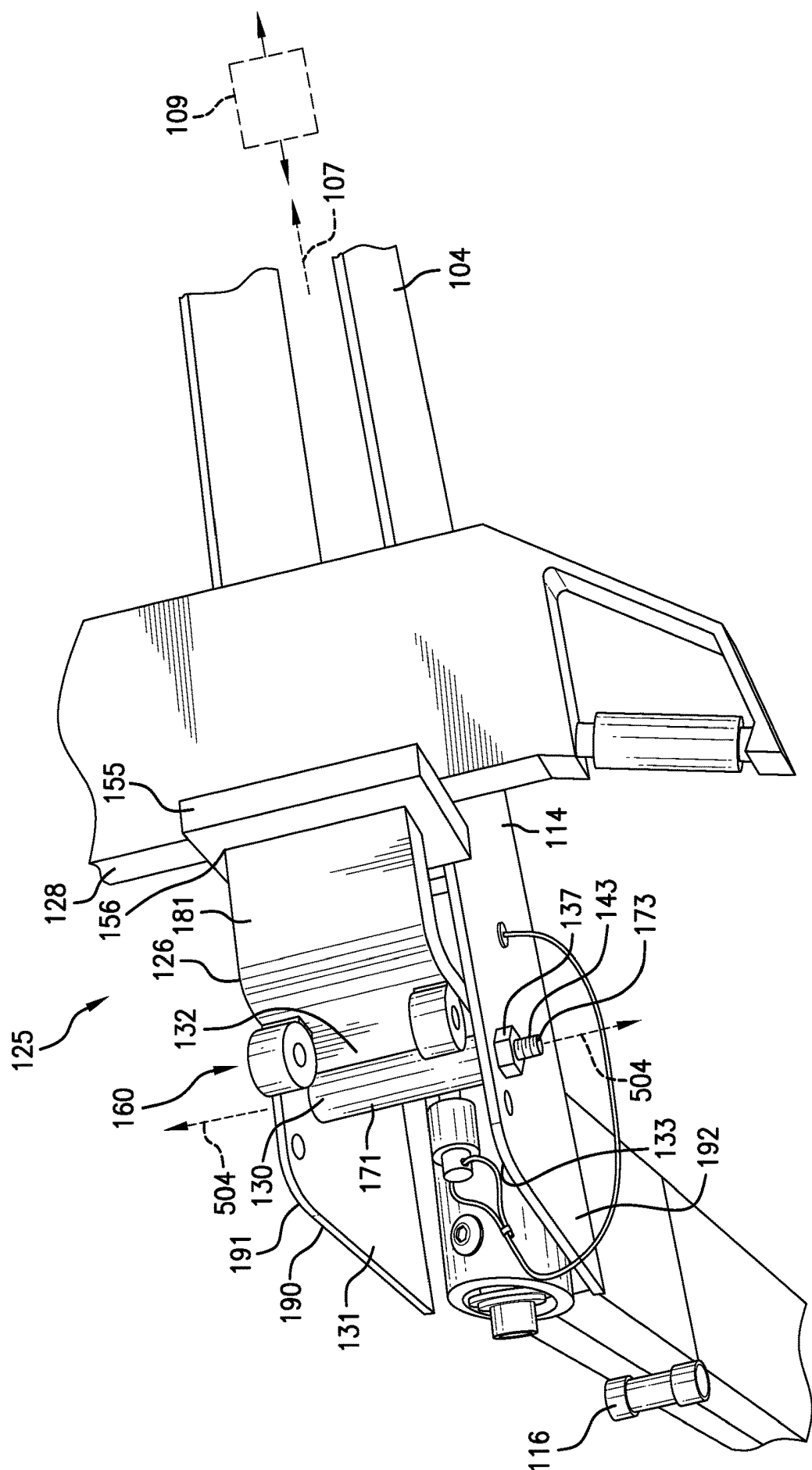


FIG. 1B

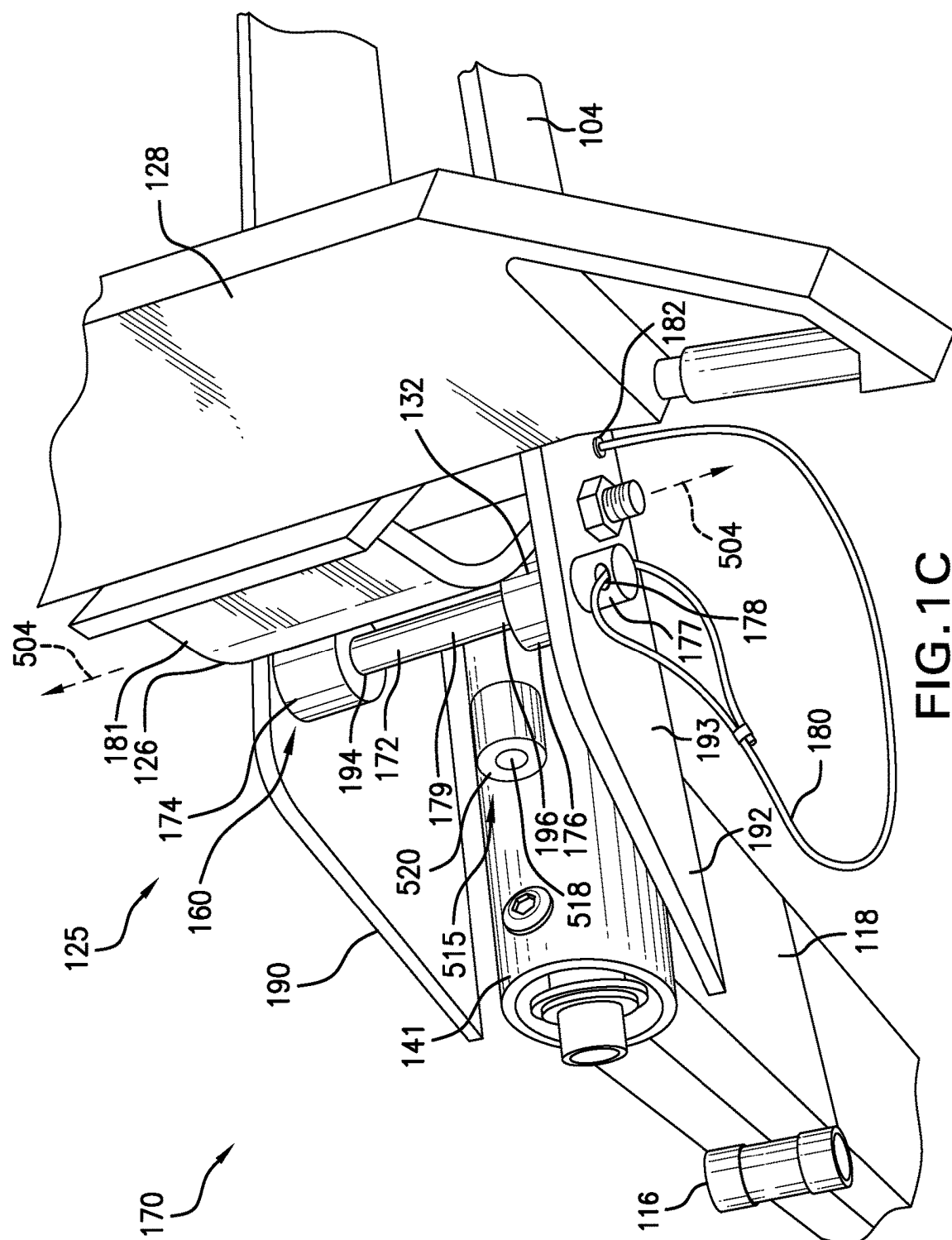


FIG. 1C

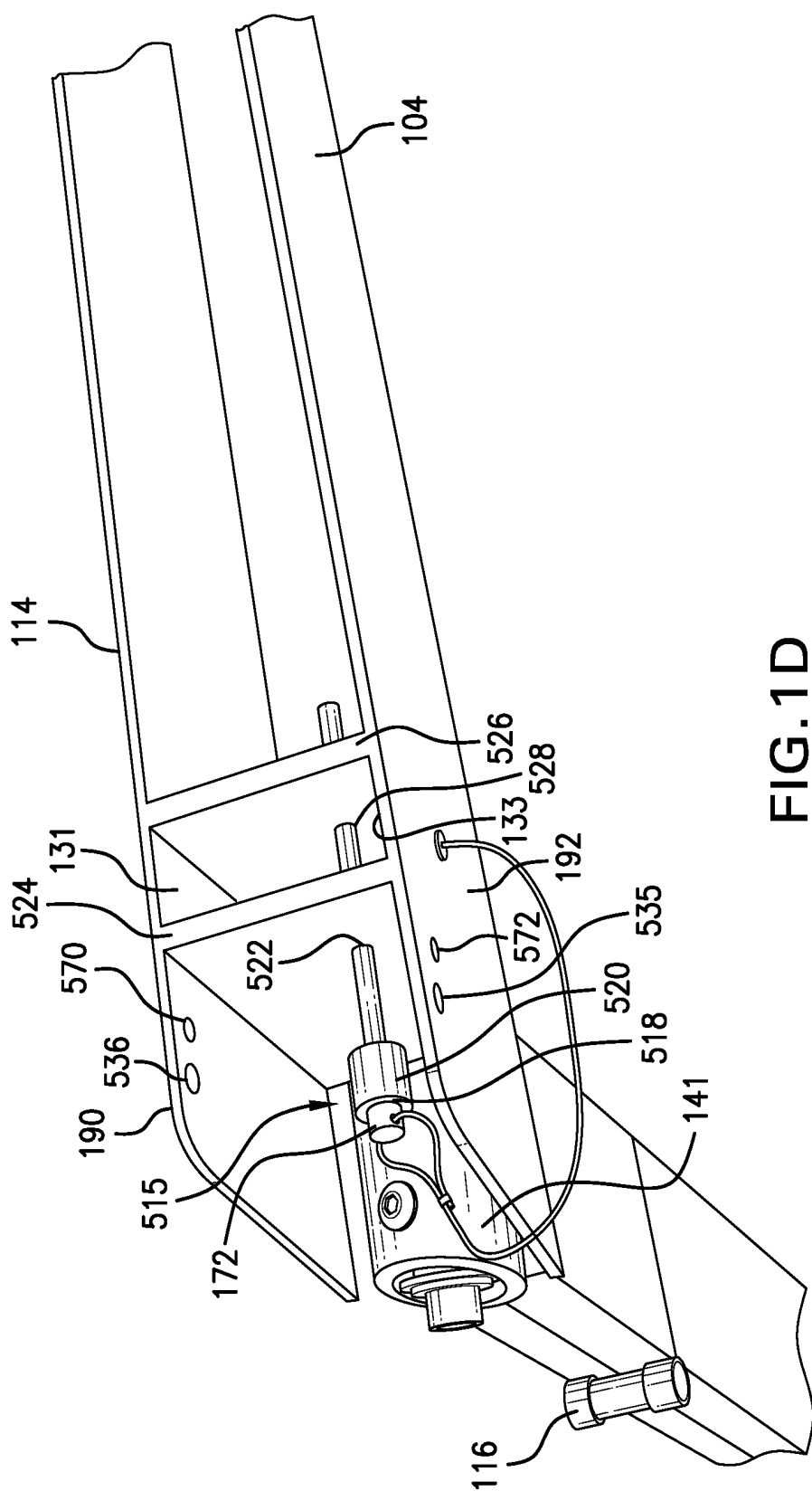


FIG. 1D

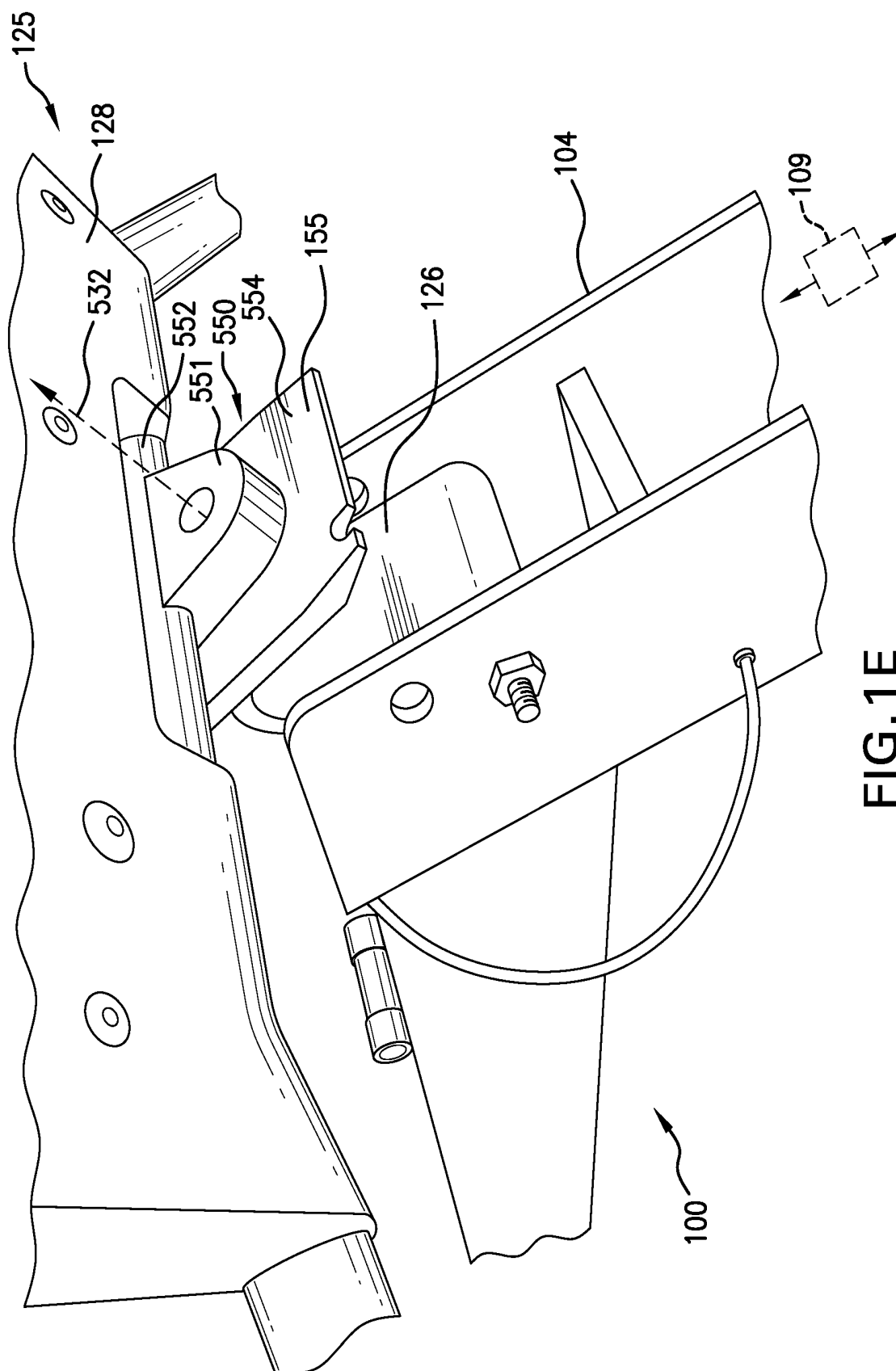


FIG. 1E

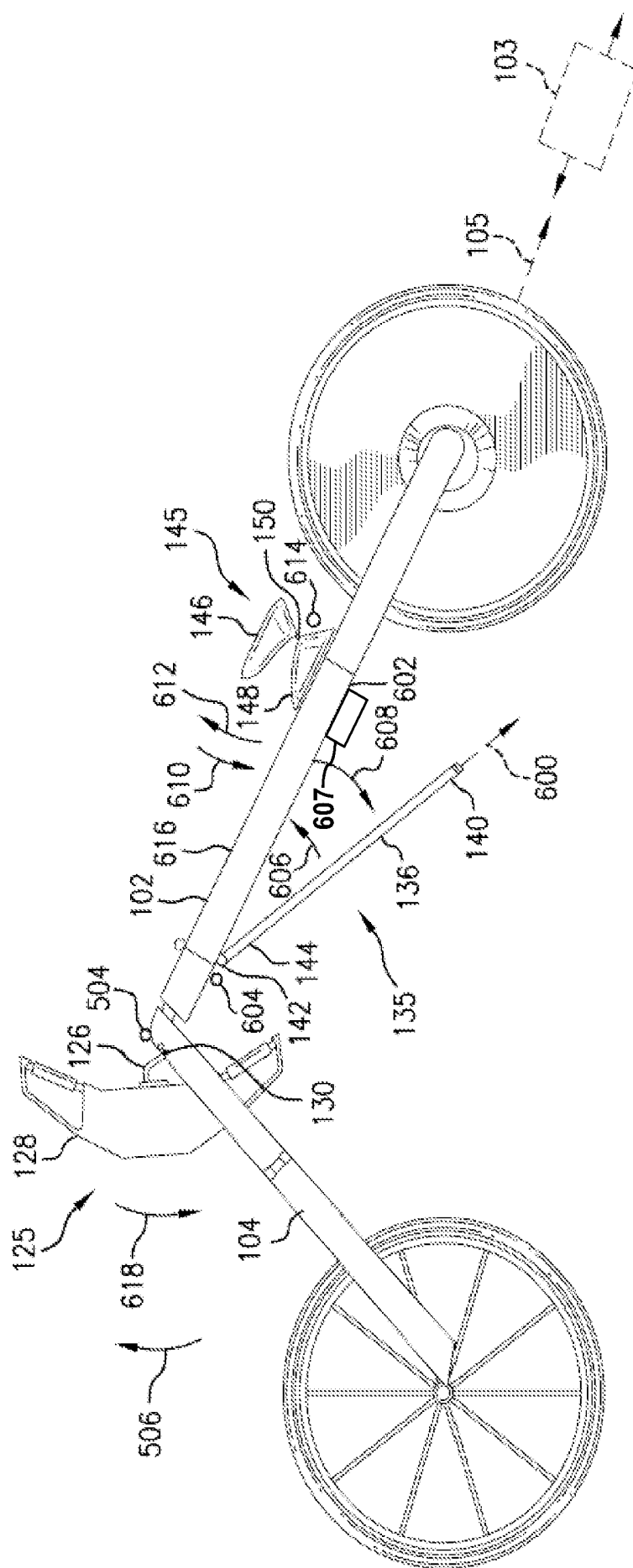
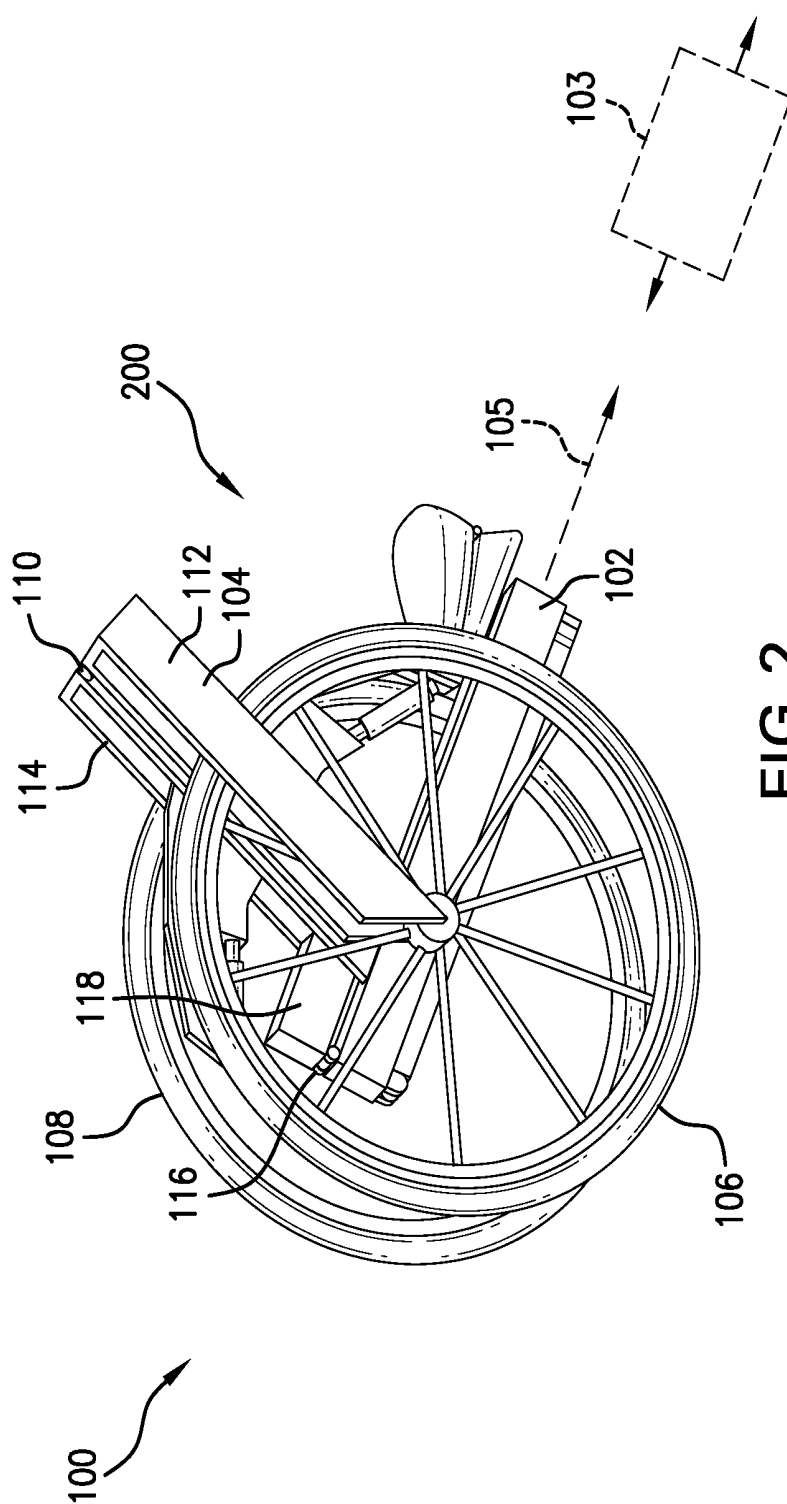
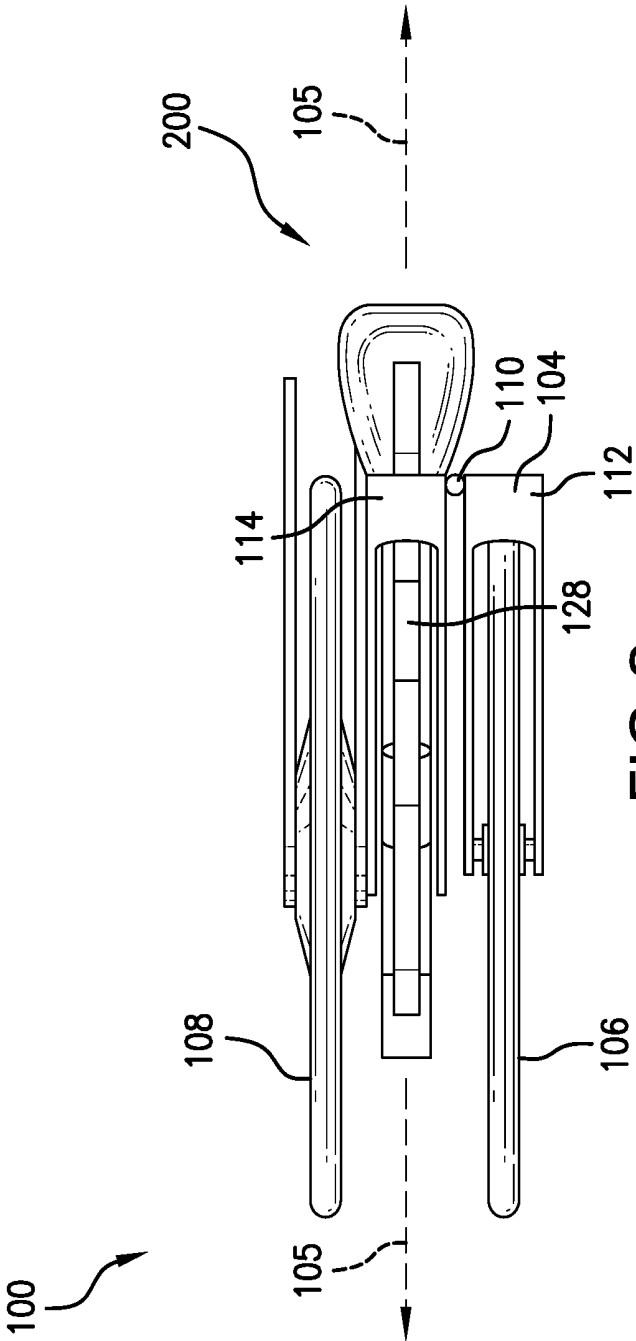


FIG. 1F





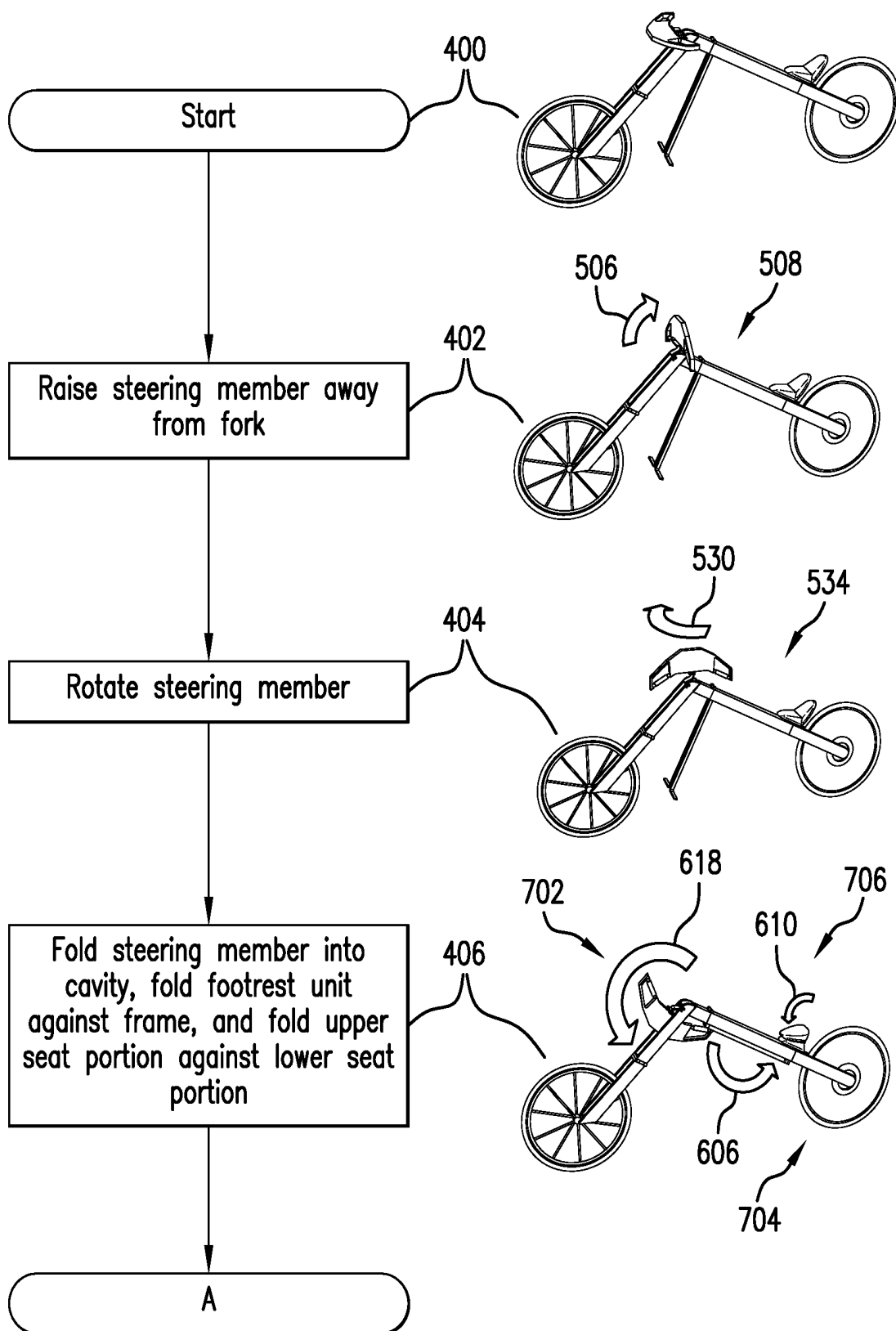


FIG. 4A

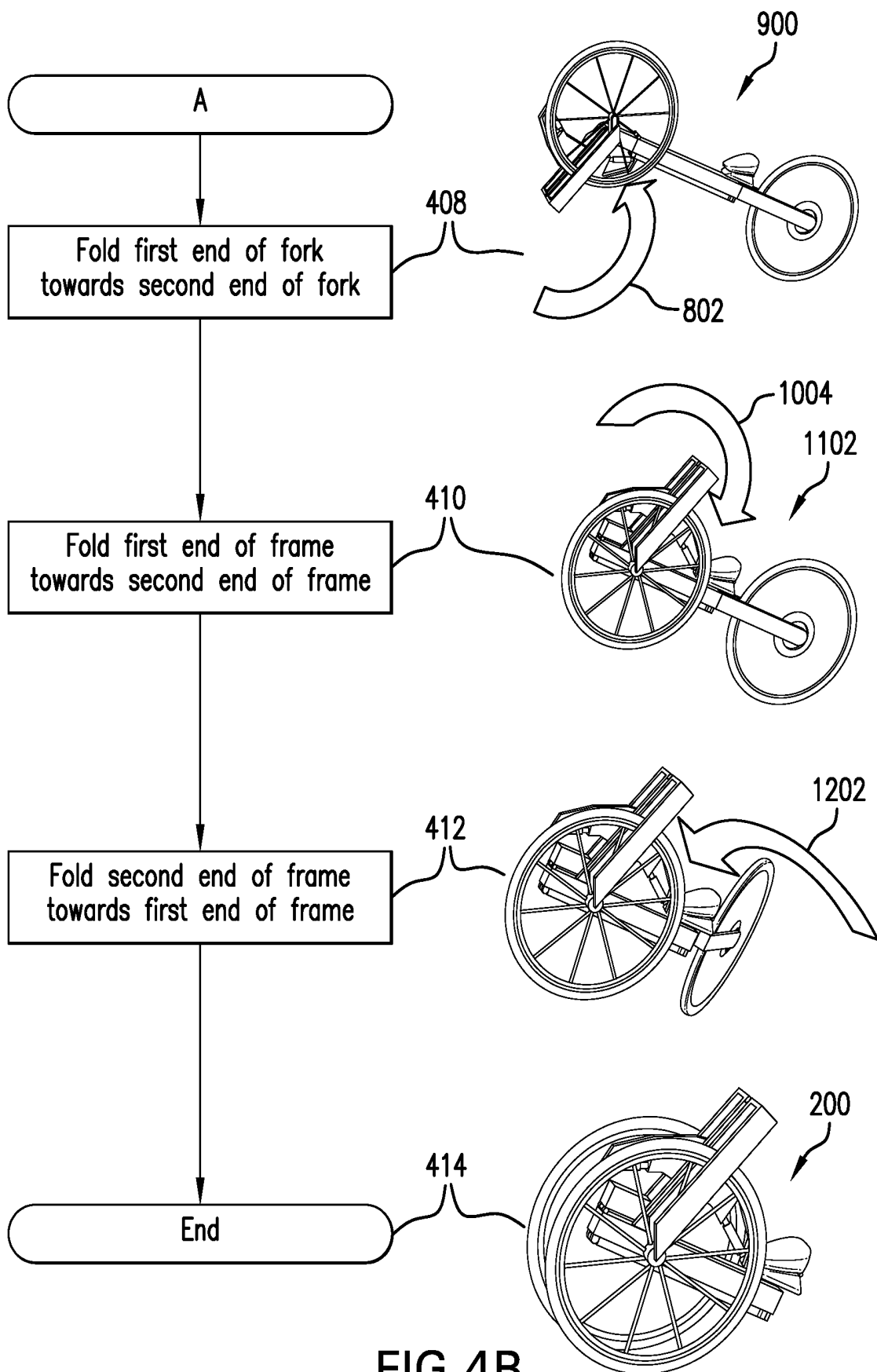


FIG.4B

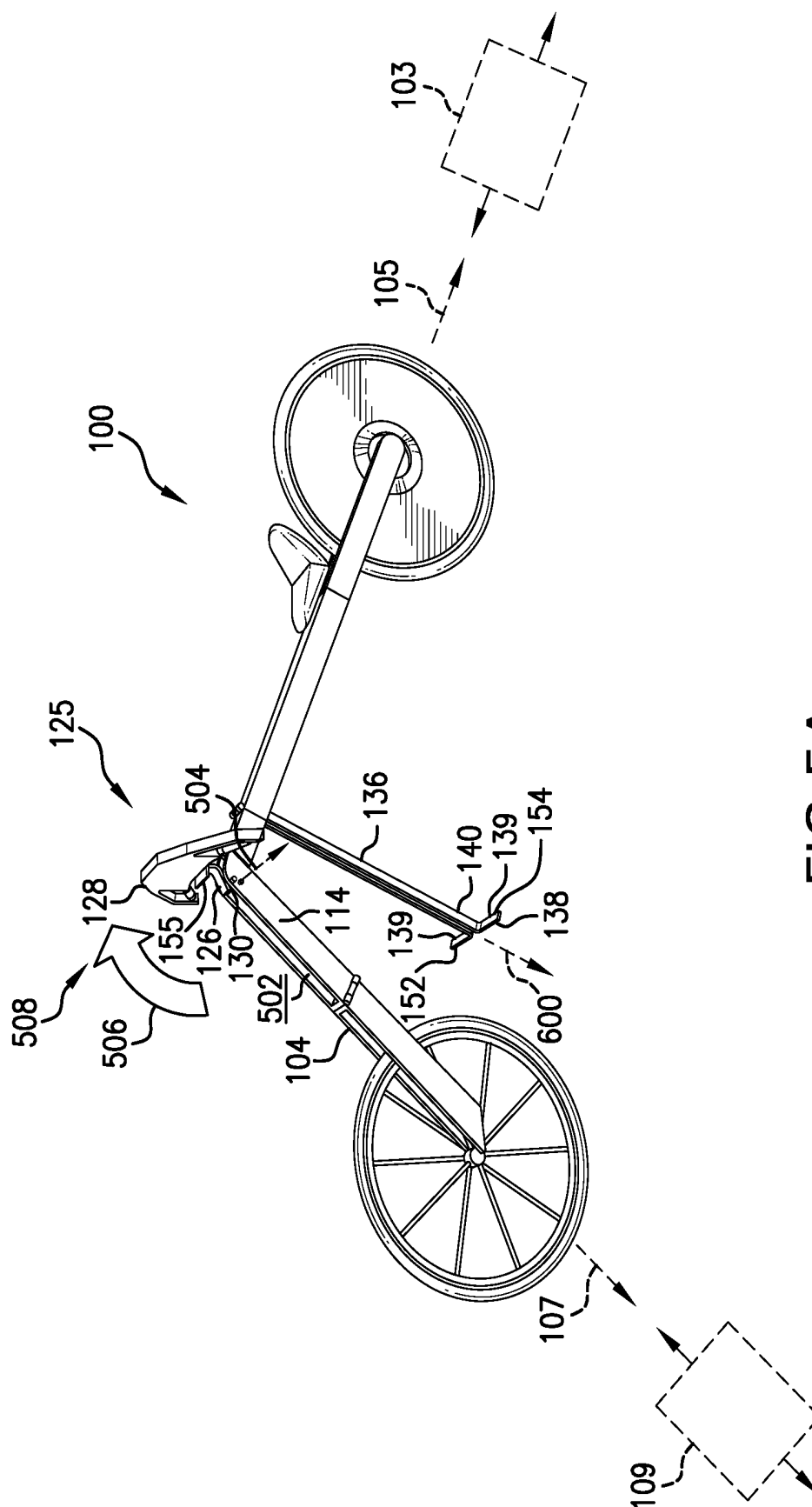


FIG. 5A

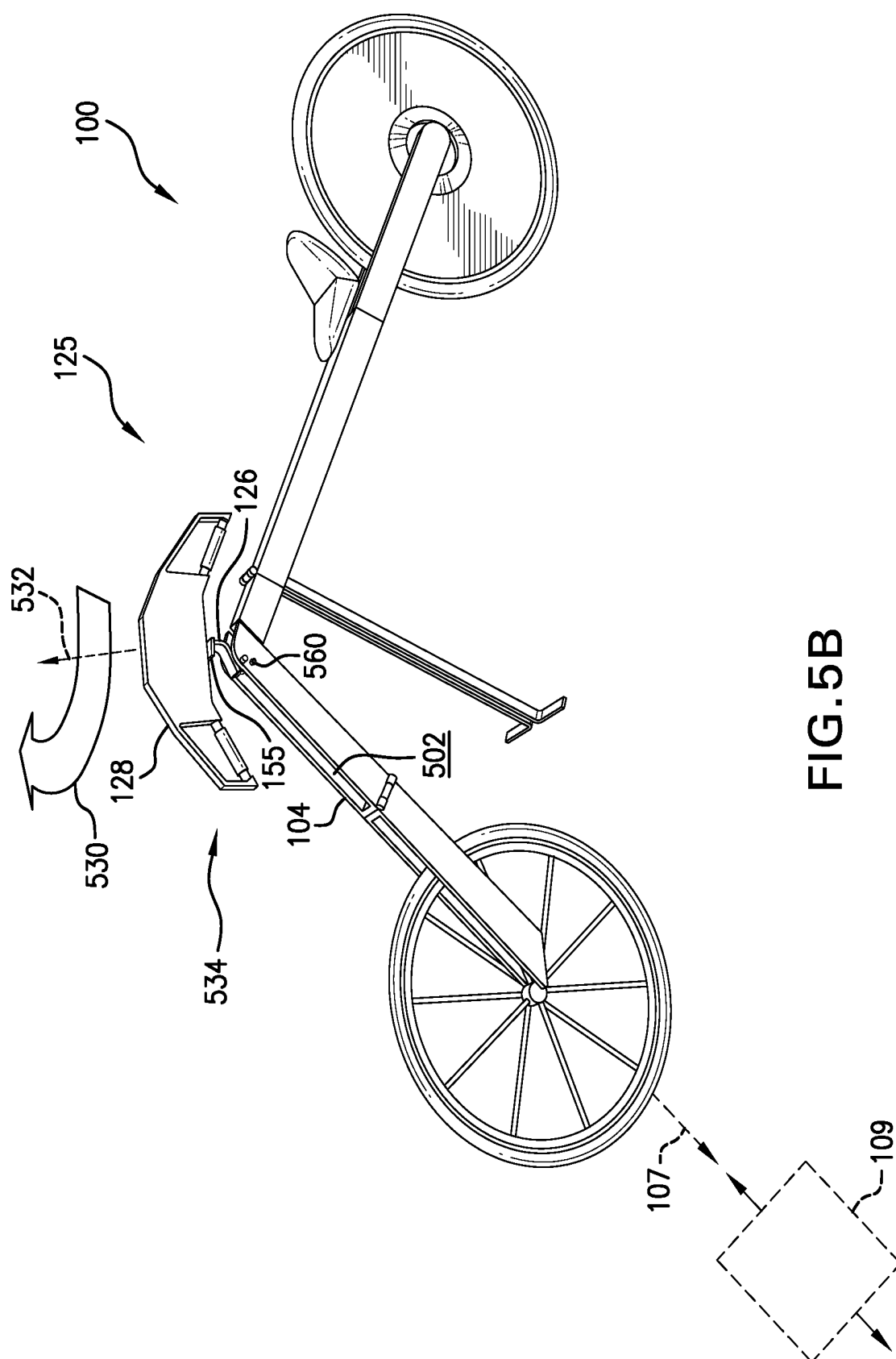
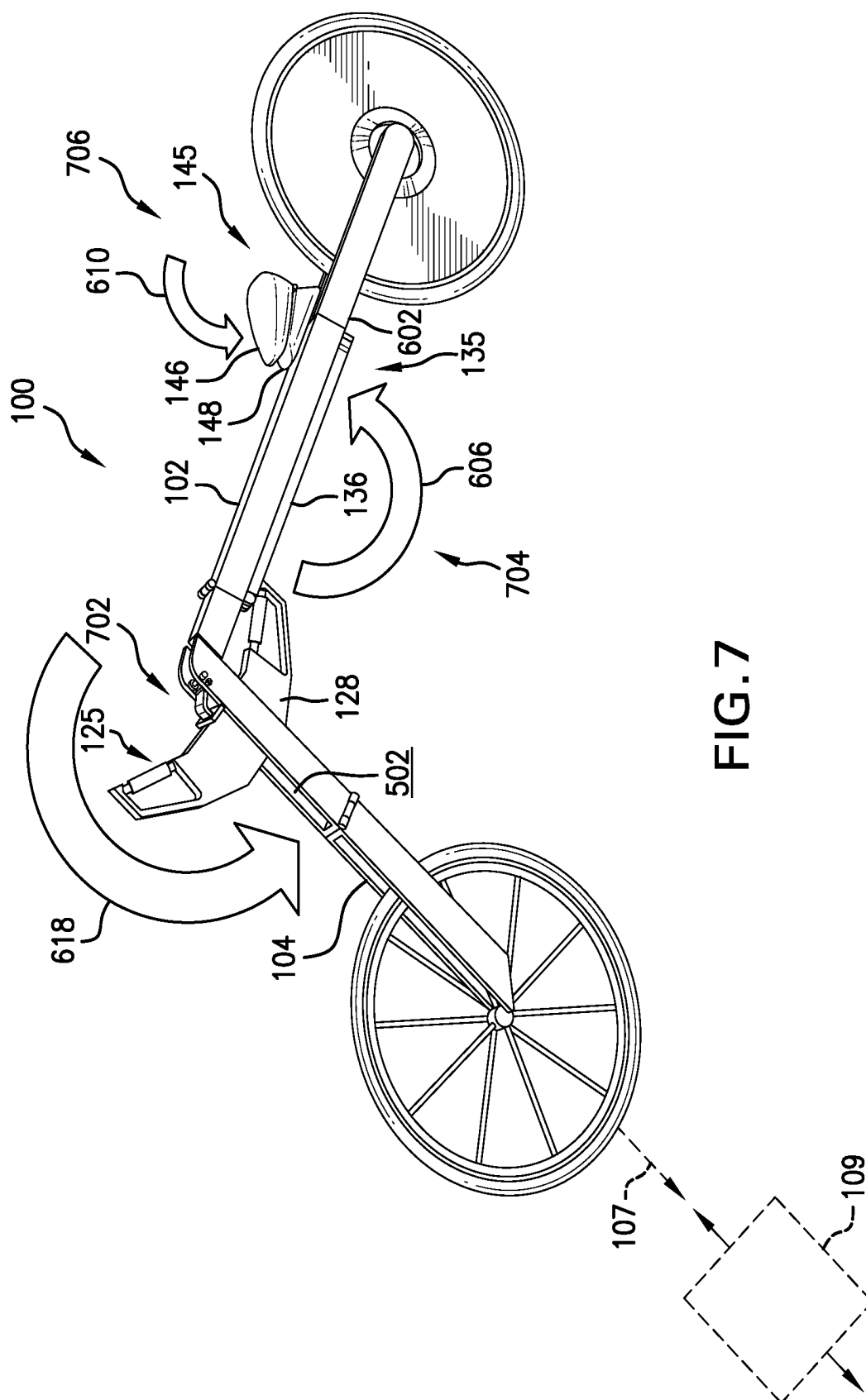
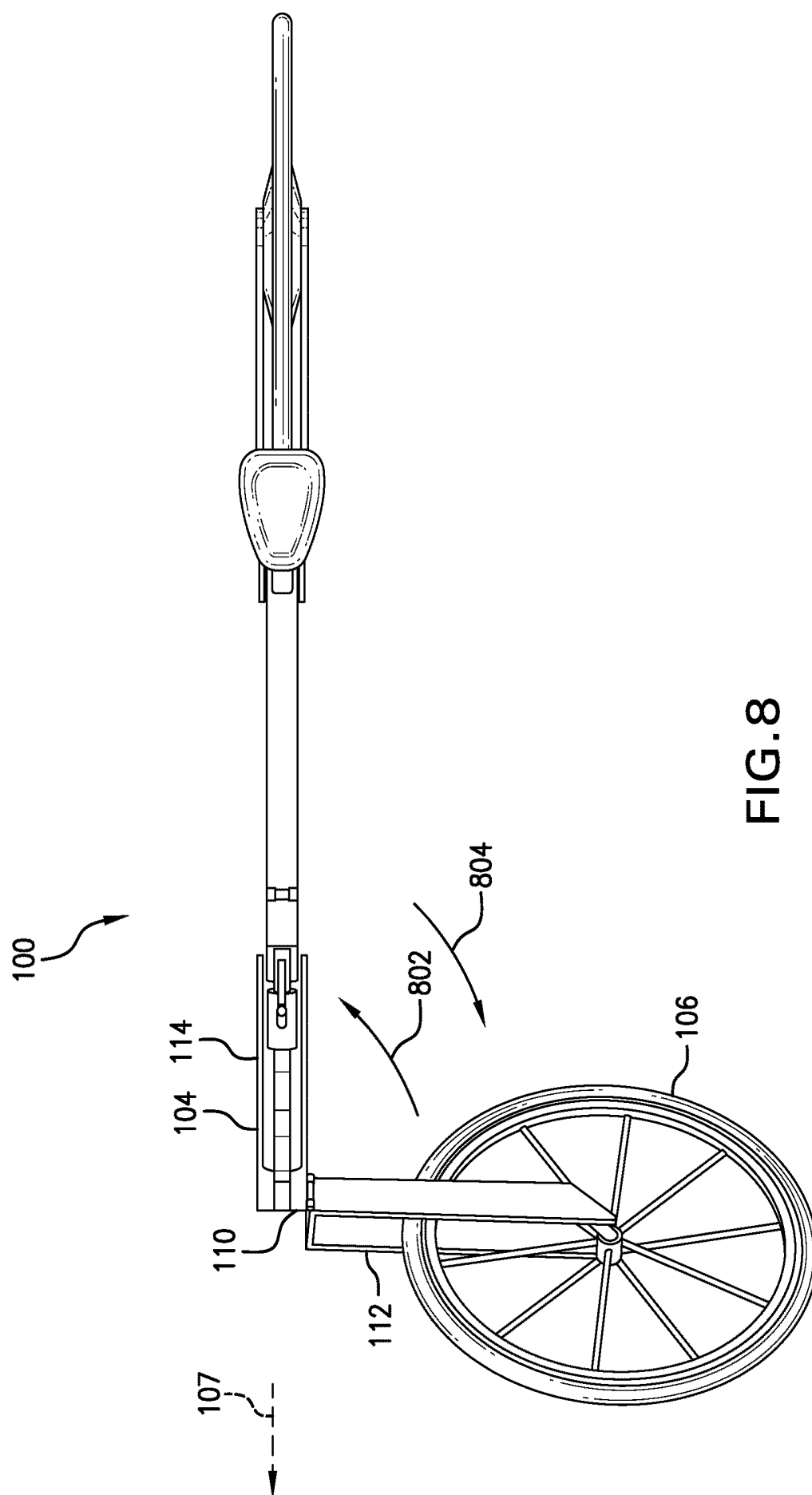
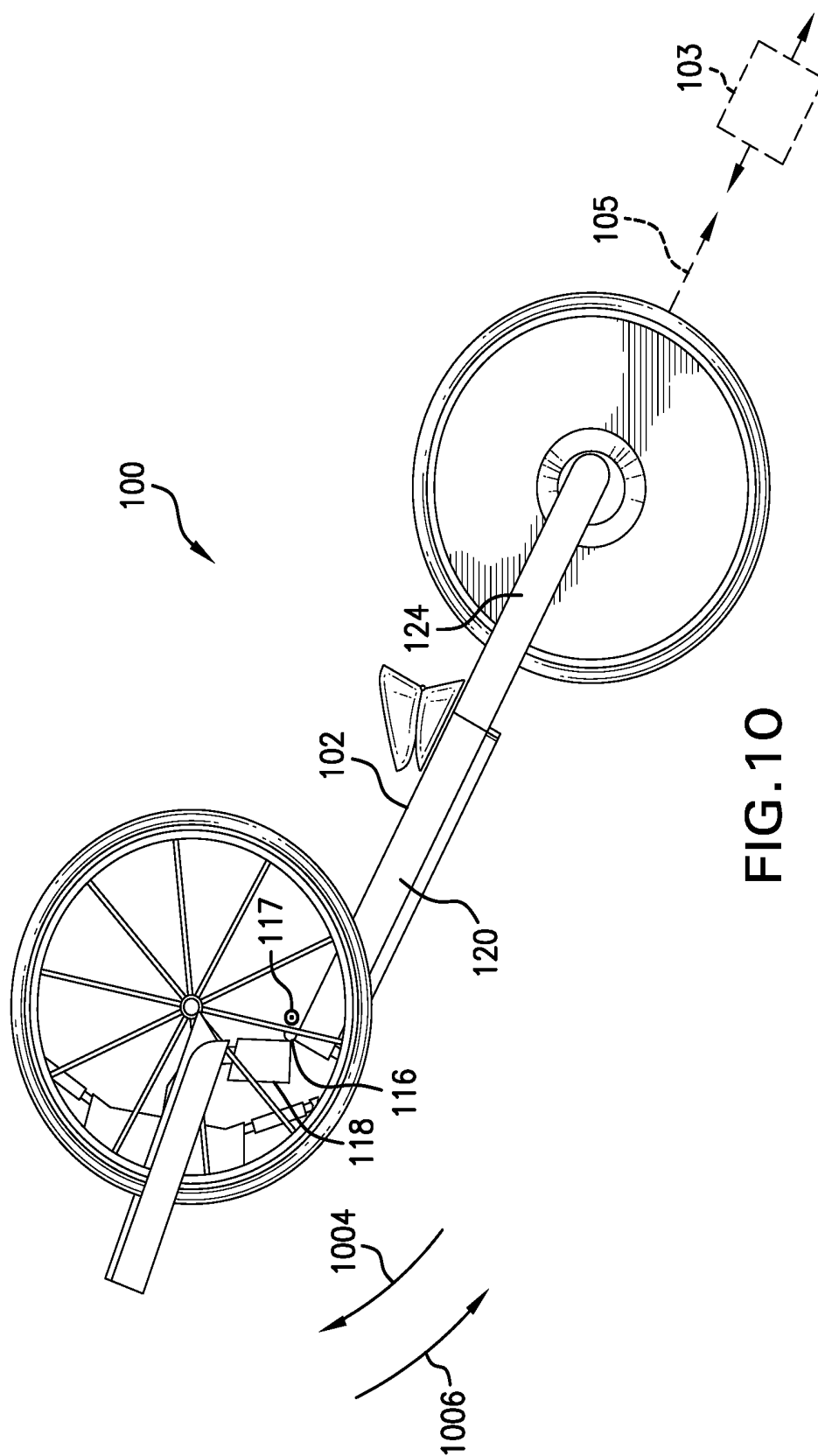


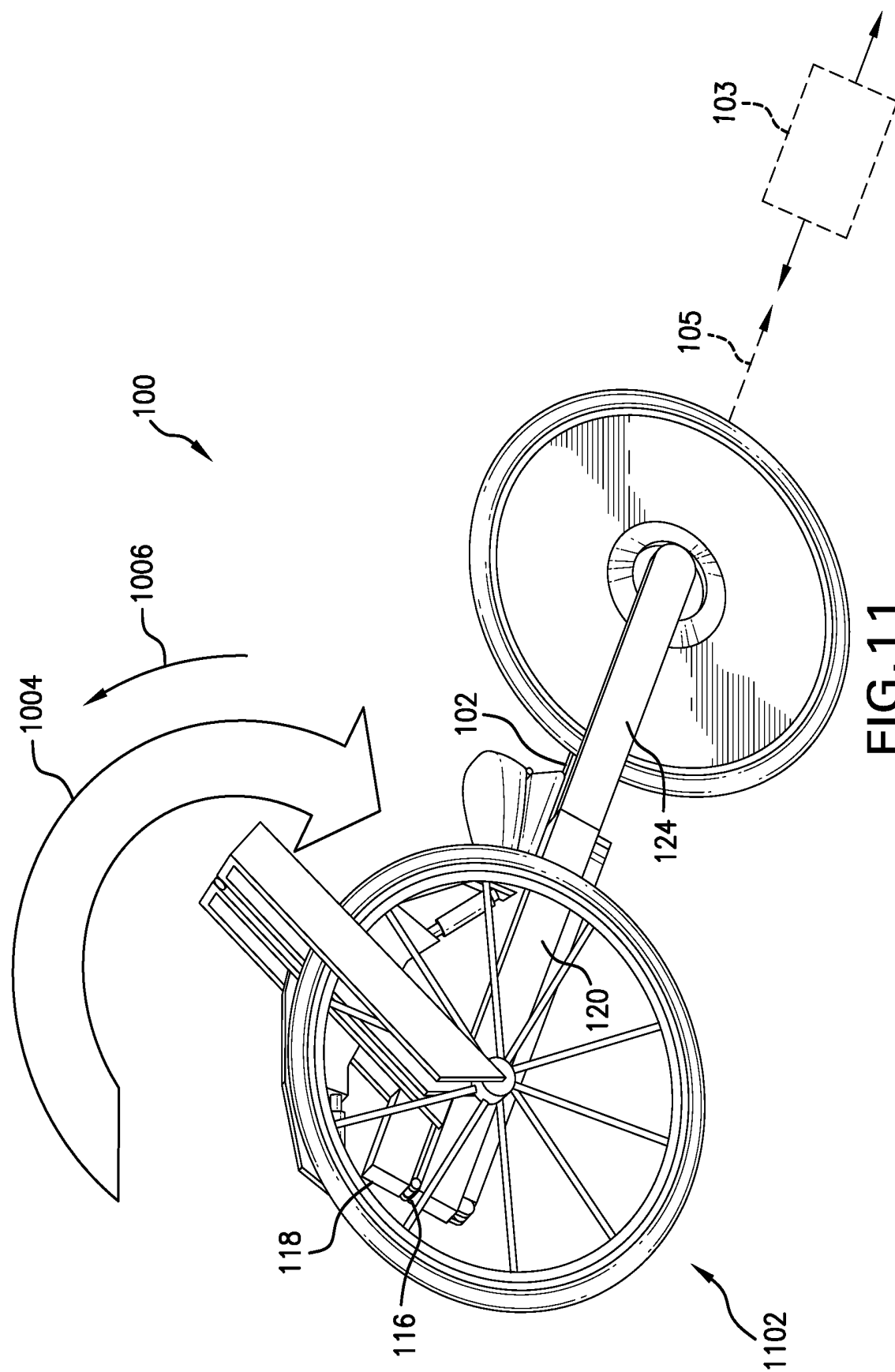
FIG. 5B

FIG. 6









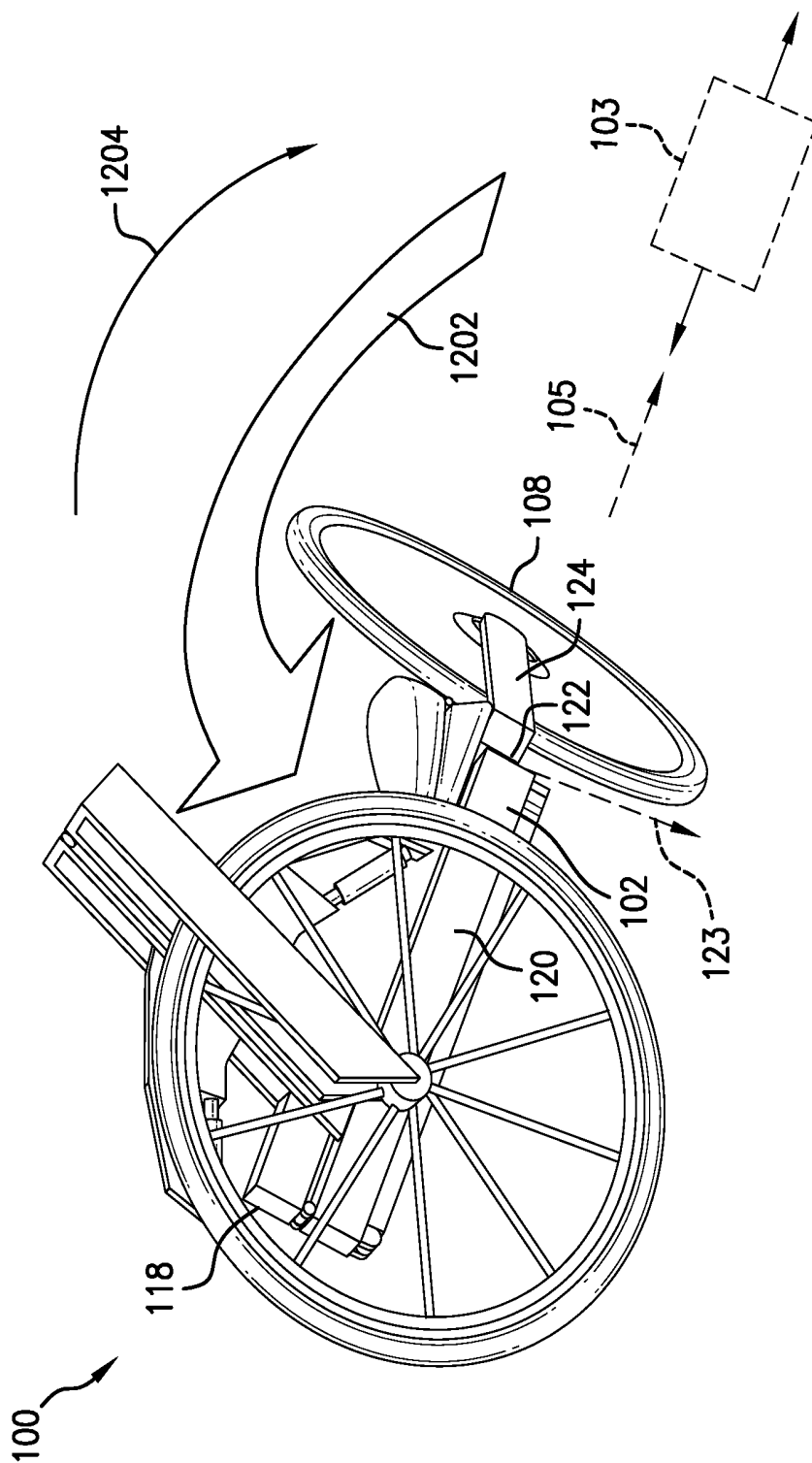


FIG. 12

FOLDING BICYCLE AND METHOD OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of Non-Provisional application Ser. No. 15/907,255, filed Feb. 27, 2018, which is a continuation of Non-Provisional application Ser. No. 14/942,398, filed Nov. 16, 2015, which is a continuation of Non-Provisional application Ser. No. 14/444,249, filed Jul. 28, 2014, which is a continuation of Non-Provisional application Ser. No. 13/622,890, filed Sep. 19, 2012, and issued as U.S. Pat. No. 8,789,840 on Jul. 29, 2014, the entire contents of the entire chain of applications is herein incorporated by reference.

FIELD OF THE INVENTION

[0002] This invention relates generally to the field of bicycles, and, more particularly, to a novel and improved folding bicycle and method of use. Notably, the application of this invention extends to, but is not limited to, electric bicycles, gas bicycles and manual bicycles.

BACKGROUND OF THE INVENTION

[0003] Often times the distance one must travel is seemingly too short or too inconvenient to ride a bus or subway or to drive a car, but too long to walk. These circumstances present opportune times to ride a bicycle. Moreover, people living in large, mid-sized, or even small metropolitan areas often find it more convenient to travel around the city by bicycle, which provides an efficient mode of transportation in such crowded areas. Accordingly, in today's crowded urbanized areas, it is desirable to use a bicycle for traveling short to medium distances. A bicycle provides personal transportation, can carry small loads, is easy and convenient to maneuver and park in crowded places, and is low in cost to purchase and maintain. Automobiles consume large amounts of fossil fuels, create pollution, are a safety hazard, and are costly to maintain and park. Motorcycles have all of the problems of automobiles (though perhaps to a lesser degree) but present a greater safety hazard when operating at high speeds. It is also beneficial to use a bicycle as a means of transportation in crowded cities as it alleviates, among other things, the need to locate parking for a car, pay for parking a car, and abide by the schedule and inconvenience of public transportation.

[0004] Although riding a bicycle for transportation can alleviate the above drawbacks, bicycles typically are bulky and inconvenient for portability and storage. This inconvenience of portability and storage often results in bicycles being left outside, leaving them susceptible to theft. To make even greater use of bicycles beyond just point-to-point transport, it would be desirable to have a bicycle that could be quickly folded so that it can be transported inside the trunk of a car or as baggage on a train or airplane; so that it could be used locally at a remote destination. Foldable bicycles have an advantage of a relatively compact arrangement for storage and/or transport, making them popular with users wishing to reduce storage space, such as commuters, recreation enthusiasts, and campers, among others. However, known folding bicycles have myriad shortcomings. For example, in general, the large size of the folding bicycles of the prior art prohibit the storage of these folding bicycles within a closet, or a small area and make it difficult to easily

and conveniently fit them into a suitcase or carrying-bag for transporting. Moreover, many of the known folding bicycles do not provide all of the qualities of being low in cost, easy and simple to fold into a small volume such as a suitcase, and sturdy and reliable to use. Many other folding bicycles necessitate the removal of one or both wheels, which is an inconvenient and complex procedure. Some folding bicycles that have sturdy folding frame parts are very expensive and/or utilize heavy metal parts that increase the overall weight. Others that are less costly have folding parts that are not as sturdy, do not fold easily or well, or are excessively heavy.

[0005] In some conventional or manual folding bicycles, folding joints are situated in the central area of the frame, such as within one or more of the down tube, top tube, seat tube and head tube, or bearing tube. A disadvantage of such an arrangement is that the bicycle's ability to fold into a compact volume is dramatically reduced. A further disadvantage is that known folding bicycles have frames that frequently are smaller than the frames of a comparable standard non-folding bicycle. This reduces the ergonomic suitability for a rider. A result of this for many riders is a decrease in the distance that can be ridden with comfort.

[0006] Current folding bicycles typically have pedals, thus requiring the user to exert a substantial amount of energy to ride. Exerting the amount of energy necessary to ride a bicycle often results in the user sweating upon arrival at his or her destination. Because riding a bicycle causes the rider to sweat, the user often must dress down and change into appropriate clothing upon arriving at his or her destination. This is yet another drawback of current folding bicycles.

[0007] Electric bicycles are becoming increasingly popular throughout the world. However, it is laborious for a bicycle rider to carry a folded electric bicycle because electric bicycles are generally heavier than typical bicycles due to the additional weight of the electric motor, battery pack, and associated components. Moreover, due to the bulky design, electric motor, battery pack, and associated components, it is difficult to fold current electric bicycles to a compact and portable size. Thus, the need for improvement still exists.

[0008] There is therefore a need for a folding bicycle and method of use that overcomes some or all of the previously delineated drawbacks of prior folding bicycles.

SUMMARY OF THE INVENTION

[0009] The present invention includes a folding bicycle and method of use that is preferably ergonomically comfortable when riding, preferably can be readily folded into a compact arrangement, preferably can be battery powered, gas powered, manually powered, preferably can be provided without the traditional drive chain mechanism and pedals of manually powered bicycles, preferably can be easily transported and stored, and/or preferably can maintain its structural rigidity and integrity despite repeated folding and unfolding.

[0010] The present invention includes a folding bicycle and method of use. The folding bicycle is preferably used as a means for transportation. Moreover, the folding bicycle is preferably battery powered, however, it should be appreciated that the present invention can be implemented with electrical or battery powered bicycles, gas powered bicycles, and standard, manually powered bicycles, without limiting the scope of the present invention. While the present inven-

tion will be described below with respect to a battery powered folding bicycle, it should be appreciated that any type of bicycle, including but not limited to the types of bicycles just indicated, may be incorporated with the present invention, without limiting the scope of the present invention.

[0011] In a first non-limiting aspect of the invention, a folding bicycle is provided. The folding bicycle preferably comprises: (i) a frame having a first end and an opposing second end; (ii) a rear wheel rotatably connected to the second end of the frame, the rear wheel and frame being located in a first plane; (iii) a fork having a first end and an opposing second end, the second end of the fork pivotally connected to the first end of the frame, wherein the fork is adapted to pivot about the first plane, thereby allowing a rider to steer the bicycle; (iv) a front wheel rotatably connected to the first end of the fork, the front wheel and fork being located in a second plane; (v) a first primary pivot member or hinge having a first pivot axis to allow the first end of the fork to pivot towards the second end of the fork; (vi) a second primary pivot member or hinge having a second pivot axis to allow the first end of the frame to pivot towards the second end of the frame; and (vii) a third primary pivot member or hinge having a third pivot axis to allow the second end of the frame to pivot towards the first end of the frame.

[0012] It is also contemplated that the folding bicycle of the invention preferably comprises: (i) a steering unit having a coupling member or an elbow-shaped member comprising a first end rotatably coupled to a steering member or handlebar, via a first secondary pivot member or swivel mount, and an opposing second end pivotally coupled to the second end of the fork, via a second secondary pivot member or axle; (ii) a footrest unit having an elongated member comprising a first end preferably pivotally coupled to the underside of the frame, via a third secondary pivot member or hinge, and an opposing second end, whereby a flange extends generally perpendicularly from the second end of the elongated member; and (iii) a seat unit or saddle having an upper seat portion pivotally connected to a lower seat portion, via a fourth secondary pivot member or hinge.

[0013] As previously stated, it is contemplated that the folding bicycle be battery powered. As such, the folding bicycle of the invention and its method of use may be utilized for transportation while limiting the manual effort required to be expended by the rider or user of the folding bicycle. The folding bicycle of the invention is also preferably designed to fold or collapse into a compact arrangement, thereby allowing a user to easily transport and store the bicycle. This is preferably done by providing the three primary pivot members or hinges described above, the secondary pivot members or hinges described above, and a battery to power the bicycle, and by eliminating from the bicycle design the traditional chain drive mechanism and pedals employed by most manually powered bicycles. For example, the implementation of the three primary folds, the three secondary folds, and a battery, and the elimination of the traditional chain drive mechanism and pedals from the bicycle design allow a rider and/or owner of the bicycle to fold the bicycle into an extremely compact arrangement for easy transport and storage.

[0014] It is contemplated that the folding bicycle provides a means for conveniently and practically commuting and for conveniently and safely stowing and transporting the

bicycle. The implementation of a battery-powered bicycle allows the rider to ride the bicycle while avoiding breaking a sweat. Thus, it is further contemplated that the folding bicycle of the present invention may be used as transportation, where the rider is able to wear the desired attire for the destination rather than require the rider to first wear appropriate attire for riding the bicycle and then change into appropriate attire upon arrival at his or her destination. It is further contemplated that the folding bicycle of the present invention may be folded or collapsed into a small enough size fit for safe and convenient storage and/or transportation inside appropriate areas, such as, but not limited to hallways, corridors, passageways, alleys, stairwells, foyers, elevators, closets, storage rooms, offices, and the like, within office buildings, residential apartments, homes, restaurants, shopping centers, etc. Allowing the user of the bicycle to store the folded bicycle inside prevents the bicycle from being left outside with the possibility of it being stolen and allows it to be easily recharged once brought inside. It is further contemplated that the folding bicycle may be folded into a compact or appropriate size fit for being stored and/or transported in a small bag.

[0015] In a second non-limiting aspect of the invention, a folding bicycle is provided. The folding bicycle comprises a front frame section and a rear frame section. The front frame section has a first member including a first wheel, a second member, and a first pivot member pivotally connecting the first member and the second member along a first axis, the first pivot member having a first pivot axis substantially perpendicular to the first axis to allow the first member to pivot towards the second member until the first member is substantially parallel to the second member. The rear frame section has a third member connected to the front frame section, a fourth member, a fifth member including a second wheel, and a second pivot member pivotally connecting the third member and the fourth member along a second axis, the second pivot member having a second pivot axis substantially perpendicular to the second axis to allow the third member to pivot towards fourth member until the third member is substantially parallel to the fourth member. The rear frame section also has a third pivot member pivotally connecting the fourth member and the fifth member along the second axis, the third pivot member having a third pivot axis substantially perpendicular to the second axis to allow the fifth member to pivot towards fourth member until the fifth member is substantially parallel to the fourth member.

[0016] In a third non-limiting aspect of the invention, a method for folding a bicycle is provided. The method preferably comprises the steps of folding a first end of a fork of the bicycle connected to a first wheel about a first pivot axis towards a second end of the fork until the first end is substantially parallel to the second end; folding a first end of a frame of the bicycle pivotally connected to the fork about a second pivot axis towards a second end of the frame until the first end of the frame is substantially parallel to the frame; and folding the second end of the frame connected to a second wheel about a third pivot axis towards the first end of the frame until the second wheel is substantially parallel to the first wheel.

[0017] The method preferably further comprises pivoting a steering member connected to the second end of the fork about a fourth pivot axis away from the fork; rotating the steering member about a fifth pivot axis until the steering member is substantially parallel to the fork; and folding the

steering member about the fourth pivot axis at least partially within a cavity of the fork. The method further comprises folding a footrest unit about a sixth pivot axis towards the frame and folding an upper seat portion of a seat unit about a seventh pivot axis towards a lower seat portion of the seat unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] A further understanding of the invention can be obtained by reference to a preferred embodiment set forth in the illustrations of the accompanying drawings. Although the illustrated embodiment is merely exemplary of systems and methods for carrying out the invention, both the organization and method of operation of the invention, in general, together with further objectives and advantages thereof, may be more easily understood by reference to the drawings and the following description. The drawings are not intended to limit the scope of this invention, which is set forth with particularity in the claims as appended or as subsequently amended, but merely to clarify and exemplify the invention.

[0019] For a more complete understanding of the invention, reference is now made to the following drawings in which:

[0020] FIG. 1A illustrates a left side view of a folding bicycle in a riding configuration according to an embodiment of the invention.

[0021] FIG. 1B illustrates a perspective view of the steering unit of the folding bicycle of FIG. 1A according to an embodiment of the invention.

[0022] FIG. 1C illustrates a perspective view of the steering unit of the folding bicycle of FIG. 1A in the riding configuration according to an embodiment of the invention.

[0023] FIG. 1D illustrates a perspective view of the folding bicycle of FIG. 1A with the steering unit removed to depict the fork locking mechanism according to an embodiment of the invention.

[0024] FIG. 1E illustrates a perspective view of the underside of the steering unit of the folding bicycle of FIG. 1A according to an embodiment of the invention.

[0025] FIG. 1F illustrates a left side view of the folding bicycle of FIG. 1A depicting a steering unit, a footrest unit, and a seat unit of the folding bicycle of FIG. 1A according to an embodiment of the invention.

[0026] FIG. 2 illustrates a left side view of the folding bicycle of FIG. 1A in a collapsed and/or storage configuration according to an embodiment of the invention.

[0027] FIG. 3 illustrates a top view of the folding bicycle of FIG. 1A in a collapsed and/or storage configuration according to an embodiment of the invention.

[0028] FIGS. 4A-B is a flow diagram illustrating the method of folding the bicycle of FIGS. 1A-3 from the riding configuration of FIG. 1A to the collapsed and/or storage configuration of FIGS. 2 and 3 and corresponding images according to an embodiment of the invention.

[0029] FIG. 5A illustrates a left side view of the folding bicycle of FIG. 1A with the steering unit in a first folded position according to an embodiment of the invention.

[0030] FIG. 5B illustrates a left side view of the folding bicycle of FIG. 1A with the steering unit in a second folded position according to an embodiment of the invention.

[0031] FIG. 6 illustrates a perspective view of the folding bicycle of FIG. 1A with the steering unit in a third folded position according to an embodiment of the invention.

[0032] FIG. 7 illustrates a left side view of the folding bicycle of FIG. 1A in a first folded position according to an embodiment of the invention.

[0033] FIG. 8 illustrates a top view of the folding bicycle of FIG. 1A depicting a first primary fold of the folding bicycle in mid-fold position according to an embodiment of the invention.

[0034] FIG. 9 illustrates a left side view of the folding bicycle of FIG. 1A in a second folded position according to an embodiment of the invention.

[0035] FIG. 10 illustrates a left side view of the folding bicycle of FIG. 1A depicting a second primary fold of the folding bicycle in mid-fold position according to an embodiment of the invention.

[0036] FIG. 11 illustrates a left side view of the folding bicycle of FIG. 1A in a third folded position according to an embodiment of the invention.

[0037] FIG. 12 illustrates a left side view of the folding bicycle of FIG. 1A depicting a third primary fold of the folding bicycle in mid-fold position according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0038] The invention may be understood more readily by reference to the following detailed description of preferred embodiment of the invention. However, techniques, systems and operating structures in accordance with the invention may be embodied in a wide variety of forms and modes, some of which may be quite different from those in the disclosed embodiment. Consequently, the specific structural and functional details disclosed herein are merely representative, yet in that regard, they are deemed to afford the best embodiment for purposes of disclosure and to provide a basis for the claims herein, which define the scope of the invention. It must be noted that, as used in the specification and the appended claims, the singular forms “a”, “an”, and “the” include plural referents unless the context clearly indicates otherwise.

[0039] Referring now to the figures, wherein like numerals indicate like elements throughout, FIG. 1A illustrates an embodiment of folding bicycle 100 in a riding configuration 101. As shown in FIG. 1A, folding bicycle 100 comprises a frame 102 and a rear wheel 108 rotatably connected to frame 102. As further shown in FIG. 1A, frame 102 may extend only longitudinally along a first axis. Rear wheel 108 and frame 102 are located in a first plane 103. Folding bicycle 100 also comprises a fork 104, whereby fork 104 is pivotally connected to frame 102, via a steering column or headset 141 (best shown in FIG. 1C), and a front wheel 106 rotatably connected to fork 104. Front wheel 106 and fork 104 are located in a second plane 109. As further shown in FIG. 1A, rear wheel 108 may be connected to frame 102 at a first height, and fork 104 may be connected to frame 102 at a second height which is higher than the first height. Also, the angle between frame 102 and fork 104 may be approximately 90 degrees.

[0040] Folding bicycle 100 also comprises first, second, and third primary pivot members 110, 116 and 122. First primary pivot member or hinge 110 preferably has a pivot axis 111 substantially parallel to plane 109. First primary pivot member 110 pivotally connects a first end 112 of fork 104 to a second end 114 of fork 104 along an axis 107 of fork 104. Pivot axis 111 is substantially perpendicular to axis 107

of fork 104. Second primary pivot member or hinge 116 has a pivot axis 117 substantially perpendicular to plane 103. Second primary pivot member 116 pivotally connects a first end 118 of frame 102 to a middle portion 120 of frame 102 along an axis 105 of frame 102. Pivot axis 117 is substantially perpendicular to axis 105 of frame 102. Third primary pivot member or hinge 122 has a pivot axis 123 substantially parallel to plane 103. Third primary pivot member 122 pivotally connects a second end 124 of frame 102 to middle portion 120 of frame 102 along axis 105 of frame 102. Pivot axis 123 is substantially perpendicular to axis 105 of frame 102.

[0041] Furthermore, folding bicycle 100 comprises a steering unit 125 having a coupling member or elbow-shaped member 126 (best shown in FIG. 1B) and a steering member or handlebar 128. Handlebar 128 is pivotally connected to fork 104 by coupling member 126. Folding bicycle 100 also comprises a footrest unit 135 pivotally connected to frame 102 by a secondary pivot member or hinge 142. Finally, folding bicycle 100 comprises a seat unit or saddle 145 connected to frame 102 to allow a rider to sit on folding bicycle 100. Saddle 145 comprises a secondary pivot member or hinge 150 to allow saddle 145 to fold.

[0042] As shown in detail in FIG. 1B, folding bicycle 100 comprises a steering unit 125 having a coupling member or elbow-shaped member 126 pivotally coupled to fork 104, and a steering member or handlebar 128 rotatably coupled to coupling member 126. Steering unit 125 further comprises a plate 155 molded or welded to a first end 156 of coupling member 126, a secondary pivot member or swivel mount 550 (best shown in FIG. 1E) rotatably connecting steering member or handlebar 128 to plate 155, a secondary pivot member or axle 130 pivotally connecting a second end 132 of coupling member 126 to second end 114 of fork 104, and a locking mechanism 160 coupled to second end 132 of coupling member 126.

[0043] Moreover, as shown in FIG. 1B, secondary pivot member or axle 130 comprises a hollow cylindrical member 171 that extends between internal surfaces 131 and 133 of fork 104 and a nut 137 coupled to a bolt 143. Hollow cylindrical member 171 comprises a bore (not shown) adapted to receive bolt 143. The bore (not shown) extends internally through the entire length of hollow cylindrical member 171. Bolt 143 resides within the bore (not shown). Hollow cylindrical member 171 is preferably molded or welded to external surface 181 of coupling member 126 near second end 132 of coupling member 126. Bolt 143 comprises a head portion 560 (best shown in FIG. 5B) at a first end and a threaded portion 173 at an opposed second end. Nut 137 preferably comprises threads (not shown) adapted to grip threaded portion 173 of bolt 143. Nut 137 and bolt 143 may be any type of nut and bolt combination commonly known and used in the art, without departing from the spirit of the present invention.

[0044] Axle 130 is created by sliding bolt 143 through an aperture 570 (best shown in FIG. 1D) provided on sidewall 190 of fork 104 and through hollow cylindrical member 171 until head portion 560 (FIG. 5B) of bolt 143 abuts external surface 191 of fork 104 and threaded portion 173 of bolt 143 protrudes through an aperture 572 (best shown in FIG. 1D) provided on sidewall 192 of fork 104. Nut 137 is then coupled to threaded portion 173 of bolt 143 to secure bolt 143 in place. Axle 130 has a pivot axis 504. Pivot axis 504 is perpendicular to axis 107 and plane 109 of fork 104. Axle

130 serves to pivotally connect coupling member 126 to fork 104 and thereby allows coupling member 126, and therefore handlebar 128, to pivot about pivot axis 504 when locking mechanism 160 is in the unlocked position.

[0045] Turning now to FIG. 1C, steering unit 125 is depicted in a locked position 170 suitable for riding configuration 101. In this position, coupling member 126, and therefore handlebar 128, are prevented from rotating about pivot axis 504. Locking mechanism 160 comprises two donut-shaped members 174 and 176 and a locking pin 172. Donut-shaped members 174 and 176 are cylindrical in shape and each contains a bore 194 and 196, respectively, extending from end to end. Furthermore, donut-shaped members 174 and 176 are preferably molded or welded to external surface 181 of coupling member 126, near second end 132 of coupling member 126, and are adapted to fit within the sidewalls of fork 104. Locking pin 172 comprises a cylindrical head portion 177 and a cylindrical rod portion 179 extending laterally from head portion 177. Cylindrical rod portion 179 generally has a length longer than the width of fork 104 so that it may extend entirely through fork 104 in order to lock steering unit 125 in place. Additionally, the diameter of cylindrical head portion 177 is generally larger than the diameter of cylindrical rod portion 179 to prevent cylindrical head portion 177 from entering aperture 535 (best shown in FIG. 1D) with the result that it may abut external surface 193 of fork 104 when it is in place. Cylindrical head portion 177 comprises an aperture 178 adapted to receive a retaining wire 180. Retaining wire 180 is provided to retain locking pin 172 to folding bicycle 100 by securely coupling retaining wire 180 to fork 104. Locking pin 172 is coupled to folding bicycle 100 by first sliding a first end of retaining wire 180 through aperture 178 of cylindrical head portion 177 and subsequently coupling the first end of retaining wire 180 to another portion of retaining wire 180, then sliding a second end of retaining wire 180 through an aperture 182 provided on fork 104, and finally creating a loop or knot (not shown) on the second end of retaining wire 180 to prevent that end from sliding back through aperture 182 of fork 104.

[0046] To place steering unit 125 in locked position 170, first, handlebar 128 must be rotated about pivot axis 504 until bore 194 of donut-shaped member 174 is aligned with an aperture 536 (best shown in FIG. 1D) provided on sidewall 190 of fork 104 and bore 196 of donut-shaped member 176 is aligned with an aperture 535 (best shown in FIG. 1D) provided on sidewall 192 of fork 104; then, cylindrical rod portion 179 of locking pin 172 is slid through aperture 535 (FIG. 1D) provided on sidewall 192, through bore 196 of donut-shaped member 176, through bore 194 of donut-shaped member 174 and finally through aperture 536 (FIG. 1D) provided on sidewall 190 of fork 104 until cylindrical rod portion 179 protrudes through aperture 536 (FIG. 1D). Furthermore, locking pin 172 is preferably slid from sidewall 192 of fork 104 to sidewall 190 of fork 104 until the bottom surface of cylindrical head portion 177 of locking pin 172 abuts external surface 193 of fork 104, as shown in FIG. 1C. Once locking pin 172 is in place, as just described, handlebar 128 is prevented from rotating about pivot axis 504 and steering unit 125 is in locked position 170. It should be appreciated that, when in the position shown in FIG. 1C, locking pin 172 serves to keep handlebar

128 stable and at the appropriate level to allow a rider or user of folding bicycle 100 to easily and comfortably ride folding bicycle 100.

[0047] FIGS. 1C and 1D also depict a fork locking mechanism 515. More specifically, FIG. 1D illustrates a perspective view of the folding bicycle of FIG. 1A with steering unit 125 removed so as to enable fork locking mechanism 515 to be seen more readily. As shown in FIGS. 1C and 1D, folding bicycle 100 preferably comprises a fork locking mechanism 515 adapted to lock fork 104 to steering column 141, thereby preventing fork 104 from being able to pivot about steering column 141 when in the locked position. By preventing fork 104 from pivoting about steering column 141, folding bicycle 100 becomes more stable, thus making it easier to control and subsequently fold folding bicycle 100. Fork locking mechanism 515 comprises a donut-shaped member 520 connected to steering column 141. Donut-shaped member 520 is preferably molded or welded to steering column 141; however, it should be understood and appreciated that donut-shaped member 520 may be connected to steering column 141 by any known means or method without departing from the spirit of the invention. Moreover, donut-shaped member 520 comprises a bore 518 that extends completely through the body of donut-shaped member 520, as shown in FIGS. 1C and 1D. Fork locking mechanism 515 also comprises two plates 524 and 526 both of which extend between internal surfaces 131 and 133 of fork 104 near the top of fork 104. Specifically, plates 524 and 526 are located near the top of second end 114 of fork 104, in close proximity to where fork 104 pivotally couples to steering column 141 of frame 102. As shown in FIG. 1D, plate 524 comprises an aperture 522 that extends completely through plate 524, and plate 526 comprises an aperture 528 that extends completely through plate 526. Fork locking mechanism 515 is placed into the locked position by preferably sliding locking pin 172 through bore 518 of donut-shaped member 520, into aperture 522 of plate 524, and into aperture 528 of plate 526, as shown in FIG. 1D. Once locking pin 172 is in place, as just described, fork 104 is prevented from rotating about steering column 141 of frame 102.

[0048] In operation, when a rider or user of folding bicycle 100 desires to fold folding bicycle 100, it is preferred that the user first unlock locking mechanism 160 and then lock fork locking mechanism 515. Starting from the riding configuration, locking mechanism 160 is unlocked by removing locking pin 172 from fork 104, thereby releasing secondary pivot member 130 from its locked position and subsequently allowing handlebar 128 to pivot about pivot axis 504. After locking mechanism 160 is unlocked, as just described, fork locking mechanism 515 is locked using locking pin 172, in the manner described above, to prevent fork 104 from rotating about steering column 141, thereby allowing a user to more easily fold folding bicycle 100.

[0049] FIG. 1E depicts the underside of steering unit 125 of folding bicycle 100 of FIG. 1A according to an embodiment of the invention. As shown, steering unit 125 preferably comprises a secondary pivot member or swivel mount 550 adapted to pivotally or rotatably connect steering member or handlebar 128 to coupling member 126. Secondary pivot member 550 preferably comprises a swivel member 551 that allows steering member 128 to rotate or swivel about coupling member 126. Swivel member 551 is molded or welded to the underside 552 of steering member 128. More specifically, one of the exterior surfaces of swivel

member 551 is preferably molded or welded to underside 552 of steering member 128, as shown in FIG. 1E. Swivel member 551 is also preferably rotatably coupled to an exterior surface 554 of plate 155, thereby allowing steering member 128 to rotate or swivel relative to coupling member 126.

[0050] It should be understood and appreciated that while a particular swivel mount 550 has been depicted and described, any type of swivel member or device commonly known or used in the art may be used to couple steering member 128 to coupling member 126, so as to allow steering member 128 to rotate relative to coupling member 126, without departing from the separate of the invention.

[0051] Moreover, secondary pivot member or swivel mount 550 preferably has a pivot axis 532 that is substantially parallel to plane 109 of fork 104 and substantially perpendicular to plate 155 of coupling member 126. Secondary pivot member 550 allows steering member 128 to pivot or rotate about pivot axis 532, after secondary pivot member 550 is released from its locked position. Secondary pivot member 550 preferably allows steering member 128 to pivot or rotate in a direction 530 about pivot axis 532 in order for steering member 128 to align substantially parallel with fork 104 and align with cavity 502, as shown in FIGS. 5B and 6, to form folded configuration 534 (FIG. 5B). It should be understood and appreciated that steering member 128 may be any type of handlebar or handlebars commonly known or used in the art, which a rider of folding bicycle 100 may use to steer folding bicycle 100, without limiting the scope of the invention.

[0052] Referring now to FIG. 1F, steering unit 125, footrest unit 135, and seat unit 145 of folding bicycle 100 are illustrated. As shown in FIG. 1F, steering member 128 is adapted to pivot about pivot axis 504 in a direction 618 towards fork 104 and in a direction 506 away from fork 104, via secondary pivot member 130.

[0053] Footrest unit 135 comprises an elongated member 136 pivotally connected to frame 102. Footrest unit 135 also comprises a flange or footrest member 138 (best shown in FIG. 5A) preferably connected to elongated member 136 and a secondary pivot member or hinge 142 pivotally connecting elongated member 136 to frame 102. Moreover, footrest unit 135 is adapted to allow a rider of folding bicycle 100 to rest his or her feet when folding bicycle 100 is in riding configuration 101 and is adapted to be pivoted, via secondary pivot member 142, in directions 606 and 608 towards and away from, respectively, frame 102. For example, to fold footrest unit 135 for storage, after secondary pivot member or hinge 142 has been released from its locked position, elongated member 136 is pivoted in direction 606 toward frame 102 until elongated member 136 abuts the underside 602 of frame 102. A retaining member or clip 607 (schematically shown) may be provided on underside 602 of frame 102 to retain footrest unit 135 to frame 102.

[0054] As illustrated in FIG. 1F, elongated member 136 extends along an axis 600 and has a first end 144 and a second end 140. Secondary pivot member or hinge 142 is adapted to pivotally connect first end 144 of elongated member 136 to frame 102 and footrest member 138 (best shown in FIG. 5A) is preferably connected to second end 140 of elongated member. Moreover, secondary pivot member 142 comprises a pivot axis 604 substantially perpendicular to plane 103 and axis 105 and substantially perpen-

dicular to axis 600 of elongated member 136 that allows elongated member 136 to pivot about pivot axis 604 after secondary pivot member 142 is released from its locked position. In particular, secondary pivot member 142 is adapted to allow elongated member 136 to pivot about pivot axis 604 in a direction 606 towards frame 102 and in a direction 608 away from frame 102.

[0055] Briefly turning to FIG. 5A, footrest unit 135 also preferably comprises flange 138 comprising two members 152 and 154 extending substantially perpendicular from elongated member 136. Members 152 and 154 are preferably flat and are provided to allow a rider to rest his or her feet on the top surface 139 of members 152 and 154 while the rider is riding folding bicycle 100. While not shown in the figures, it is further contemplated that two pivot members or hinges may be adapted to pivotally connect members 152 and 154 to elongated member 136. Each pivot member preferably comprises a pivot axis substantially parallel with plane 103 and perpendicular with axis 600 to allow members 152 and 154 of flange 138 to fold or pivot about their respective pivot axis towards elongated member 136 until each member 152 and 154 is substantially parallel to axis 600 and away from elongated member 136 until each member 152 and 154 is substantially perpendicular to elongated member 136.

[0056] Referring back to FIG. 1F, folding bicycle 100 also comprises a seat unit or saddle 145 connected to frame 102. Seat unit 145 preferably comprises an upper seat portion or upright, rear portion 146, a lower seat portion or base 148, and a secondary pivot member or hinge 150 pivotally connecting upper seat portion 146 to lower seat portion 148. Seat unit 145 is preferably connected or mounted to frame 102 by connecting lower seat portion 148 to the topside 616 of frame 102. Lower seat portion 148 may be connected or mounted to frame 102 via any method known in the art for connecting a bicycle saddle to a frame, including but not limited to, the use of a nut and bolt, screws, and the like.

[0057] Seat unit 145 is preferably adapted to allow a rider of folding bicycle 100 to sit when folding bicycle 100 is in riding configuration 101 and adapted to be pivoted, via secondary pivot member 150, in directions 610 and 612 towards and away from, respectively, frame 102. For example, to fold seat unit 145 for storage, after secondary pivot member or hinge 150 has been released from its locked position, upper seat portion 146 is preferably pivoted in direction 610 toward frame 102 until upper seat portion 146 abuts lower seat portion 148. While not shown, it is contemplated that a retaining member, clip, strap, or the like may be provided to retain upper seat portion 146 to lower seat portion 148. Moreover, lower seat portion 148 is preferably connected to topside 616 of frame 102 by any commonly known means and method.

[0058] Specifically, as illustrated in FIG. 1F, seat unit 145 preferably comprises a secondary pivot member or hinge 150 adapted to pivotally connect upper seat portion 146 to lower seat portion 148. Moreover, secondary pivot member 150 preferably comprises a pivot axis 614 substantially perpendicular to plane 103 and axis 105 to allow upper seat portion 146 to pivot about pivot axis 614 relative to lower seat portion 148 after secondary pivot member 150 is released from its locked position. In particular, secondary pivot member 150 is adapted to allow upper seat portion 146 to pivot about pivot axis 614 in a direction 610 towards frame 102 and in a direction 612 away from frame 102.

[0059] As shown in FIGS. 1A and 1B, folding bicycle 100 comprises several components implemented by traditional, manually powered bicycles. For example, folding bicycle 100 comprises steering unit 125, steering column or headset 141, fork 104, frame 102, and wheels 106 and 108. It should be understood and appreciated that one skilled in the art would know how to pivotally mount fork 104 comprising any type of traditional handlebar to steering column or headset 141 of frame 102, thereby allowing a rider to steer folding bicycle 100. It should also be understood and appreciated that (i) steering column or headset 141 may be coupled to frame 102 by any method or implementation commonly known in the art, particularly by being threaded, bolted, or welded to first end 118 of frame 102; (ii) fork 104 may be coupled to steering column or headset 141 by any method or implementation commonly known in the art to allow fork 104 to pivot about frame 102; and (iii) steering column or head set 141 operates in a similar manner as any steering column or headset commonly known or used in the art, without departing from the spirit of the present invention and without limiting the scope of the present invention. Additionally, it should be understood and appreciated that steering column or headset 141 may be any steering column or headset commonly known or used in the art, without departing from the spirit of the present invention. Moreover, any known method and implementation and any known components for pivotally mounting steering unit 125 to folding bicycle 100 may be employed, without limiting the scope of the present invention. Furthermore, it should be understood that one skilled in the art would also know how to rotatably mount wheels 106 and 108 to folding bicycle 100. Accordingly, any known method or implementation of any known components for mounting wheels 106 and 108 to folding bicycle 100 may be employed, without limiting the scope of the present invention.

[0060] Moreover, while not shown, it is contemplated that folding bicycle 100 is preferably powered by a drive mechanism comprising an electric throttle (not shown) provided on steering unit 125 and powered by a rechargeable battery (not shown) housed under seat unit 145. It is further contemplated that the drive mechanism, which is powered by the rechargeable battery (not shown), drives rear wheel 108 to propel folding bicycle 100, via a motor (not shown), preferably housed in a rear wheel axle drum (not shown) and connected to rear wheel 108. It should be understood that one skilled in the art would know how to implement any commonly known or used drive mechanism with folding bicycle 100 in order to propel folding bicycle 100. Accordingly, any known method and implementation of any known components for utilizing a commonly known or used drive mechanism to power an electric bicycle may be employed, without limiting the scope of the present invention.

[0061] It should also be understood that while folding bicycle 100 is in the riding configuration 101, as illustrated in FIG. 1A, all pivot members or hinges implemented by folding bicycle 100 are in a locked position to prevent the hinges from folding and to maintain the rigid structure of folding bicycle 100. Moreover, while not shown in the figures, it is contemplated that any locking mechanism commonly known or used in the art, such as a hole or interlocking teeth with a mating pin inserted therethrough, mating snap or clasp members, and the like, may be implemented to maintain each of the hinges in a locked position when folding bicycle 100 is in riding configuration 101, as

illustrated in FIG. 1A, without limiting the scope of the invention. It should also be appreciated that any locking mechanism employed to lock the hinges is capable of being unlocked to allow the hinges to pivot about their respective pivot axes.

[0062] Referring to FIGS. 2 and 3, folding bicycle 100 is illustrated in fully folded, collapsed or storage configuration 200. Specifically, FIGS. 2 and 3 provide a side view and a top view, respectively, of folding bicycle 100 in its completely folded state. When wheel 106 is folded at hinge 110, wheel 106 becomes aligned with the left side of fork 104. When the front end 118 of frame 102 is folded at hinge 116, front wheel 106 is moved so that it is along the left side of frame 102. When wheel 108 is folded at hinge 122 (FIG. 1A), it becomes aligned with the right side of frame 102. While it has been described that when folding bicycle 100 is in collapsed or storage configuration 200, wheel 106 is aligned with the left side of fork 104 and wheel 108 is aligned with the right side of frame 102, it should be appreciated that wheels 106 and 108 may be aligned on either side of folding bicycle 100, without limiting the scope of the invention. Notably, it should be understood that when folding bicycle 100 is in configuration 200, wheels 106 and 108 are folded on opposite sides of folding bicycle 100.

[0063] FIGS. 4A-4B depict a flow diagram illustrating a preferred method for folding bicycle 100 of FIGS. 1A-3 and 5A-12 from riding configuration 101 of FIG. 1A to collapsed and/or storage configuration 200 of FIGS. 2-3 according to an embodiment of the invention. The method starts at step 400 where folding bicycle 100 is in riding configuration 101 and where fork 104 and plane 109 are aligned in parallel with frame 102 and plane 103. In step 402, locking mechanism 160 is first unlocked, in the manner described above, thereby releasing secondary pivot member 130 from its locked position and subsequently allowing handlebar 128 to pivot about pivot axis 504. After locking mechanism 160 is unlocked, fork locking mechanism 515 is locked, in the manner described above, to prevent fork 104 from rotating about steering column 141, thereby allowing a user to more easily fold folding bicycle 100. After unlocking locking mechanism 160 and locking fork locking mechanism 515, steering member 128, via secondary pivot member 130, is tilted or pivoted in direction 506 about 90 degrees about pivot axis 504, thereby forming folded configuration 508. In step 404, steering member 128, via swivel mount 550, is rotated in direction 530 about 90 degrees about pivot axis 532 until steering member 128 is substantially parallel to plane 109 of fork 104, thereby forming folded configuration 534.

[0064] Next, in step 406, steering member 128 is folded in direction 618 toward fork 104, about pivot axis 504 until steering member 128 is at least partially disposed within cavity 502, thereby forming folded configuration 702. Moreover, in step 406, secondary pivot member 142 is released from its locked position and footrest unit 135 is folded in direction 606 toward frame 102, about pivot axis 604, until footrest unit 135 abuts underside 602 of frame 102, thereby forming folded configuration 704. It is contemplated that footrest unit 135 may be clipped using a retaining member (not shown) or clip (not shown) to underside 602 of frame 102 to securely retain footrest unit 135 against frame 102. Finally, in step 406, secondary pivot member 150 is released from its locked position and upper seat portion 146 is folded in direction 610 toward lower seat portion 148, about pivot

axis 614, until upper seat portion 146 abuts lower seat portion 148, thereby forming folded configuration 706. It is further contemplated that upper seat portion 146 may be securely retained to lower seat portion 148 using any known method or components. Additionally, it should be appreciated that secondary pivot members 142 and 150 may be locked using any commonly known method or implementation and, particularly, by using a locking pin as described above with respect to locking mechanism 160, without limiting the scope of the present invention.

[0065] In step 408 primary pivot member 110 is released from its locked position and first end 112 of fork 104 is folded in direction 802 towards second end 114 of fork 104 about 180 degrees about pivot axis 111 until first end 112 is substantially parallel to second end 114, planes 103 and 109, and axes 105 and 107, thereby forming folded configuration 900. Next, in step 410, primary pivot member 116 is released from its locked position and first end 118 of frame 102 is folded in direction 1004 towards second end 124 of frame 102 about 180 degrees about pivot axis 117 until first end 118 is substantially parallel to frame 102 and axis 105. Folded configuration 900 remains substantially parallel to plane 103, thereby forming folded configuration 1102. In step 412, primary pivot member 122 is released from its locked position and second end 124 of frame 102 is folded in direction 1202 towards first end 118 of frame 102 about 180 degrees about pivot axis 123 until second end 124 and consequently wheel 108 are substantially parallel to frame 102, planes 103 and 109, axes 105 and 107, wheel 106, and folded configuration 1102, thereby forming folded configuration or collapsed configuration 200. It is contemplated that any known method or components may be implemented to securely retain folding bicycle 100 in collapsed configuration 200, without limiting the scope of the invention. The method ends at step 414.

[0066] Further details of folding bicycle 100 are set forth in FIGS. 5A-12. Turning now to FIGS. 5A-7, steering unit 125 of folding bicycle 100 is illustrated. Steering unit 125 preferably comprises at least two pivot members to allow it to be folded into a cavity 502 formed in fork 104. Specifically, as illustrated in FIGS. 5A-6, steering unit 125 preferably comprises coupling member 126 having a first end 156 and a second end 132, a plate 155 molded or welded to first end 156, a secondary pivot member or swivel mount 550 (FIG. 1E) adapted to preferably pivotally mount steering member 128 to plate 155, and a secondary pivot member or axle 130 adapted to preferably pivotally connect second end 132 of coupling member 126 to second end 114 of fork 104. Turning briefly to FIG. 1E, secondary pivot member or swivel mount 550 preferably comprises a pivot axis 532 substantially parallel to plane 109 and substantially perpendicular to plate 155 to allow steering member 128 to rotate about pivot axis 532 and relative to coupling member 126. Referring back to FIG. 5A, secondary pivot member 130 preferably comprises a pivot axis 504 substantially perpendicular to plane 109 and substantially perpendicular to axis 107 to allow steering member 128 to pivot about pivot axis 504 and relative to fork 104, after secondary pivot member 130 is released from its locked position. In particular, secondary pivot member 130 is preferably adapted to allow steering member 128, via coupling member 126, to pivot about pivot axis 504 in a direction 506 away from fork 104 and in a direction 618 (FIG. 1F) towards fork 104. To fold steering unit 125 into configuration 702 after secondary

pivot member 130 has been released from its locked position, steering member 128 is preferably (i) pivoted in a direction 506 away from fork 104 to form folded configuration 508; (ii) pivoted or rotated in a direction 530 until steering member 128 is substantially parallel to fork 104 to form folded configuration 534; and (iii) pivoted in a direction 618 towards fork 104 until steering member 128 is at least partially disposed within a cavity 502 provided in fork 104.

[0067] Referring back to 1F, to fold footrest unit 135 into folded configuration 704 (FIG. 7), secondary pivot member 142 is first unlocked and elongated member 136 is then pivoted in direction 606 until elongated member 136 abuts underside 602 of frame 102. Moreover, to fold seat unit 145 into folded configuration 706 (FIG. 7), secondary pivot member 150 is first unlocked and upper seat portion 146 is then pivoted in direction 610 until upper seat portion 146 abuts lower seat portion 148. It is also contemplated that when seat unit 145 is in the folded position as depicted in FIG. 7, it may be used as a handle or grip member, thereby allowing a user to conveniently carry folding bicycle 100.

[0068] Further details of the various folding operations described above are depicted in FIGS. 7-12. Referring to FIG. 7, each of the secondary folding components, i.e., steering unit 125, footrest unit 135, and seat unit 145 are in the folded configurations 702, 704, and 706, respectively, as discussed above with respect to FIGS. 5A-6. As illustrated, steering member 128 is rotated and folded in a direction 618 into cavity 502 of fork 104, elongated member 136 is folded in a direction 606 to frame 102, and upper seat portion 146 is folded in a direction 610 to lower seat portion 148. When folded into the storage or folded configurations 702, 704, and 706, steering member 128 is preferably aligned substantially parallel with fork 104, plane 109, and axis 107 and is disposed in cavity 502, elongated member 136 preferably abuts underside 602 of frame 102, where it may be held in place by a retaining member (not shown), and upper seat portion 146 preferably rests on top of lower seat portion 148, where it may be held in place by a retaining member (not shown).

[0069] Turning now to FIGS. 8-9, the folding of fork 104 of folding bicycle 100 is illustrated. To complete this fold, first end 112 of fork 104 is pivoted towards second end 114 of fork 104 until first end 112 is substantially parallel to second end 114. Primary pivot member or hinge 110 having pivot axis 111 (FIG. 1A) pivotally connects first end 112 of fork 104 to second end 114 of fork 104. Generally, after primary pivot member or hinge 110 has been released from its locked position, first end 112 of fork 104 pivots about pivot axis 111 in a direction 802 toward second end 114 of fork 104 until first end 112 is substantially parallel to second end 114 plane 109, and axis 107.

[0070] Specifically, as illustrated in FIGS. 8-9, primary pivot member or hinge 110 is preferably provided about halfway down the length of fork 104 on the left side and is adapted to pivotally connect first end 112 of fork 104 to second end 114 of fork 104. Also provided is a locking mechanism (not shown) to releasably lock primary pivot member 110 in a rigid position. Locking mechanism may be unlocked to allow pivot member 110 to pivot about pivot axis 111. It should be understood that any commonly known or used locking mechanism may be incorporated, without limiting the scope of the invention. When folding bicycle 100 is in riding configuration 101 as illustrated in FIG. 1A,

first end 112 and second end 114 of fork 104 extend along plane 109 and axis 107. Moreover, primary pivot member 110 comprises pivot axis 111 substantially parallel to plane 109 of fork 104 and substantially perpendicular to axis 107 of fork 104 to allow first end 112 of fork 104 to pivot in direction 802 towards second end 114, and about pivot axis 111, after primary pivot member 110 is released from its locked position. Primary pivot member 110 allows first end 112 to pivot in directions 802 and 804, towards and away from, respectively, second end 114, as illustrated in FIGS. 8-9.

[0071] Referring to FIG. 9, folding bicycle 100 is illustrated in yet another folded configuration 900. Specifically, folding bicycle 100 is in folded configuration 900, as discussed above with respect to FIG. 8. As illustrated in FIG. 9, first end 112 of fork 104 is folded in a direction 802 to second end 114 of fork 104. When folding bicycle 100 is folded into folded configuration 900, first end 112 of fork 104 is preferably aligned substantially parallel with second end portion 114 of fork 104, plane 109, and axis 107, where it may be held in place by a retaining member (not shown). In particular, primary pivot member 110 allows first end 112 of fork 104 to pivot towards second end 114 of fork 104 about 180 degrees about pivot axis 111 until first end 112 of fork 104 and consequently wheel 106 is substantially parallel to second end 114 of fork 104, plane 109, axis 107, and folded steering member 128, thereby forming folded configuration 900.

[0072] FIGS. 10-11 depict the folding of the front end 118 of frame 102 on itself. To do this, first end 118 of frame 102 is pivoted towards frame 102. Primary pivot member or hinge 116 having pivot axis 117 is provided to make this fold. Generally, after primary pivot member or hinge 116 has been released from its locked position, first end 118 of frame 102 is pivoted about pivot axis 117 in a direction 1004 toward middle portion 120 of frame 102 until first end 118 of frame 102 is substantially parallel to frame 102, plane 103, and axis 105.

[0073] Specifically, as illustrated in FIGS. 10-11, primary pivot member or hinge 116 is provided about an eighth to about a quarter of the way down the length of frame 102 on the top side and is adapted to pivotally connect first end 118 of frame 102 to middle portion 120 of frame 102. Also provided is a locking mechanism (not shown) to releasably lock primary pivot member 116 in a rigid position. Locking mechanism is unlocked to allow pivot member 116 to pivot about pivot axis 117. It should be understood that any commonly known or used locking mechanism may be incorporated, without limiting the scope of the invention. When folding bicycle 100 is in riding configuration 101 as illustrated in FIG. 1A, first end 118 and middle portion 120 of frame 102 extend along plane 103 and axis 105. Moreover, primary pivot member 116 comprises pivot axis 117 substantially perpendicular to plane 103 and axis 105 of frame 102 to allow first end 118 of frame 102 to pivot in direction 1004 towards middle portion 120 or second end 124 of frame 102, and about pivot axis 117, after primary pivot member 116 is released from its locked position. Primary pivot member 116 allows first end 118 to pivot in directions 1004 and 1006, towards and away from, respectively, middle portion 120 and second end 124 of frame 102, as illustrated in FIGS. 10-11.

[0074] Referring to FIG. 11, folding bicycle 100 is illustrated at the completion of the folding of first end 118 of

frame 102. First end 118 of frame 102 is folded in a direction 1004 to middle portion 120 and second end 124 of frame 102 causing the folded configuration 900 of FIG. 9 to pivot in direction 1004 towards second end 124 of frame 102 about 180 degrees about pivot axis 117. When the first end 118 of frame 102 is folded, as just described, folded configuration 1102 is formed. Specifically, first end 118 of frame 102 is aligned substantially parallel to middle portion 120, second end 124, and axis 105 of frame 102, while remaining substantially parallel to plane 103, where it may be held in place by a retaining member (not shown). In particular, primary pivot member 116 allows first end 118 of frame 102 and consequently wheel 106 to pivot towards middle portion 120 and second end 124 of frame 102 about 180 degrees about pivot axis 117 until first end 118 of frame 102 is substantially parallel to middle portion 120 of frame 102, second end 124 of frame 102, plane 103, and axis 105, and while wheel 106 remains substantially parallel to plane 103 and folded steering member 128, thereby forming folded configuration 1102.

[0075] FIG. 12 depicts the folding of the rear wheel 108 against frame 102. To make this fold, second end 124 of frame 102 is pivoted towards frame 102. Primary pivot member or hinge 122 having pivot axis 123 is provided to complete this fold. Generally, after primary pivot member or hinge 122 has been released from its locked position, second end 124 of frame 102 pivots about pivot axis 123 in a direction 1202 toward middle portion 120 of frame 102 until second end 124 of frame 102 is substantially parallel to frame 102, plane 103, and axis 105.

[0076] Specifically, as illustrated in FIG. 12, primary pivot member or hinge 122 is provided about two thirds of the way down the length of frame 102 on the right side and is adapted to pivotally connect second end 124 of frame 102 to middle portion 120 of frame 102. Also provided is a locking mechanism (not shown) to releasably lock primary pivot member 122 in a rigid position. Locking mechanism may be unlocked to allow pivot member 122 to pivot about pivot axis 123. It should be understood that any commonly known or used locking mechanism may be incorporated, without limiting the scope of the invention. When folding bicycle 100 is in riding configuration 101 as illustrated in FIG. 1A, first end 118, middle portion 120, and second end 124 of frame 102 extend along plane 103 and axis 105. Moreover, primary pivot member 122 preferably comprises pivot axis 123 substantially parallel to plane 103 of frame 102 and substantially perpendicular to axis 105 of frame 102 to allow second end 124 of frame 102 to pivot in direction 1202 towards middle portion 120 or first end 118 of frame 102, about pivot axis 123, relative to frame 102, after primary pivot member 122 is released from its locked position, thereby forming collapsed or storage configuration 200 (FIGS. 2 and 3).

[0077] Primary pivot member 122 preferably allows second end 124 to pivot in directions 1202 and 1204, towards and away from, respectively, middle portion 120 and first end 118 of frame 102, as illustrated in FIG. 12.

[0078] While hinge 110 has been described as being on the left side of fork 104 and hinge 122 on the right side of frame 102, it should be appreciated that hinge 110 could be mounted on the right side of fork 104 and hinge 122 on the left side of frame 102 so that wheels 106 and 108 are on the right and left sides, respectively, of frame 102 when folding bicycle 100 is folded.

[0079] Furthermore, it should be appreciated and understood that each pivot member disclosed and described throughout this specification may be any commonly known and used component or hinge that is capable of performing the desired pivoting action and achieving the desired result. As such, any known or used pivot member or hinge may be incorporated with folding bicycle 100 for any of the pivot members described above, without limiting the scope of the invention.

[0080] It should also be appreciated and understood that each component of folding bicycle 100 may constructed from any type of sturdy material commonly known or used in the art, such as, but not limited to, steel, titanium, and the like, without limiting the spirit of the invention.

[0081] It should also be understood that this invention is not limited to the disclosed features and other similar method and system may be utilized without departing from the spirit and the scope of the invention.

[0082] While the invention has been described with reference to the preferred embodiment and alternative embodiments, which embodiments have been set forth in considerable detail for the purposes of making a complete disclosure of the invention, such embodiments are merely exemplary and are not intended to be limiting or represent an exhaustive enumeration of all aspects of the invention. The scope of the invention, therefore, shall be defined solely by the following claims. Further, it will be apparent to those of skill in the art that numerous changes may be made in such details without departing from the spirit and the principles of the invention. It should be appreciated that the invention is capable of being embodied in other forms without departing from its essential characteristics.

What is claimed is:

1. A bicycle comprising:

a frame extending only longitudinally along a first axis;
a rear wheel rotatably connected to the frame;
a fork connected to the frame;
a front wheel rotatably connected to the fork;
a steering unit connected to the fork; and
a seat connected to the frame.

2. The bicycle of claim 1, wherein the rear wheel and the frame are located in a first plane.

3. The bicycle of claim 1, wherein the rear wheel is connected to the frame at a first height, wherein the fork is connected to the frame at a second height, and wherein the second height is higher than the first height.

4. The bicycle of claim 3, wherein the angle between the frame and the fork is approximately 90 degrees.

5. The bicycle of claim 4, wherein the rear wheel and the frame are located in a first plane.

6. The bicycle of claim 1, further comprising a motor, a drive mechanism, and a rechargeable battery.

7. The bicycle of claim 6, wherein the rechargeable battery is located under the seat.

8. The bicycle of claim 7, wherein the rechargeable battery powers the drive mechanism.

9. The bicycle of claim 6, wherein the motor is located in a rear wheel axle drum connected to the rear wheel.

10. The bicycle of claim 1, further comprising a footrest connected to the frame.

11. The bicycle of claim 10, wherein the footrest comprises an elongated member and a flange.

12. The bicycle of claim 11, wherein the elongated member extends from a first end to a second end, wherein

the first end of the elongated member is connected to the frame, and wherein the flange is connected to the second end of the elongated member.

13. The bicycle of claim 12, wherein the flange extends substantially perpendicular to the elongated member.

14. The bicycle of claim 12, wherein the first end of the elongated member is pivotally connected to the frame.

15. The bicycle of claim 12, wherein the flange comprises a first member and a second member.

16. The bicycle of claim 15, wherein the first member of the flange and the second member of the flange are flat.

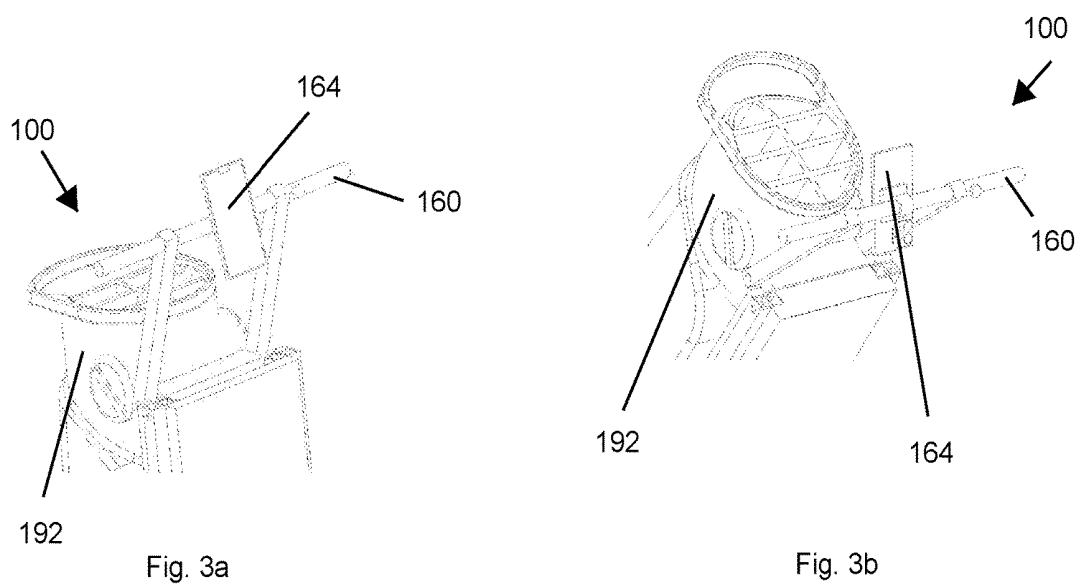
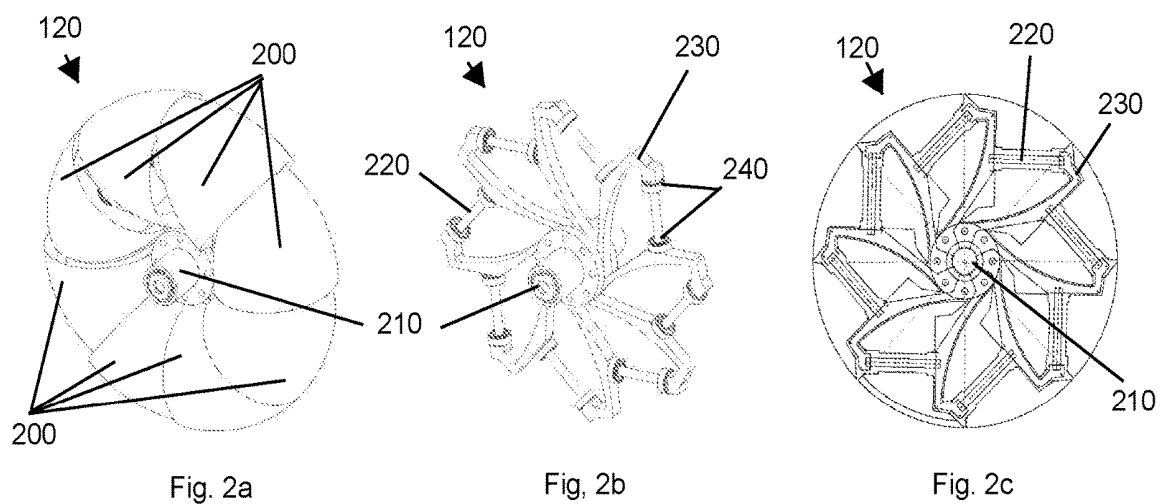
17. The bicycle of claim 3, further comprising a motor, a drive mechanism, and a rechargeable battery.

18. The bicycle of claim 17, wherein the rechargeable battery is located under the seat.

19. The bicycle of claim 18, wherein the rechargeable battery powers the drive mechanism.

20. The bicycle of claim 17, wherein the motor is located in a rear wheel axle drum connected to the rear wheel.

* * * * *



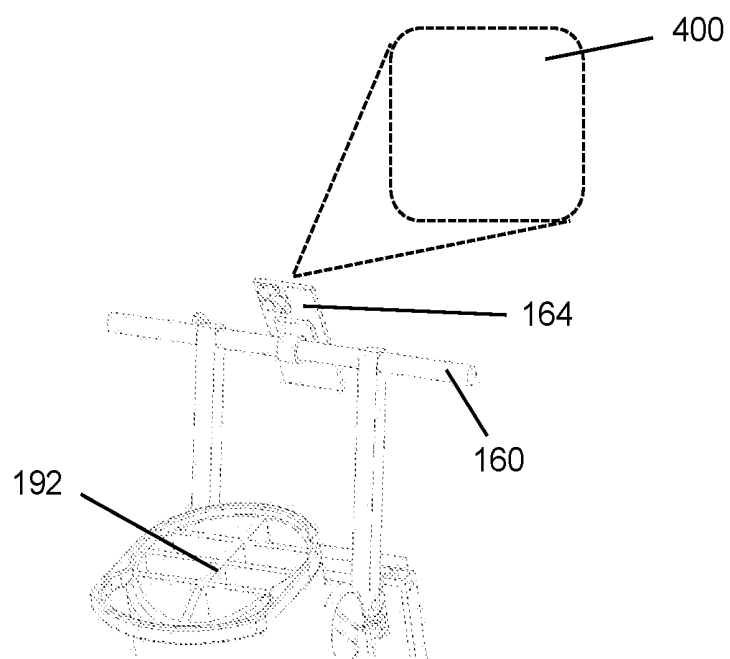


Fig. 4

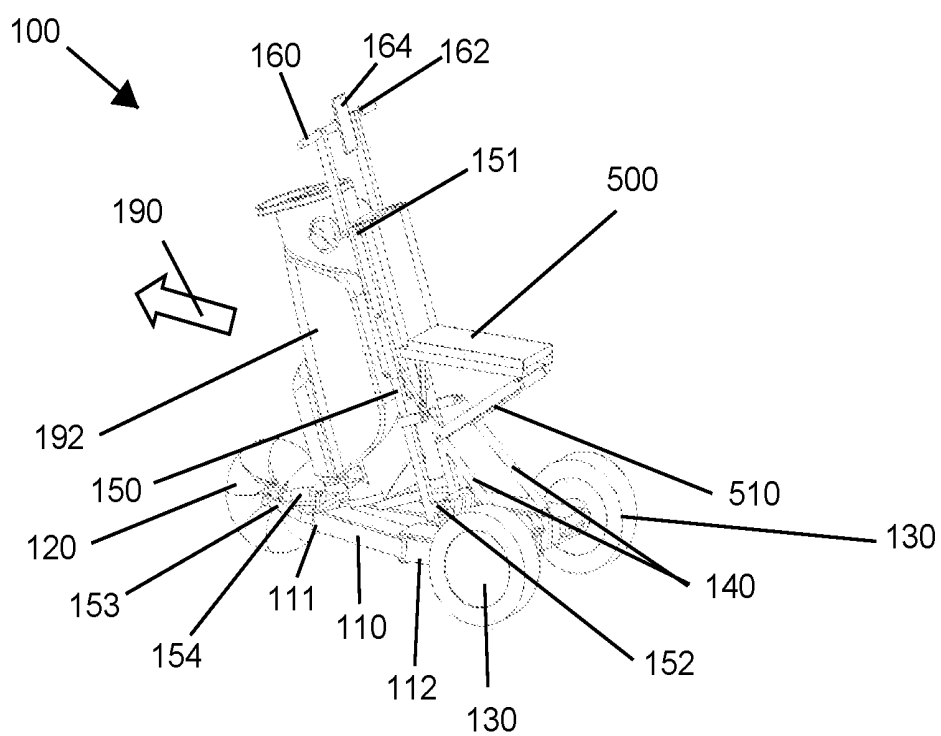


Fig. 5

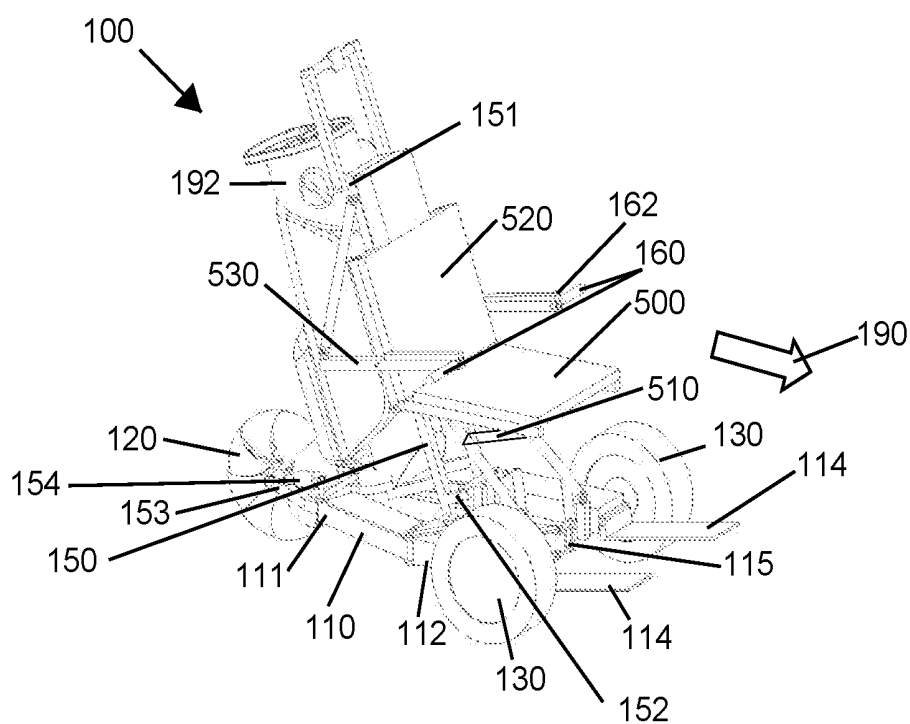


Fig. 6

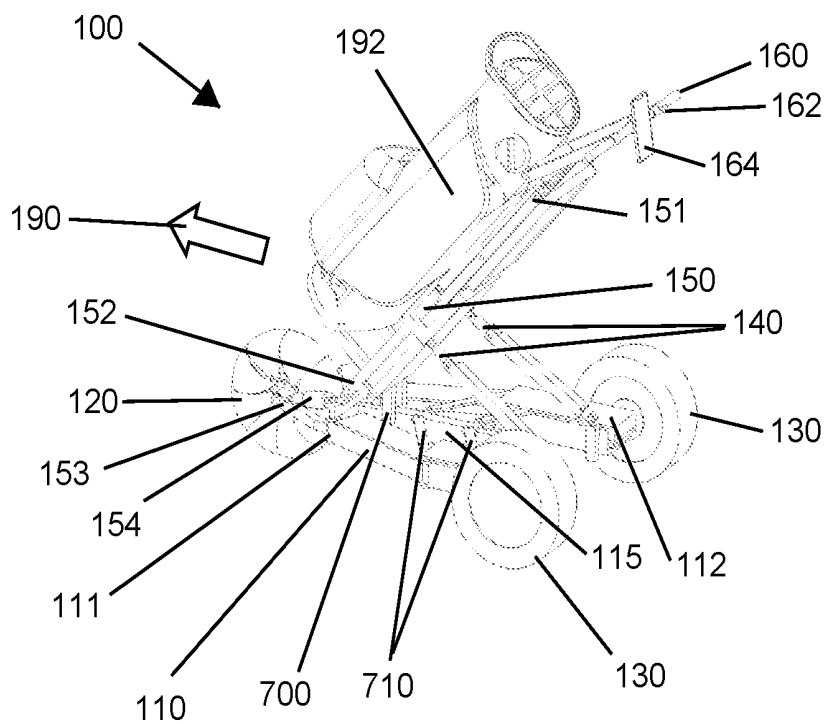


Fig. 7

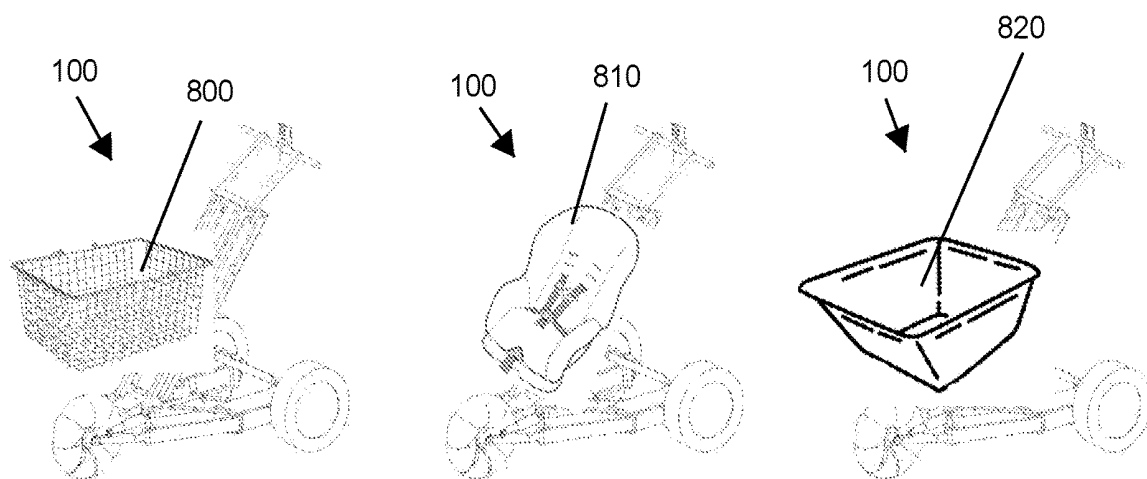


Fig. 8

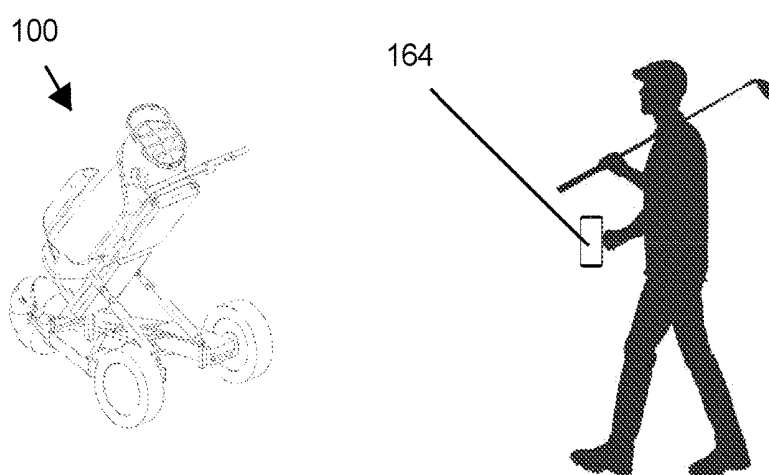


Fig. 9

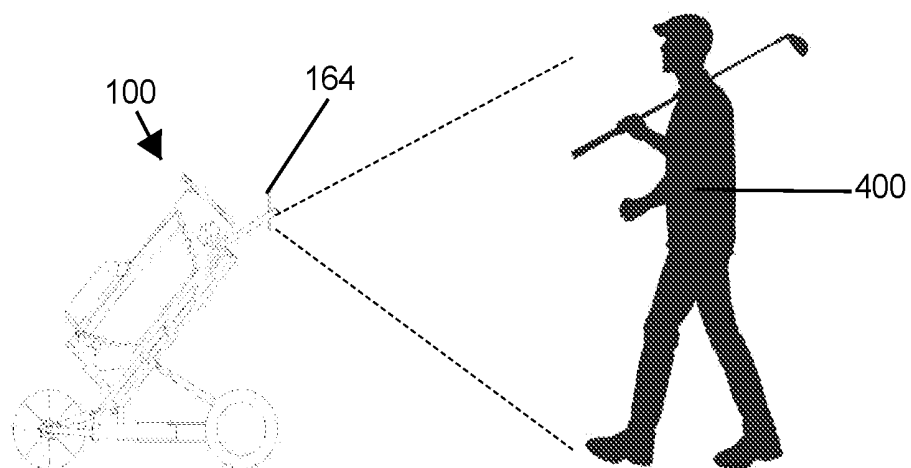


Fig. 10

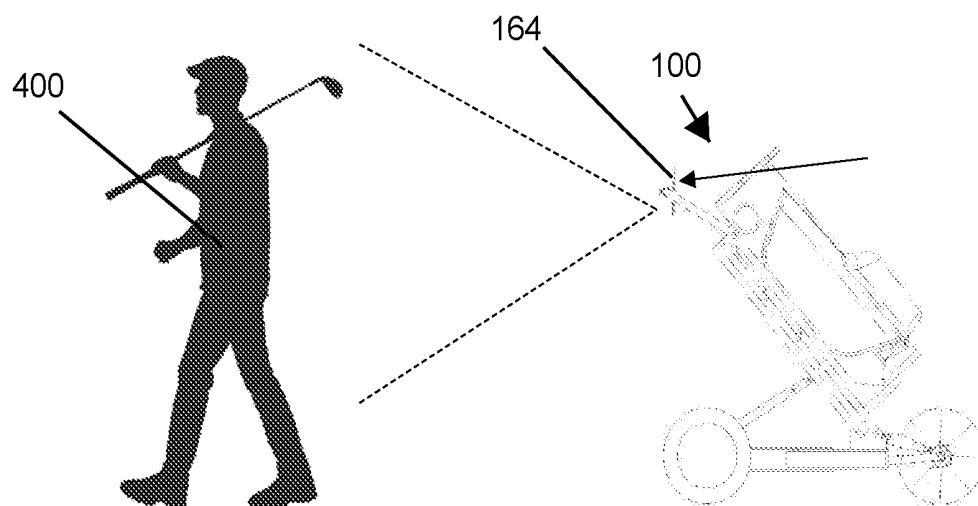


Fig. 11

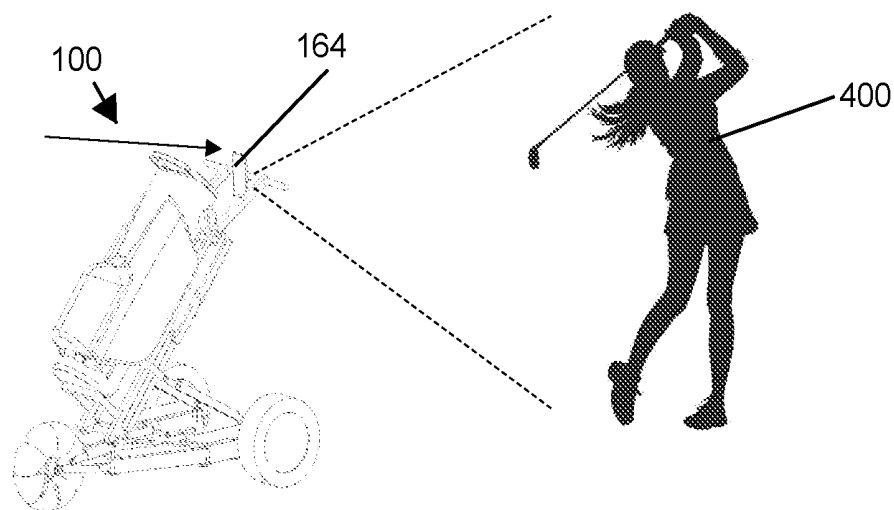


Fig. 12

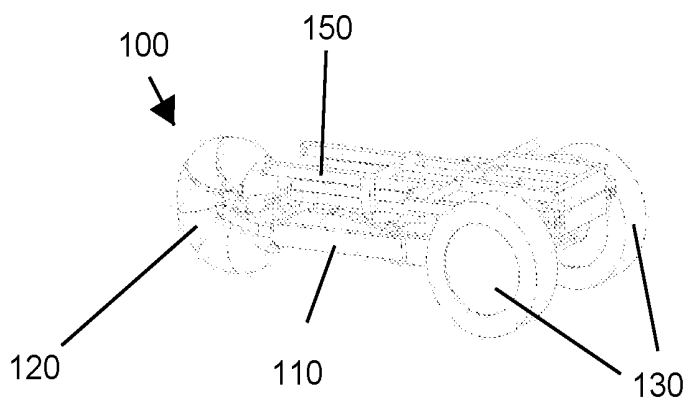


Fig. 13

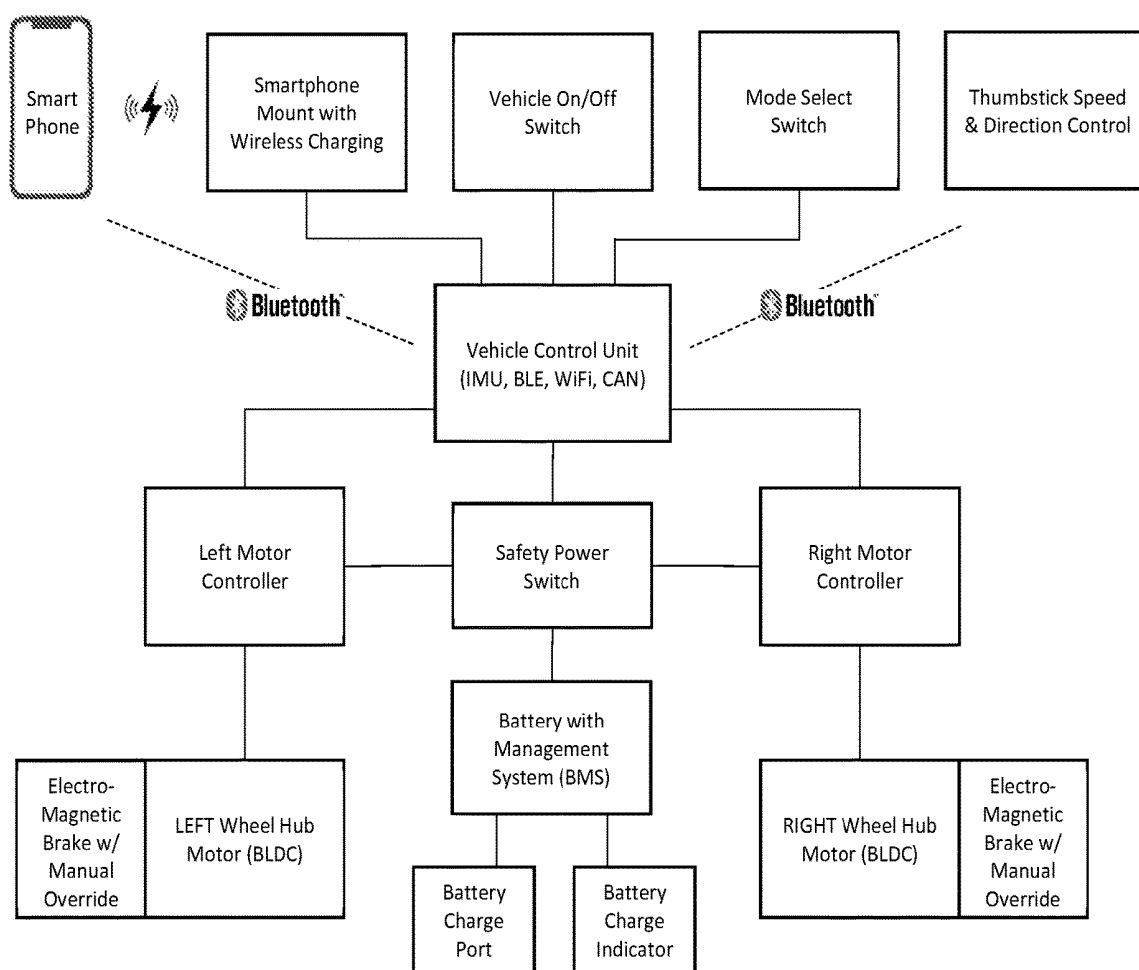


Fig. 14

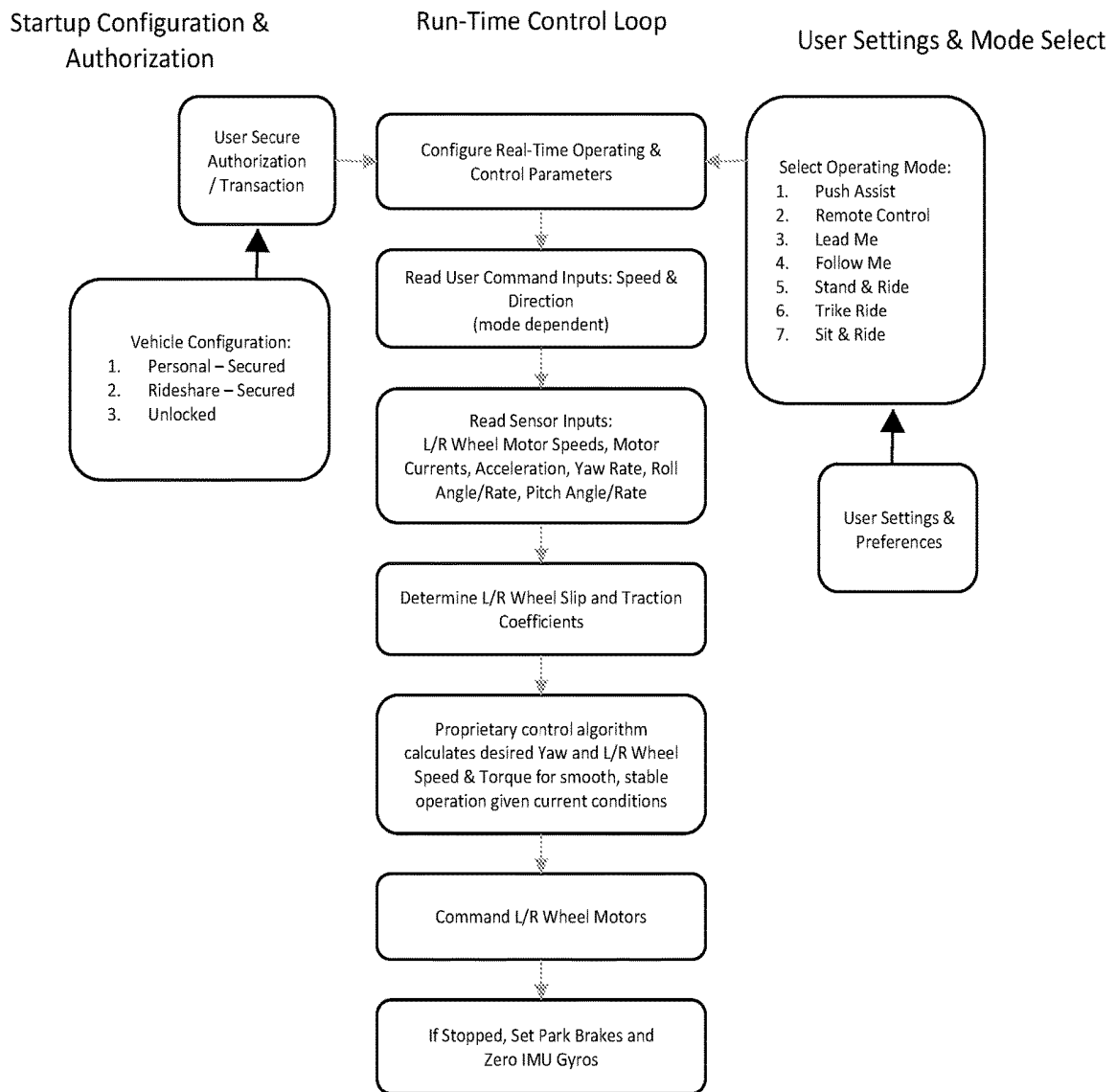


Fig. 15

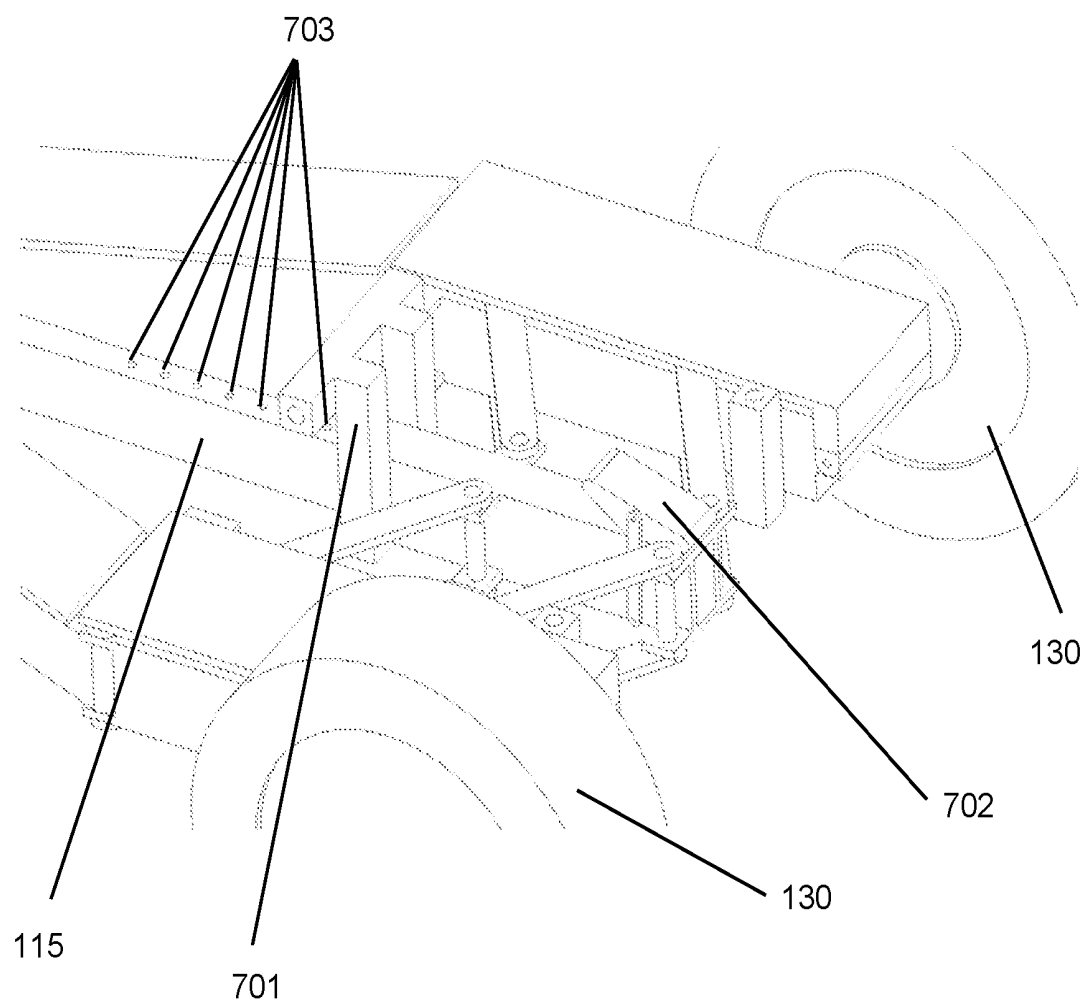


Fig. 16

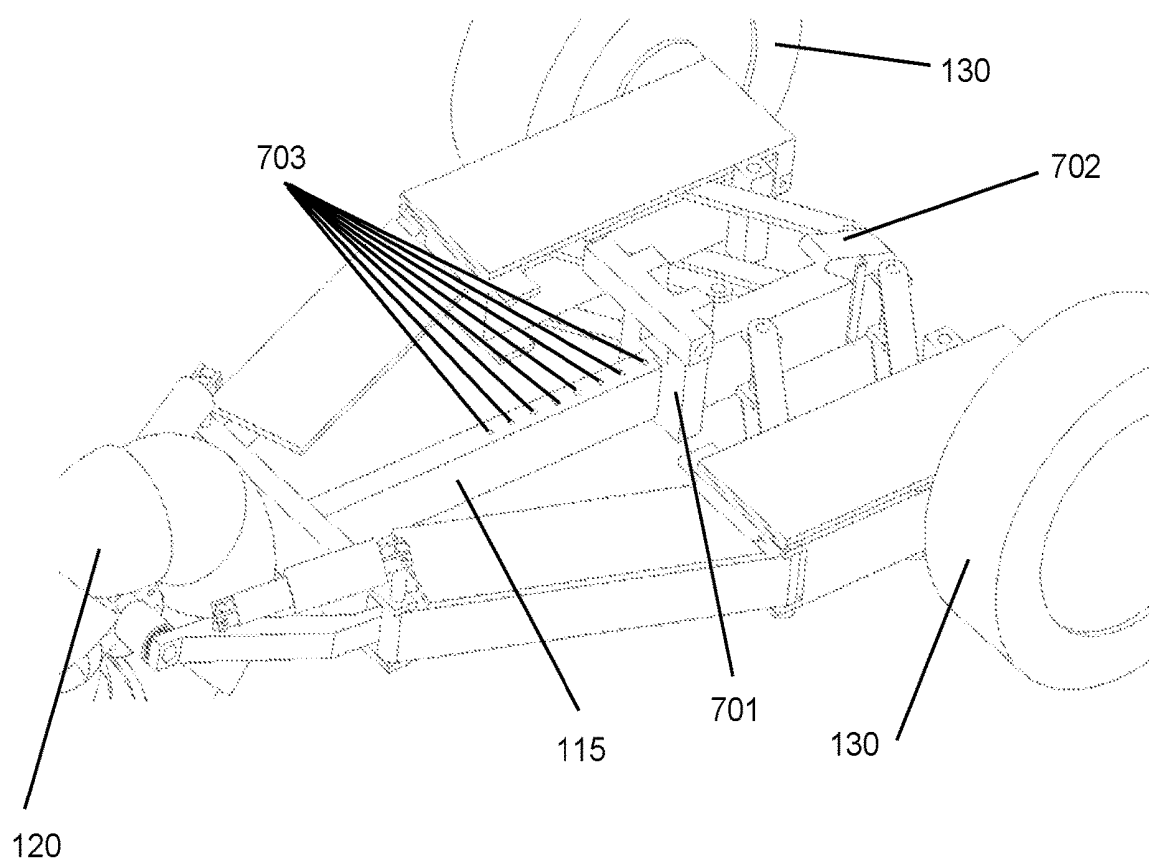


Fig. 17

WHEELED PERSONAL ROBOTIC OMNI VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/151,638, filed on Feb. 20, 2021, the entirety of which is hereby incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates generally to a personal mobility vehicle. In particular, this invention provides for a personal robotic vehicle capable of being reconfigured to operate in multiple modes, including a stand-up scooter, sit-down wheelchair, trike, push-assist cart, or autonomous robotic vehicle.

BACKGROUND

[0003] With recent advancements in battery and electric vehicle technologies, there has been a proliferation in electric mobility solutions in the market. Consumers are increasingly dependent on electric vehicles for both recreation and transportation, whether due to the need for mobility assistance or the desire for faster, more efficient, and more enjoyable transport. However, the existing solutions in the market are limited in utility and versatility, and therefore typically only suited for specific applications or a specific market segment. Other electric mobility solutions are limited to specific use-cases and modes of operation (i.e., golf carts, golf trolleys, e-bikes, scooters, self-balancing hoverboards, wheelchairs, etc.).

[0004] For at least these reasons, an improved personal mobility vehicle is desired. The disclosed invention, referred to as the ProV3, addresses these deficiencies with a versatile lifestyle mobility vehicle that is safe, stable, smart, simple, fun, functional, fast, and affordable for users of all demographics across many varied venues (golf course, a campus, a conference center, or a factory complex for example) and applications. The ProV3 is a smart personal mobility solution that will transform how people and their things get around.

BRIEF SUMMARY

[0005] In accordance with various embodiments of the invention, a personal mobility vehicle, referred to as the ProV3, configured to be operated in multiple modes is provided. The ProV3 operates in multiple modes to address multiple needs in a single all-in-one solution. With an omni-directional wheel and folding frame, the ProV3 can transform into a stand-up scooter, sit-down wheelchair, trike, push-assist cart, autonomous robotic vehicle, or other configurations, yet is still compact and portable. The ProV3 also integrates with the user's smartphone to provide affordable, advanced functionality such as autonomous tracking and navigation utilizing the embedded computer vision and artificial intelligence capabilities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0007] FIG. 1 illustrates a personal mobility vehicle in a stand and ride mode with a golf bag attachment in accordance with an embodiment of the invention.

[0008] FIG. 2a illustrates an omnidirectional wheel with nested rollers in accordance with an embodiment of the invention.

[0009] FIG. 2b illustrates the omnidirectional wheel with rollers removed from view in accordance with an embodiment of the invention.

[0010] FIG. 2c illustrates a cross-sectional view of an assembled omnidirectional wheel in accordance with an embodiment of the invention.

[0011] FIG. 3a illustrates a smartphone used as a connected intelligent vehicle head unit in a front-facing configuration in accordance with an embodiment of the invention.

[0012] FIG. 3b illustrates a smartphone used as a connected intelligent vehicle head unit in a rear-facing configuration in accordance with an embodiment of the invention.

[0013] FIG. 4 illustrates a lean-to-steer control function using a smartphone camera in accordance with an embodiment of the invention.

[0014] FIG. 5 illustrates a trike sit and ride mode in accordance with an embodiment of the invention.

[0015] FIG. 6 illustrates a wheelchair sit and ride mode in accordance with an embodiment of the invention.

[0016] FIG. 7 illustrates a push assist mode in accordance with an embodiment of the invention.

[0017] FIG. 8 illustrates examples of optional attachments for multi-purpose use in accordance with an embodiment of the invention.

[0018] FIG. 9 illustrates a remote control mode in accordance with an embodiment of the invention.

[0019] FIG. 10 illustrates an autonomous lead-me mode in accordance with an embodiment of the invention.

[0020] FIG. 11 illustrates an autonomous follow-me mode in accordance with an embodiment of the invention.

[0021] FIG. 12 illustrates auto video capture with computer vision recognition in accordance with an embodiment of the invention.

[0022] FIG. 13 illustrates a folded configuration of a personal mobility vehicle in accordance with an embodiment of the invention.

[0023] FIG. 14 illustrates an electrical system block diagram in accordance with an embodiment of the invention.

[0024] FIG. 15 illustrates a motion control system with dynamic stability and traction control in accordance with an embodiment of the invention.

[0025] FIG. 16 illustrates a sliding and locking mechanism in accordance with an embodiment of the invention.

[0026] FIG. 17 illustrates a sliding and locking mechanism in accordance with an embodiment of the invention.

DETAILED DESCRIPTION

[0027] Some embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all, embodiments of the invention are shown. Various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout. Some components of the apparatus are not

shown in one or more of the figures for clarity and to facilitate explanation of embodiments of the present invention.

[0028] As shown in FIG. 1 a personal mobility vehicle 100 in a stand and ride configuration is shown. Personal mobility vehicle 100 may alternatively be referred to as vehicle 100, ProV3 100, ProV3 Personal Robotic Omni Vehicle 100, or a variation of any of these names without departing from the scope of the disclosure. The ProV3 Personal Robotic Omni Vehicle 100 is a cart/scooter comprising an aluminum (or otherwise lightweight structural material) folding frame, folding seat, adjustable handlebar 160 and grips, two electrically driven wheels 130, an omnidirectional wheel 120, rechargeable batteries 170, motor controls 180, sensors, user input controls, and a wireless charging mount for a Bluetooth-connected smartphone.

[0029] Frame

[0030] The frame consists of multiple sliding and hinged locking joints which allow the vehicle 100 to be configured and secured into multiple modes of operation, as well as to be folded into a compact form for storage or hauling, such as in an automobile trunk. Various optional frame attachments provide a means for carrying cargo, such as a golf bag 192 as shown in FIG. 1. In one embodiment, the frame comprises a base 110 that provides a stable base for vehicle 100 as well as a stable attachment structure for omnidirectional wheel 120, drive wheels 130, and other components of vehicle 100. In certain configurations of vehicle 100, the base 110 provides a stable footrest for a person standing or sitting on vehicle 100. Base 110 may be constructed from matching and opposing beams with generally rectangular cross sections wherein one of the beams is disposed on the left side of vehicle 100 and the other beam is disposed on the right side of vehicle 100. Each beam of base 110 may have a first end coupled to swing arm 153 which attach to omnidirectional wheel 120 and a second end coupled to one of the driven wheels 130. A non-skid foot pad 114 may be mounted at or near the second end 112 on the top side of each beam of base 110. In one embodiment the first end 111 of the left beam of base 110 couples to the left side swing arm 153 that attaches to the left side of omnidirectional wheel 120 and the second end 112 of the left beam of base 110 couples to the left driven wheel 130. Similarly, in one embodiment the first end 111 of the right beam of base 110 couples to the right side swing arm 153 that attaches to the right side of omnidirectional wheel 120 and the second end 112 of the right beam of base 110 couples to the right driven wheel 130. A central support beam 115 mounted between the right and left beams of base 110 allows for moving parts of the frame to slide and lock into place to achieve different configurations of vehicle 100.

[0031] The frame further comprises an upright frame support 150 having a first end 151 coupled to adjustable handlebar 160 and a second end 152 coupled to central support beam 115. Upright frame support 150 may be moved into various positions to achieve multiple configurations of vehicle 100. Upright frame support 150 is configured to slide along the length of central support beam 115 and lock into position.

[0032] A left support arm 140 hingedly connects the left side of upright frame support 150 to the left beam of base 110, and a right support arm 140 hingedly connects the right side of upright frame support 150 to the right beam of base 110. Support arms 140 provide additional support for the

frame and other components of vehicle 100. One end of seat support braces 510 hingedly connect to support arms 140. In certain configurations of vehicle 100, such as the stand and ride configuration shown in FIG. 1, seat support braces 510 sit atop support arms 140 such that the support arms 140 are nested within the seat support braces 510. In other configurations of vehicle 100, such as the tricycle sit and ride configuration shown in FIG. 5, seat support braces 510 are rotated about their hinged ends attached to support arms 140 and their opposite ends are attached to seat 500, thus locking seat 500 securely into a position such that a person can ride vehicle 100 sitting on seat 500.

[0033] All components of the frame may be constructed of aluminum or any other suitable structural material. Attachments, such as the golf bag 192 shown in FIG. 1, may be attached to the frame to allow an operator to carry items while using vehicle 100.

[0034] A suspension system may be installed on vehicle 100 between omnidirectional wheel 120 and base 110. The suspension system may include a swing arm 153 and shock absorbers 154. The suspension system is configured to provide a smoother ride to a person riding on vehicle 100.

[0035] Adjustable Handlebar 160

[0036] An adjustable handlebar, 160 with latching joint to lock into place, can be positioned to best fit operator height and comfort. Left and right handles with grips can be removed and attached to the frame in alternative locations, based on whether the vehicle is configured for stand and ride (FIG. 1) or sit and ride (FIG. 6) modes.

[0037] One or both hand grips include a user control input 162 for commanding the desired speed and yaw rate (steering) of vehicle 100. In one embodiment user control input 162 may comprise a thumbstick (multi-direction mini joystick operated with the thumb) on one handle. In other embodiments user control input 162 could include dual thumb throttles, thumb wheels, twist grips, or other potential rotary input sensing devices. The user control input 162 is electrically powered through either a physical connection to a battery (battery 170 or another power source) or a wireless electrical connection that automatically engages when the handle is attached to the frame.

[0038] The user's smartphone 164 is docked to a wireless charging mount attached to adjustable handlebar 160 and connected to the vehicle 100 via Bluetooth or via another wireless or wired connection to vehicle 100. Software running on smartphone 164 provides the user display and interface for interacting with the vehicle 100. In one embodiment smartphone 164 comprises a smartphone having a touchscreen and camera such as an iPhone or Android phone; however, smartphone 164 may also comprise a tablet or similar device having a touchscreen and camera without departing from the scope of the disclosure.

[0039] The vehicle 100 is propelled and steered by two electrically driven wheels 130. Electrically driven wheels 130 may be referred to as drive wheels 130 or wheels 130 without departing from the scope of the disclosure. In one embodiment, drive wheels 130 comprise brushless DC hub motors with tires designed for traction and off-road use while also minimizing compaction and damage to turf or other surfaces. Both left and right drive wheels 130 are electrically controlled independently by a motor controller 180 to control vehicle speed and yaw when operated at different speeds to provide differential steering. Each drive wheel 130 may also include an electromagnetic park brake

which can be electrically engaged and disengaged to automatically lock the motors and thus the drive wheels 130 when stopped to eliminate roll, and automatically unlock the motors and thus the drive wheels 130 when the user commands motion of vehicle 100 using user control input 162 or software running on smartphone 164. In one embodiment, the left drive wheel 130 is mounted on the outside edge of the left beam of base 110 at or near the second end 112 of the left beam of base 110, and the right drive wheel 130 is mounted on the outside edge of the right beam of base 110 at or near the second end 112 of the right beam of base 110. Power for drive wheels 130 is provided by batteries 170.

[0040] Integrated electro-magnetic park brakes in drive wheels 130 automatically engage when there is no user command from user control input 162 or smartphone 164, or can be manually disengaged for free wheel operation.

[0041] Omnidirectional Wheel 120

[0042] An unpowered omnidirectional wheel 120 mounted to base 110 allows unrestricted motion in any direction, like a caster wheel, while providing improved strength, stability, and functionality for the vehicle 100 through all modes of operation and dynamically through turns. The omni wheel 120 is mounted to a suspended swing arm 153 with shock absorbers 154 to provide a smoother ride of vehicle 100 over rough surfaces. Omnidirectional wheel 120 may also be referred to as omni wheel 120 or omni-directional wheel 120 without departing from the scope of the disclosure.

[0043] FIGS. 2a, 2b, and 2c provide more detailed illustrations of the omni wheel 120 design. FIG. 2a illustrates an assembled view of omnidirectional wheel 120. FIG. 2b illustrates a omnidirectional wheel 120 without rollers 200. FIG. 2c illustrates a cross-sectional view of assembled omnidirectional wheel 120. The omni wheel 120 is mounted to the swing arm 153 or fork with a primary axle through the omni wheel 120 hub 210 with bearings. The omni wheel 120 rotates freely forward and backwards around this primary axle as in a typical motorcycle or scooter wheel. In one embodiment there are 8 spokes 230 made of aluminum or another lightweight structural material securely attached with bolts between the 2 primary hubs 210. The spokes 230 provide support for 8 roller axles 220 that are oriented perpendicular to the primary axle. Rollers 200 are attached between the spokes 230 and around the roller axles 220, supported by small bearings 240 which may be the same or similar to in-line skate or skateboard wheel bearings. The rollers 200 are designed with a curved, conical shape that together provide a smooth and continuous outer surface for the omni wheel 120. The rollers 200 are nested inside one another with a very small gap between each roller 200 such that the outer surface of the omnidirectional wheel 120 is continuous for smooth operation. In one embodiment, the gap between rollers 200 is 0.055 inches. The rollers 200 rotate perpendicular to the primary axle and allow the omni wheel 120 to move freely left or right. The rollers 200 are made of either plastic or aluminum, overmolded with polyurethane for softer and quieter operation on all types of surfaces. FIG. 2b shows the omni wheel 120 with the rollers 200 hidden to show the design of the spokes 230 and roller axles 220 with bearings 240. FIG. 2b depicts eight roller axles 220, 8 spokes 230, and sixteen bearings 240 (one on each end of each roller axle 220) occurring in identical patterns around the circumference of omnidirectional wheel 120; however, for the sake of readability of the drawing only

one example of each is labelled. FIG. 2c shows a cross-section view of omnidirectional wheel 120 to show how the rollers 200 nest together and the entire assembly fits uniquely together to provide smooth and free operation in all directions. FIG. 2c depicts eight roller axles 220 and 8 spokes 230 occurring in identical patterns around the circumference of omnidirectional wheel 120; however, for the sake of readability of the drawing only one example of each is labelled.

[0044] This omni wheel 120 design is advantageous compared to other wheel designs due to the simplicity and small number of components, the ease of assembly, the roller 200 and spoke 230 shape that allows them to nest inside of one another around the omnidirectional wheel 120, the large roller 200 diameter that allows smooth lateral movement over all types of terrain with minimal compaction or damage to turf, the small gap between rollers 200 that allows smooth and quiet operation, and the overall compact size and shape while still structurally strong and functionally efficient.

[0045] In one embodiment, omnidirectional wheel 120 may have an overall assembled outer diameter of approximately 12.5 inches. Each roller axle 220 may have a length of approximately 3.061 inches and a diameter of 0.313 inches. Each roller 200 may be constructed from approximately 0.25-inch-thick polyurethane with a length of approximately 4.426 inches, a large end diameter of approximately 4.754 inches and a small end diameter of approximately 1.4 inches. Other dimensions and materials may be used for omnidirectional wheel 120 without departing from the scope of the disclosure.

[0046] While vehicle 100 is shown with one omnidirectional wheel 120, one or more additional omnidirectional wheels 120 may be used without departing from the scope of the disclosure. For example, vehicle 100 may include two omnidirectional wheels 120 in alternative embodiments.

[0047] Modes of Operation

[0048] As previously described, the frame of vehicle 100 comprises several hinged sections configured to slide and lock into places such that vehicle 100 can be operated in a number of modes or configurations.

[0049] Stand and Ride Mode

[0050] FIG. 1 shows the vehicle 100 configured in a stand and ride mode with a golf bag attachment 192 and indication of forward direction of travel 190. The operator stands on the left and right foot pads 114 on top of the battery 170 compartments located in base 110, places hands on the adjustable handlebar 160, and rides the vehicle 100 similar to a typical scooter. Typical use could be on a golf course, providing the golfer with a faster, easier, more enjoyable method of moving around the course independently with their own cart and able to play their own ball, resulting in a much improved experience and shorter rounds. The center of gravity is kept low and centered between the two driven wheels 130 and omnidirectional wheel 120 to enhance stability on hills and side slopes.

[0051] In the stand and ride configuration, the second end 152 of upright frame support 150 is slid along central support beam 115 and locked into place in a generally upright position. In this configuration, the second end 152 of upright frame support 150 may be positioned approximately halfway between the first end 111 and second end 112 of base 110 such that upright frame support 150 is vertical or slightly angled. Support arms 140 connect between upright frame support 150 and base 110 to provide additional

support and stability for upright frame support 150. Adjustable handlebar 160 is installed at the first end of upright frame support 150 to provide support for the operator while standing on the vehicle 100. Adjustable handlebar 160 may be rotated and locked into place in the position most comfortable for the operator. User control input 162 is positioned on the adjustable handlebar 160 and positioned for the operator's comfort. The operator's smartphone 164 is positioned on the adjustable handlebar 160 such that the touchscreen and forward-facing camera of the smartphone 164 is facing the operator and the operator may interact with smartphone 164 to control the vehicle 100. By operating the user control input 162 or user interface software running on smartphone 164, the operator can command the motor controllers 180 to operate, causing drive wheels 130 to operate and move vehicle 100.

[0052] Smartphone Operation

[0053] As shown in FIGS. 3a and 3b, multiple advanced functions are provided by the user's smartphone 164 when used with the software application associated with the vehicle 100 for interfacing with and controlling the vehicle 100. As smartphones 164 with advanced capabilities are now ubiquitous, they provide a cost-effective and personalized solution as the intelligent head unit for the vehicle 100. Through the smartphone 164 app, the vehicle 100 owner can configure the vehicle 100 in personal secured mode (only authorized users), rideshare secured mode (only paying customers), or unsecured mode (anyone can use). In a secured mode, the smartphone authenticates the user (through its inherent secure identification methods or through a rideshare app) before allowing the vehicle 100 to be operated. The owner can also configure all vehicle 100 settings and preferences through the smartphone 164 app.

[0054] During operation, the connected smartphone 164 provides the vehicle 100 operating display for information such as speed, power utilization, odometer, battery charge, range, operating mode, notifications, etc. The smartphone's 164 built-in touchscreen, speaker, voice recognition, gesture recognition, and inertial measurement unit (IMU) also provide the user interface for the operator to select modes and preferences, as well as to command and control the vehicle 100 in a personalized way. The smartphone's 164 embedded machine learning capabilities, along with cloud-connectivity, allow the smartphone 164 app to learn and adapt to operator behavior to provide the most intuitive and enjoyable riding experience. Smartphone 164 cellular connectivity and data plan provides the cloud-connectivity for data analytics, software updates, remote diagnostics, fleet management, and rideshare logistics and financial transactions.

[0055] As shown in FIG. 3a, in some front-facing configurations of vehicle 100 such as stand and ride mode (FIG. 1) or trike sit and ride mode (FIG. 5), smartphone 164 is positioned such that the touchscreen and front-facing camera of smartphone 164 are facing the operator. In these configurations, the smartphone's 164 front-facing camera and built-in computer vision capabilities can be used to control the vehicle 100 by visually tracking the location of the rider's head and torso, such that the operator can steer the vehicle 100 simply by leaning left or right, and/or control the speed by leaning forward or backward, a capability hereafter referred to as "ProVision." As shown in FIG. 4, an image 400 of the rider's position is captured in the view of the camera of smartphone 164. When the operator leans right the vehicle 100 is steered to the right as a result of tracking

the rider image 400. Similarly, when the operator leans left the vehicle 100 turns left as a result of tracking the rider image 400. This provides an intuitive and enjoyable method of controlling the vehicle 100 while also aiding in vehicle 100 stability by matching vehicle 100 dynamics with shifting center of gravity of the rider. In these configurations, in addition to providing operator position tracking, the smartphone 164 may also provide secure operator identification, gesture control, voice control, audio capabilities, inertial measurement unit (IMU), computer vision, machine learning, cloud connectivity, fleet management, remote diagnostics, software updates, ridesharing applications, and third-party applications. While the smartphone 164 is shown with touchscreen and front-facing camera facing the operator of vehicle 100 in FIG. 3a such that the operator may view and use smartphone 164, smartphone 164 may alternatively be rotated such that the rear-facing camera faces the operator and is used to guide the vehicle 100.

[0056] As shown in FIG. 3b, in other rear-facing configurations of vehicle 100, such as autonomous lead-me mode (FIG. 10) or autonomous follow-me mode (FIG. 11), the smartphone 164 can be rotated around the adjustable handlebar 160 to utilize the rear-facing camera and ProVision software running on the smartphone 164 to identify and track the operator position and gestures at further distances in order to automatically control the vehicle 100 remotely when the operator is not riding on the vehicle 100. Based on predefined settings and preferences, the vehicle 100 will maintain a consistent distance from the operator, maintain a synchronized pace, move in the same direction, and respond to operator gestures and voice commands. In these configurations, in addition to providing operator position tracking, the smartphone 164 may also provide obstacle detection, gesture control and automatic video capture. While the smartphone 164 is shown with rear-facing camera facing the operator of vehicle 100 in FIG. 3b such that the generally more capable rear-facing camera of smartphone 164 is used for guidance purposes, smartphone 164 may alternatively be rotated such that the touchscreen and front-facing camera face the operator and the front-facing camera is used to guide the vehicle 100.

[0057] As shown in FIG. 10, in autonomous lead-me mode, vehicle 100 is configured in push assist mode with the operator walking behind the vehicle 100. Smartphone 164 is positioned such that the rear-facing camera face the operator, and an image 400 of the operator is captured by the camera of smartphone 164. Software running on smartphone 164 uses computer vision and machine learning to track the operator's position for navigation of vehicle 100. Human gestures are used to command the mode of vehicle 100, start and stop vehicle 100, and increase or decrease distance between vehicle 100 and the operator.

[0058] As shown in FIG. 11, in autonomous follow-me mode, vehicle 100 is configured in push assist mode with the operator walking in front of the vehicle 100. Smartphone 164 is positioned such that the rear-facing camera face the operator, and an image 400 of the operator is captured by the camera of smartphone 164. Software running on smartphone 164 uses computer vision and machine learning to track the operator's position for navigation of vehicle 100. Human gestures are used to command the mode of vehicle 100, start and stop vehicle 100, and increase or decrease distance between vehicle 100 and the operator.

[0059] Another capability of the ProVision software built into the vehicle 100 smartphone app (FIG. 12) is to track the operator with computer vision, automatically recognize certain activity that it has been trained for (i.e., hitting a golf ball), and automatically capture video of the action for later video documentation, sharing, or analysis. Similar to drone technology that tracks and videos a person's activities, the vehicle 100 with smartphone 164 can automatically track and record activities of interest, which could be quite beneficial, for example, to a golfer for analyzing their swing and diagnosing potential causes of each shot outcome. As shown in FIG. 12, the vehicle 100 is configured in push assist mode. Smartphone 164 is positioned such that the rear-facing camera of smartphone 164 are facing the operator, and an image 400 of the operator is captured by the camera of smartphone 164. Smartphone 164 uses computer vision and artificial intelligence to recognize activity and automatically capture a video clip.

[0060] The smartphone 164 can also be used in remote control mode (FIG. 9), where the operator can control the vehicle 100 through either a virtual joystick on the touchscreen of the smartphone 164, or through utilizing the smartphone 164 inertial measurement unit (IMU) and controlling the vehicle 100 simply by the orientation of the smartphone 164 roll and pitch. In the remote control mode, smartphone 164 communicates with motor controllers 180 of the vehicle 100 through Bluetooth vehicle interface or through another wired or wireless communication protocol. This mode can be useful in golf when you might want to send the vehicle 100 on ahead to the other side of the green or to the next tee box.

[0061] Trike Sit and Ride Mode

[0062] FIG. 5 shows the vehicle 100 configured in the trike sit and ride mode, where the operator can sit if preferred with the direction of forward travel 190 indicated. The seat 500 is manually rotated up and secured by snapping seat support braces 510 into place under the seat 500. In this mode, the operator sits on the seat 500 facing in the forward direction with legs straddling the upright frame support 150 and feet resting on the beams of base 110. Similar to other modes of operation, the operator controls the speed and direction of vehicle 100 through the user control input 162, software running on smartphone 164, or by using ProVision lean-to-steer functionality which changes the direction of vehicle 100 based on the direction the operator leans. In this configuration, the drive wheels 130 are still in the rear for normal forward direction 190, which is the preferred orientation for dynamic stability at higher speeds.

[0063] In the trike sit and ride configuration, the second end 152 of upright frame support 150 is slid along central support beam 115 and locked into place in a generally upright position. In this configuration, the second end 152 of upright frame support 150 may be positioned approximately halfway between the first end 111 and second end 112 of base 110 such that upright frame support 150 is vertical or slightly angled. Support arms 140 connect between upright frame support 150 and base 110 to provide additional support and stability for upright frame support 150. Seat support braces 510 are raised and snap onto seat 500 to provide stable support for seat 500. Adjustable handlebar 160 is installed at the first end of upright frame support 150 to provide support for the operator while sitting on the seat 500 of the vehicle 100. Adjustable handlebar 160 may be rotated and locked into place in the position most comfort-

able for the operator. User control input 162 is positioned on the adjustable handlebar 160 and positioned for the operator's comfort. The operator's smartphone 164 is positioned on the adjustable handlebar 160 such that the touchscreen and forward-facing camera of the smartphone 164 is facing the operator and the operator may interact with smartphone 164 to control the vehicle 100. By operating the user control input 162 or user interface software running on smartphone 164, the operator can command the motor controllers 180 to operate, causing drive wheels 130 to operate and move vehicle 100.

[0064] Wheelchair Sit and Ride Mode

[0065] As shown in FIG. 6, by folding down the armrests 530, moving the handles of adjustable handlebar 160 to the outer ends of armrests 530, and unfolding the foot pads 114, the vehicle 100 is configured into wheelchair sit and ride mode. The seat 500 and upright frame support 150 spread apart through frame linkages to allow a wider comfortable seat, with the elastic fabric over the seat cushions 500 and 520 expanding to conform to the shape and size of seat 500 and upper cushion 520 in the expanded configuration. In this mode, the drive wheels 130 are in the front and the omni wheel 120 in the rear, providing a high degree of maneuverability with sufficient dynamic stability for the limited operating speeds in this mode. For the golfer, this may provide a more relaxing and enjoyable method of moving around the golf course, or to sit and rest when waiting for others. In other applications, this mode provides convenient mobility assistance similar to other electric wheelchairs, although with a more compact and portable design.

[0066] In the wheelchair sit and ride configuration, the second end 152 of upright frame support 150 is slid along central support beam 115 and locked into place in a generally upright position. In this configuration, the second end 152 of upright frame support 150 may be positioned approximately halfway between the first end 111 and second end 112 of base 110 such that upright frame support 150 is vertical or slightly angled. Support arms 140 connect between upright frame support 150 and base 110 to provide additional support and stability for upright frame support 150. Seat support braces 510 may be raised and snap onto seat 500 to provide stable support for seat 500. In other configurations of vehicle 100, armrests 530 are placed in their storage position parallel to upright frame support 150; however for wheelchair sit and ride configuration, armrests 530 are unfolded and locked into place with one armrest 530 locked into place on each side of seat 500 and upper seat cushion 520. Armrests 530 may be padded for the operator's comfort. The handles are removed from adjustable handlebar 160 and placed on the outer ends of armrests 530 to provide support for the operator while sitting on the seat 500 of the vehicle 100. User control input 162 is positioned on one side of the adjustable handlebar 160 and positioned for the operator's comfort. By operating the user control input 162, the operator can command the motor controllers 180 to operate, causing drive wheels 130 to operate and move vehicle 100.

[0067] Push Assist Mode

[0068] FIG. 7 shows the vehicle 100 configured in push assist mode, where the operator walks behind the vehicle 100 similar to a golf pushcart or shopping cart. In this mode, the vehicle 100 can be operated by the user control input 162 on the handlebar 160, or optionally or in combination with the ProVision capability of the smartphone 164 app to track

the operator position relative to the vehicle 100. In this configuration the vehicle 100 can also be operating manually in free wheel mode with the power off and parking brakes released. Integrated electro-magnetic park brakes in drive wheels 130 automatically engage when there is no user command from user control input 162 or smartphone 164, or can be manually disengaged for free wheel operation. For the golfer, this mode may be desired when preferring to walk and get more exercise.

[0069] Although present in all configurations of vehicle 100, sliding and locking mechanism 700 is particularly easy to view in FIG. 7. Sliding and locking mechanism 700 allows components of the frame of vehicle 100 to be folded and snapped into place to achieve the various configurations and frame orientations of vehicle 100. As shown in FIGS. 16 and 17, in one embodiment, sliding and locking mechanism 700 comprises a foot-actuated latch mechanism for locking the upright frame support 150 (not shown in FIGS. 16 and 17) to the central support beam 115. The lower end 152 of the upright frame support 150 connects to a sliding mechanism 701. An over-center rocker latch 702 pivots around a center axis with a spring-loaded or other elastic tension chord that holds the rocker latch down securely in a locked or unlocked position. In the locked position, a pin on the latch 702 engages into one of many holes 703 in the central support beam 115 to secure the upright frame support 150 so it is locked in position relative to the central support beam 115. With a series of frame holes 703 with consistent spacing (for instance one hole 703 every 1 inch), the sliding mechanism 701 can be locked into one of many optional positions for configuring the vehicle frame into various modes of operation and allowing the operator to select the positions most suited to their preferences. Many other locking and latching mechanisms could be utilized, either off-the-shelf or custom-designed, for securing the upright frame support 150 to the central support beam 115 with a simple hand or foot action.

[0070] Similarly to sliding and locking mechanism 700, linkage arms 710 are present in all configurations of vehicle 100, but are particularly easy to view in FIG. 7. Linkage arms 710 maintain frame geometry and structure.

[0071] In the push assist configuration, the second end 152 of upright frame support 150 is slid along central support beam 115 and locked into place using sliding and locking mechanism 700 in an angled position. In this configuration, the second end 152 of upright frame support 150 may be positioned at or near the first end 111 of base 110. Support arms 140 connect between upright frame support 150 and base 110 to provide additional support and stability for upright frame support 150. Adjustable handlebar 160 is installed at the first end of upright frame support 150 to provide support for the operator while pushing vehicle 100. Adjustable handlebar 160 may be rotated and locked into place in the position most comfortable for the operator. User control input 162 is positioned on the adjustable handlebar 160 and positioned for the operator's comfort. The operator's smartphone 164 is positioned on the adjustable handlebar 160 such that the touchscreen and forward-facing camera of the smartphone 164 is facing the operator and the operator may interact with smartphone 164 to control the vehicle 100. By operating the user control input 162 or user interface software running on smartphone 164, the operator can command the motor controllers 180 to operate, causing drive wheels 130 to operate and move vehicle 100.

[0072] Attachments

[0073] FIG. 8 shows a few examples of the many potential cargo attachments and applications for the vehicle 100. In addition to carrying a golf bag 192, vehicle 100 may carry a shopping basket 800, child seat 810, or wheelbarrow 820. The versatile vehicle 100 platform can provide an intelligent and convenient solution for shopping carts, strollers, utility carts, factory material transport, and many others. The versatility of the vehicle 100 provides greater value in leveraging the vehicle 100 investment for many users across many applications.

[0074] Folded Configuration

[0075] With the vehicle's 100 folding frame, lightweight materials, and compact design, it can be folded down into a fold and stow mode as shown in FIG. 13, where it is about the size of a bag of golf clubs, for convenient storage or transporting in the trunk of an automobile.

[0076] Electrical System and Software Control System

[0077] FIG. 14 shows a simplified block diagram of the electrical system, components, and connections of vehicle 100.

[0078] FIG. 15 shows a simplified view of the software control system, distributed between the smartphone 164 app, user control input 162, and left/right motor controllers 180. The motion control system utilizes multiple inertial and speed sensors, along with intelligent control algorithms, to dynamically control stability and traction in all variety of surface conditions and terrain, to minimize wheel slip, maintain smooth and predictable steering, acceleration, and braking response, and to prevent tipping.

[0079] The disclosed vehicle 100 is differentiated from competitors due to its versatile all-in-one solution for multiple applications and modes of operation, all in a simple, affordable, portable, and highly intelligent design. It includes a superior omni wheel 120 design for smooth, functional, and stable maneuverability across all terrains including turf. Using deep integration with smartphone 164 capabilities, the vehicle 100 provides secure autonomous, robotic operation using computer vision and machine learning. Intelligent control systems and user interfaces that learn and adapt to users and their environment make the vehicle 100 more stable, safe, intuitive, and easy to use for all demographics.

[0080] Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

1. A personal mobility vehicle comprising:

- a base having a first end and a second end,
- one or more non-powered omnidirectional wheels mounted to the first end of the base;
- two independently controlled driven wheels with electric hub motors mounted to the second end of the base; and
- a frame mounted to the base wherein the frame is configured to be folded and locked into a plurality of configurations.

2. The personal mobility vehicle of claim 1 wherein the plurality of configurations comprises a stand and ride mode, a tricycle sit and ride mode, a wheelchair sit and ride mode, a push-assist mode, a remote control mode, an autonomous lead-me mode, an autonomous follow-me mode, and a folded stow and go mode.

3. The personal mobility vehicle of claim 1 wherein the driven wheels with electric hub motors are configured to provide propulsion and differential steering to the personal mobility vehicle.

4. The personal mobility vehicle of claim 1 further comprising attachment points for mounting one or more attachments.

5. The personal mobility vehicle of claim 4 wherein the attachments comprise one or more of a golf bag, a shopping basket, a child seat, or a wheelbarrow.

6. The personal mobility vehicle of claim 1 wherein the vehicle is configured to be controlled by image recognition software running on a smartphone.

7. The personal mobility vehicle of claim 6 wherein the image recognition software is configured to recognize one or more gestures made by an operator of the personal mobility vehicle and alter an action of the personal mobility vehicle in response to the one or more gestures.

8. The personal mobility vehicle of claim 7 wherein the gesture recognized by the image recognition software comprises leaning and the action of the personal mobility vehicle comprises steering in the direction of the leaning.

9. The personal mobility vehicle of claim 7 wherein the gesture recognized by the image recognition software comprises walking behind the personal mobility vehicle and the action of the personal mobility vehicle comprises traveling ahead of the operator.

10. The personal mobility vehicle of claim 7 wherein the gesture recognized by the image recognition software comprises walking in front of the personal mobility vehicle and the action of the personal mobility vehicle comprises traveling behind the operator.

11. The personal mobility vehicle of claim 7 wherein the gesture recognized by the image recognition software comprises a golf swing and the action of the personal mobility vehicle comprises recording a video.

12. The personal mobility vehicle of claim 1 wherein the personal mobility vehicle is configured to be controlled by security software running on a smartphone, and wherein the security software is configured to verify that an operator is authorized to use the personal mobility vehicle before the personal mobility vehicle will operate.

13. The personal mobility vehicle of claim 1 wherein the personal mobility vehicle is configured to be controlled by rideshare software running on a smartphone, and wherein the rideshare software is configured to verify that an operator has paid to use the personal mobility vehicle before the personal mobility vehicle will operate.

14. The personal mobility vehicle of claim 1 further comprising a dynamic traction control system configured to maintain stability and differential steering integrity across different types of terrain and surface conditions.

15. The personal mobility vehicle of claim 1 wherein the personal mobility vehicle comprises a battery powered electric vehicle.

16. An omnidirectional wheel comprising:

a central hub,

a plurality of spokes radiating outwardly from the central hub;

a plurality of roller axles wherein each roller axle has a first end and a second end and wherein the first end of each roller axle connects to a spoke associated with the roller axle and the second end of each roller axle connects to an adjacent spoke;

a plurality of bearings installed on each roller axle; and

a plurality of nested rollers wherein each roller is installed on a roller axle supported by bearings and wherein each roller is configured to rotate about the roller axle it is installed upon.

17. The omnidirectional wheel of claim 16 wherein each roller comprises a curved conical shape.

18. The omnidirectional wheel of claim 16 wherein a first end of each roller is nested within a second end of an adjacent roller such that the plurality of nested rollers form a continuous outer surface of the omnidirectional wheel.

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