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(54) **TWO-WHEEL SELF-BALANCING VEHICLE WITH INDEPENDENTLY MOVABLE FOOT PLACEMENT SECTIONS**

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See application file for complete search history.

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(57) **ABSTRACT**

A two-wheel, self-balancing personal vehicle having independently movable foot placement sections. The foot placement sections have an associated wheel, sensor and motor and are independently self-balancing which gives the user independent control over the movement of each platform section by the magnitude and direction of tilt a user induces in a given platform section. Various embodiments are disclosed including those with a continuous housing, discrete platform sections and/or tapering platform sections.

16 Claims, 4 Drawing Sheets

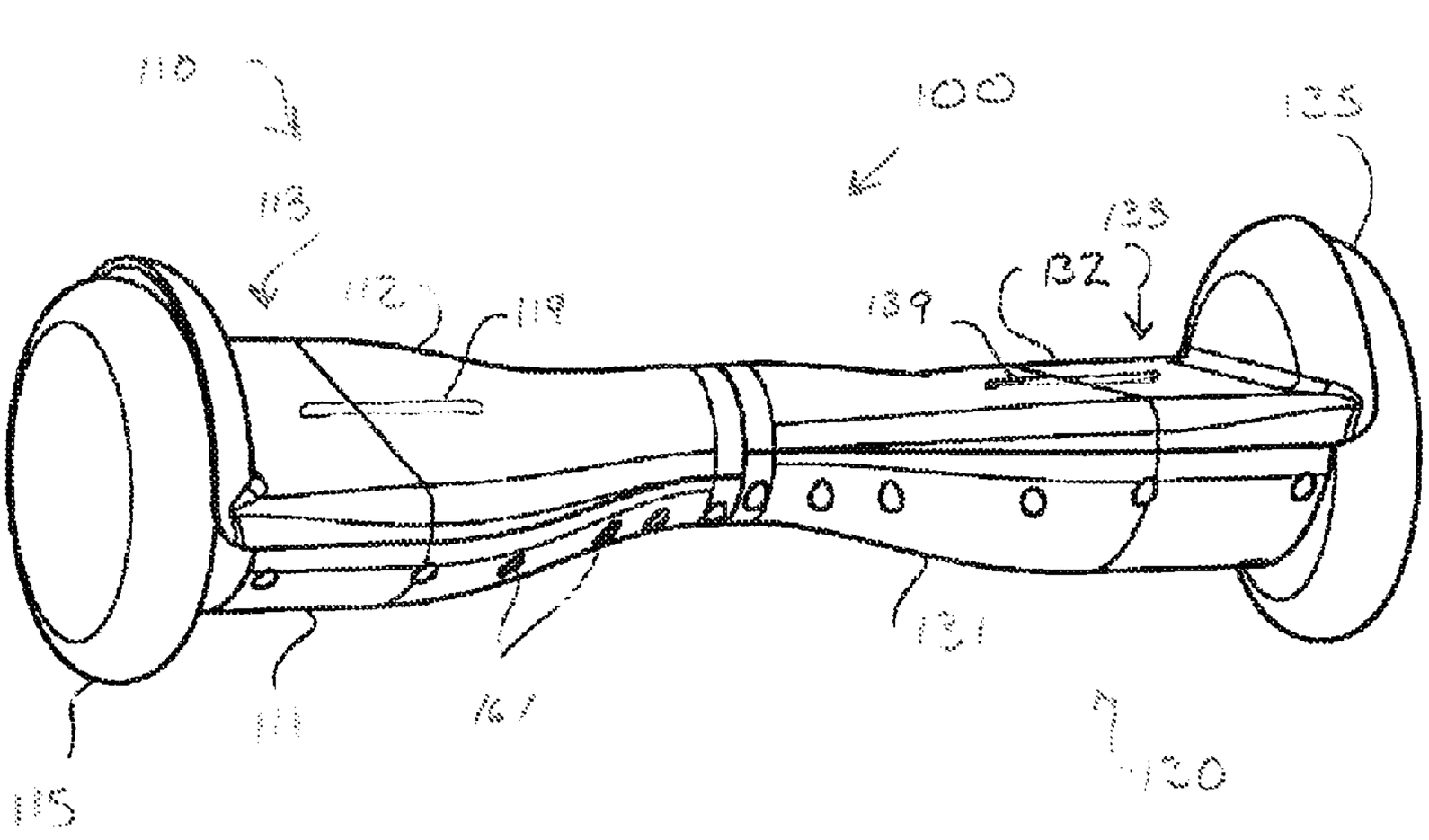

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Fig. 1

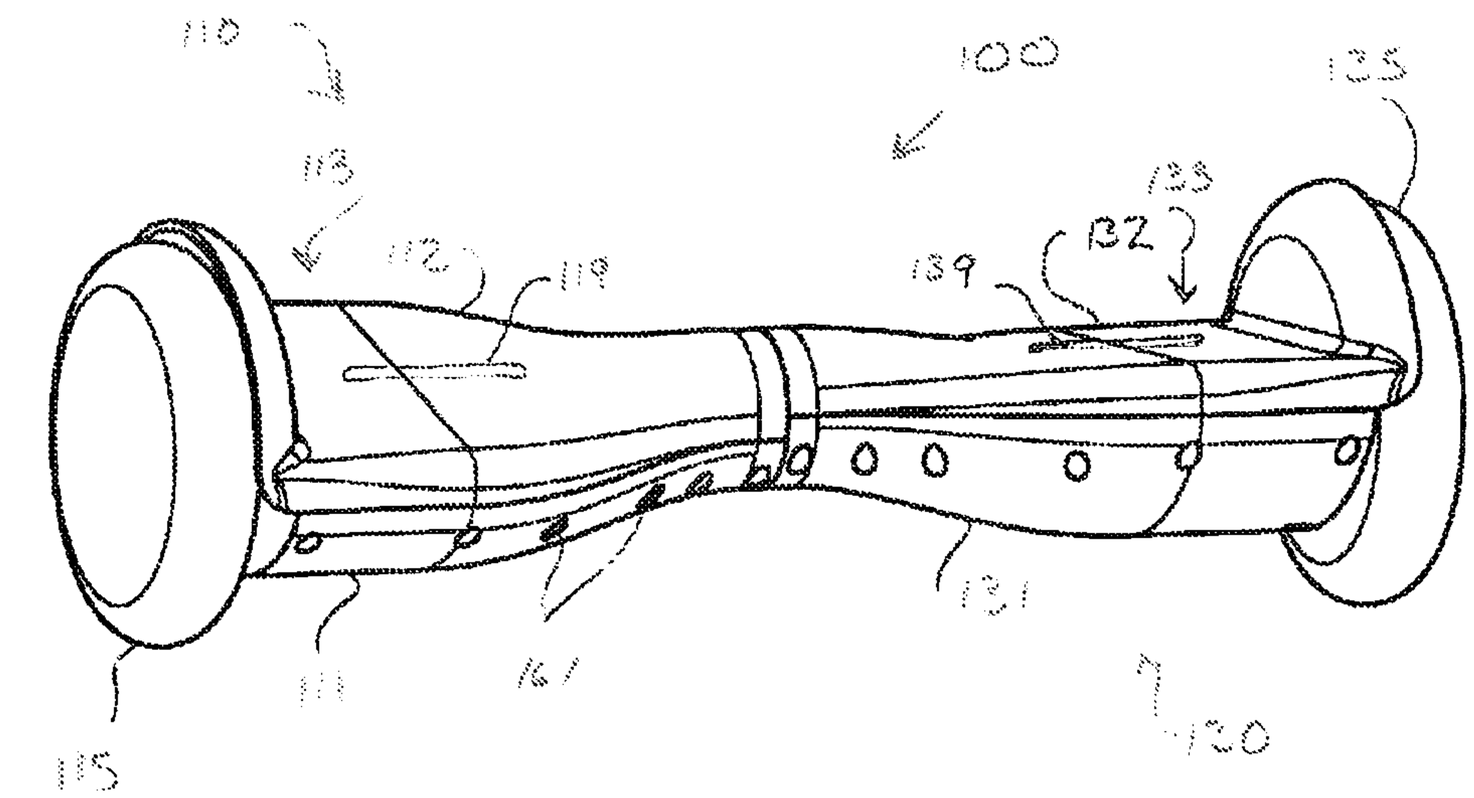

FIG. 2

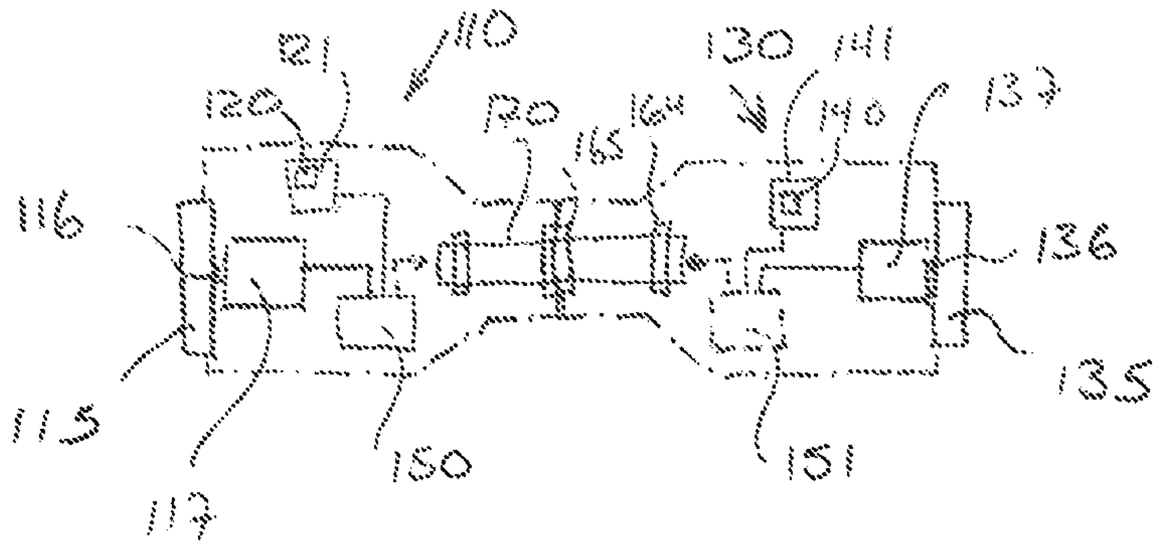
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Fig 3

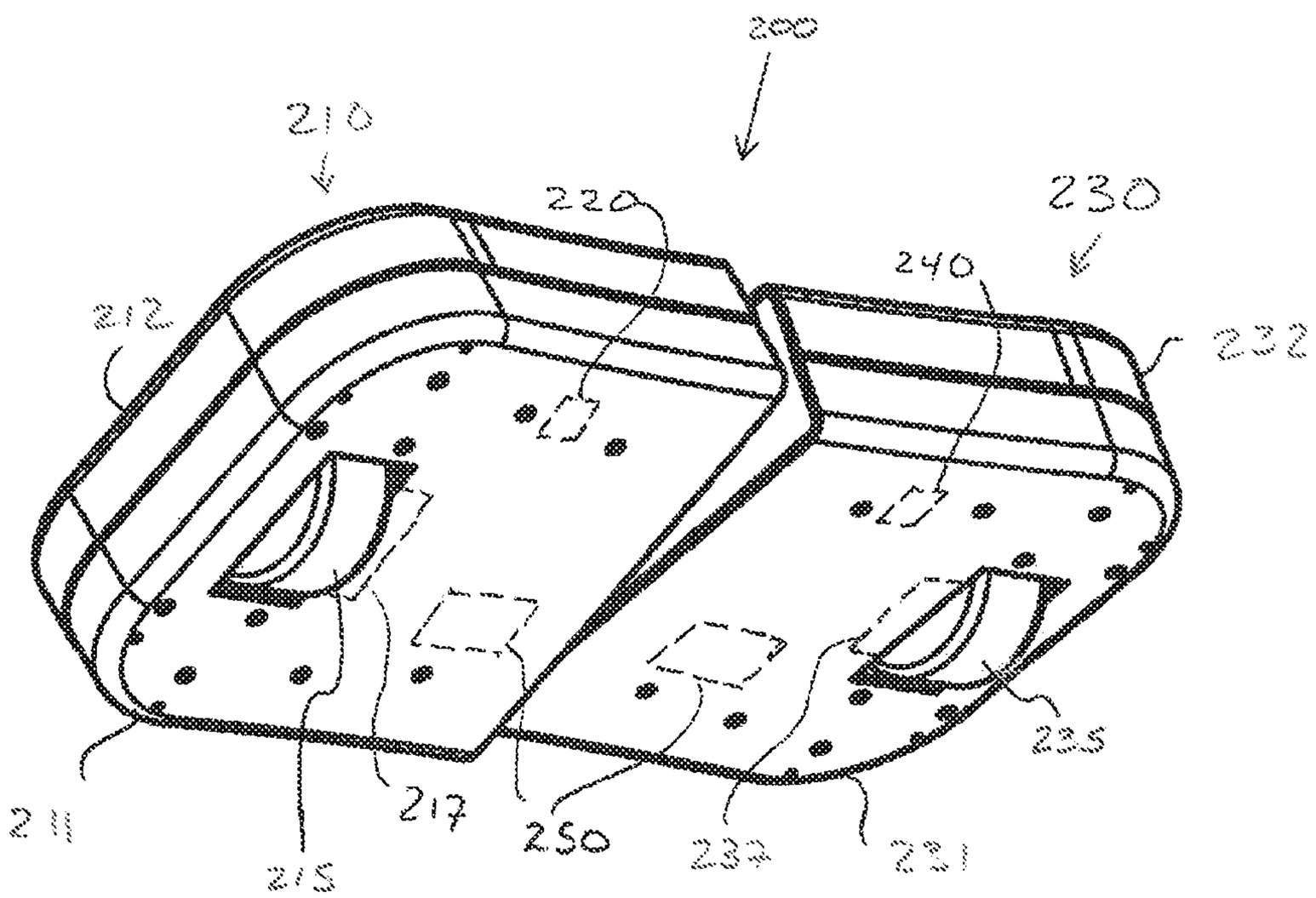


Fig 4

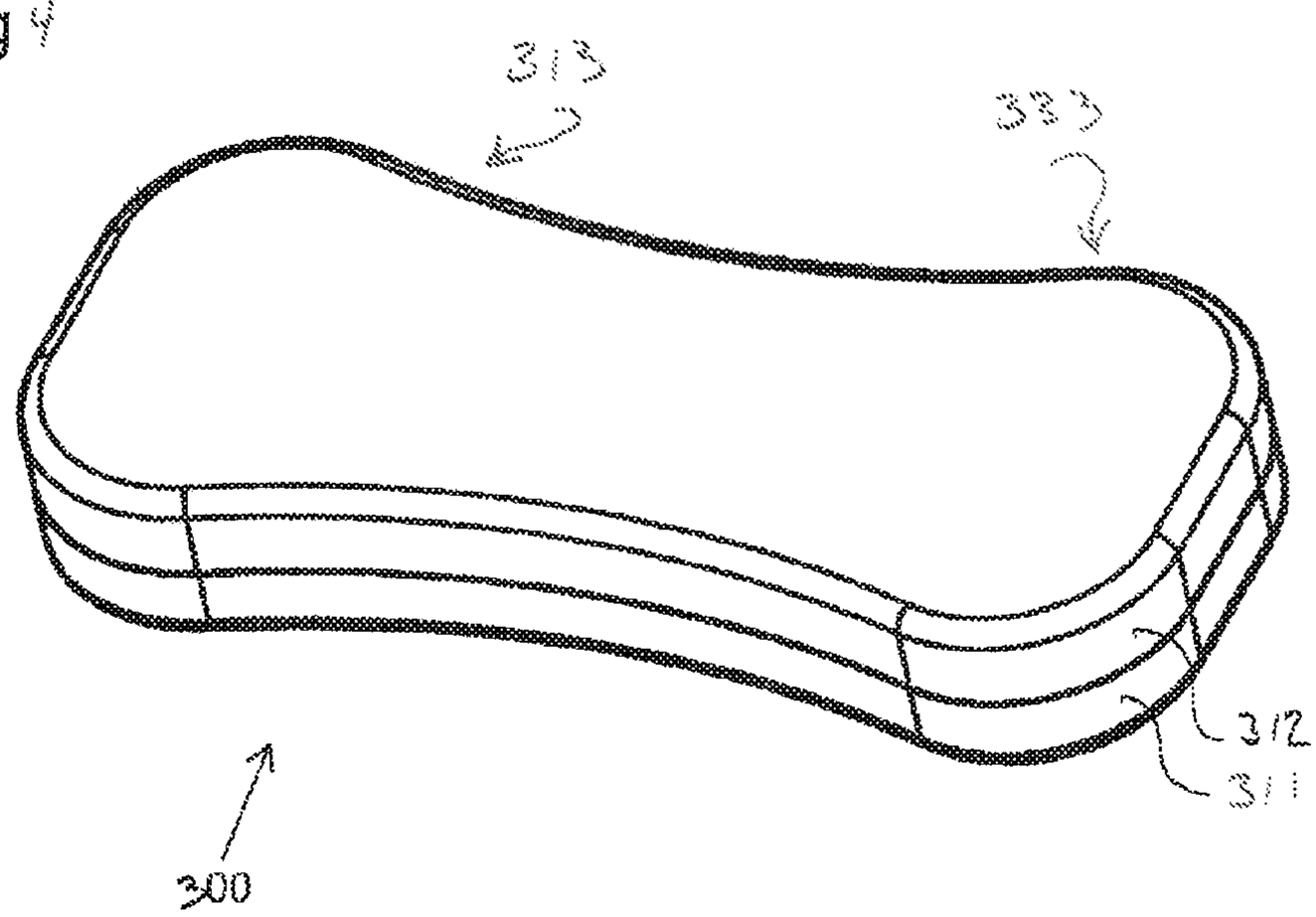
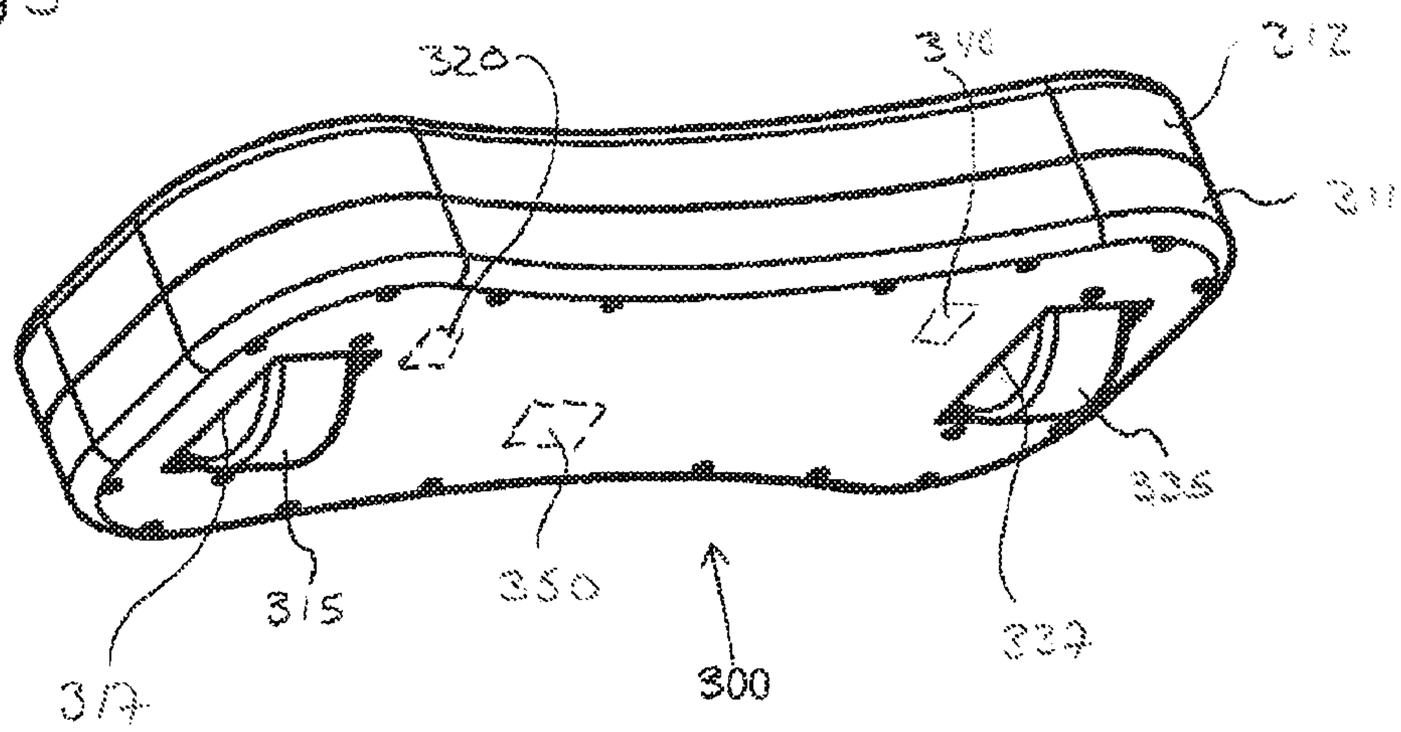


Fig 5



TWO-WHEEL SELF-BALANCING VEHICLE WITH INDEPENDENTLY MOVABLE FOOT PLACEMENT SECTIONS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of provisional application No. 61/597,777, filed Feb. 12, 2012, for a Two-Wheeled Self-Balancing Vehicle by the inventor herein.

FIELD OF THE INVENTION

The present invention relates to two-wheel, self-balancing vehicles and, more specifically, to such vehicles with two platform sections or areas that are independently movable with respect to one another and that thereby provide independent control and/or drive of the wheel associated with the given platform section/area.

BACKGROUND OF THE INVENTION

A first group of prior art two-wheel self-balancing vehicles is represented by a product known commonly as the "Segway." This product is disclosed in U.S. Pat. No. 6,302,230, issued to Sramek et al (the '230 patent). While a contribution in the field, the Segway and like devices are disadvantageous in that they are large, heavy and expensive, i.e., too heavy to be carried by a commuter or youth, too expensive for most to buy. Furthermore, turning is achieved through a handle bar structure that ascends from the platform upward toward the chest of a user. This tall steering structure is a trip hazard when a user makes an unplanned exit from the vehicle.

Another group of prior art two-wheel self-balancing vehicles has two platform sections, each associated with a given wheel, that tilt from side-to-side as a user leans left or right. The two platform sections move in a linked or "dependent" manner (for example, through a parallelogram frame, and not independently) and there is a single "vertical" axis for the platforms. When the axis is tilted directly forward or backward, both wheels drive at the same speed (as required for self-balancing). If a user leans to the side (tilts the "vertical" axis sideways), then the outside wheel is driven faster than the inside wheel to effect a turn toward the direction of the tilt.

These devices typically require a multi-component parallelogram structure to coordinate/link movement of the two platform sections and the wheels. Such componentry adds to the weight, bulk, complexity, and potential for mechanical failure of the device. Also, the turning radius is fairly large as one wheel is typically rotating around the other (moving in the same direction though at different speeds).

A need exists for a two-wheel self-balancing vehicle that provides independent wheel control, is light-weight and compact, is easy and safe to use, and that may be made in a cost-effective manner. A need also exits for a two-wheel self-balancing vehicle that is more maneuverable and more ergonomic (functioning more naturally with the bio-mechanics of a user's legs and body) than prior art devices.

Other prior art includes skateboards that have two platforms sections that are movable with respect to one another. Some have a shared shaft about which the two platform sections pivot, while others have a degree of flexibility in the platform. In both of these arrangements, the platform sections are arranged longitudinally, one primarily behind the other in the longitudinal line-of-direction of travel.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a two-wheel, self-balancing vehicle that overcomes the shortcomings of the prior art.

It is another object of the present invention to provide a two-wheel, self-balancing vehicle that has independently movable foot placement sections.

It is also an object of the present invention to provide such a two-wheel, self-balancing vehicle in which the independently movable foot placement sections are used by an operator to assert independent control over the driving of the wheel associated with the respective foot placement section. These and related objects of the present invention are achieved by use of a two-wheel, self-balancing vehicle with independently movable foot placement sections as described herein.

The attainment of the foregoing and related advantages and features of the invention should be more readily apparent to those skilled in the art, after review of the following more detailed description of the invention taken together with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a two-wheel, self-balancing vehicle with independently movable platform sections in accordance with the present invention.

FIG. **2** is a block diagram of components within the vehicle of FIG. **1**.

FIG. **3** is a bottom perspective view of another embodiment of a two-wheel, self-balancing vehicle with independently movable platform sections in accordance with the present invention.

FIGS. **4-5** are a top perspective view and a bottom perspective view of another embodiment of a two-wheel, self-balancing vehicle with independently movable platform sections in accordance with the present invention.

DETAILED DESCRIPTION

Referring to FIG. **1**, is a perspective view of a two-wheel, self-balancing vehicle **100** with independently movable platform sections in accordance with the present invention is shown.

Vehicle **100** may have a first and a second platform section **110**,**130**. Each platform section **110**,**130** may include a housing formed of a bottom housing member **111**,**131** and a top housing member **112**,**132**. The top housing members may have a foot placement section or area **113**,**133** formed integrally therewith or affixed thereon. The foot placement section is preferably of sufficient size to receive the foot of a user and may include a tread or the like for traction and/or comfort.

The housing may be formed of metal, sturdy plastic or other suitable material. The housing members may be molded and incorporate strengthening reinforcements, and

be shaped to receive and "nest" the internal components (discussed below) of the vehicle. The bottom and top housing sections are formed complementarily so that after the internal components are installed, the top housing section is fitted onto the bottom housing section and secured with screws or other fasteners. FIG. **1** illustrates holes **161**, through which the fasteners are inserted.

Each platform section includes a wheel **115**,**135**, and each wheel preferably has an axle **116**,**136** and motorized hub assembly **117**,**137** (shown in FIG. **2**). Motorized hub assemblies are known in the art.

Referring to FIG. **2**, a block diagram of components within vehicle **100** in accordance with the invention is shown. The dot-dash line represents a rough outline of the housing members. Each platform section preferably includes a position sensor **120**,**140**, which may be a gyroscopic sensor, for independent measurement of the position of the respective platform section. The sensors are preferably mounted on circuit boards **121**,**141** that may be attached to the interior of the respective bottom housings. Sensed position information from sensor **120**,**140** is used to drive the corresponding motor **117**,**137** and wheel **115**,**135**. The control logic for translating position data to motor drive signals may be centralized or split between the two platform sections. For example, control logic **150** may be electrically connected to sensors **120**,**140** and to drive motors **117**,**137**, *with* electrical conduits connecting through the connecting shaft **170** between sensor **140**, control logic **150**, and drive motor **137**.

Alternatively, a separate processor/control logic **151** may be provided in the second platform section **130**. Logic **151**, in this case, **[**would be**]** is **[**connect**]** *connected* directly to sensor **140** and drive motor **137** and **[**generate**]** *generates* drive signals to motor **137** (and wheel **135**) based *on* data from sensor **140**.

Communication between these components is primarily in the direction of data from the sensor and drive signals to the motor. However, communication in the other direction may include start signals (**[**ie**]** *i.e.*, to the sensor), status signals (**[**ie**]** *i.e.*, from the motor indicating an unsafe condition (e.g., excessive rpm**[**)**]**, or a motor/drive failure or irregularity). This information, in addition to battery information, etc., could be communicated back to a user via lights or another interface, or communicated wirelessly (e.g., bluetooth) from the vehicle to a hand-held device such as a mobile phone. In addition, if the platform sections have separate and independent control logic **150**,**151**, these processing units may still share information with one another, such as status, safe operation information, etc.

The two platform sections **110**,**130** are movably coupled to one another. FIG. **2** illustrates a shaft **170** about which they may rotate (or pivot with respect to one another). Brackets **164** and flange brackets **165** may secure the shaft to the platform sections, with the flange brackets preferably configured to prevent or reduce the entry of dirt or moisture within the housings. Shaft **170** may be hollow in part and thereby allowing for the passage of conduits therethrough. Pivoting or rotating shaft arrangements are known in the art, and others may be used without deviating from the present invention as long as the foot placement sections may move independently.

Since the platform sections may rotate or pivot with respect to one another, the left section **110**, for example, may tilt forward while the right section tilts backward. This would cause the wheels to be driven in opposite directions, causing a user to spin-in-place or "pirouette" much like a figure skater. Alternatively, the platform wheels could be tilted in the same direction, but one platform more than the other. This would cause the wheel associated with the more steeply tilted platform to drive faster, in turn causing the vehicle to turn. The sharpness of the turn could be readily adjusted by the user based on the relative tilt of the platform sections.

This leg movement to control turning is a very ergonomic and natural movement, akin to skiing and other gliding/sliding activities.

The rotating shaft **170** may also include a bias mechanism integral with the flange bracket **165** or otherwise configured to return the platform section to an even level in the absence of displacement from a riders weight.

Each platform section **110**,**130** may also include a platform or "shut-off" sensor **119**,**139** that detects when a user is standing **[**of**]** *on* the platform. When a user falls off, the absence of the rider is sensed and the control logic, in response, stops driving the wheels such that the vehicle comes to a stop (and does not carry on **[**rider less**]** *riderless*). In the absence of such a shut-off sensor, the vehicle would still stop rather soon as the wheels will be driven to a self-balancing position for their respective sections bringing the device to rest.

Referring to FIG. **3**, a bottom perspective view of another embodiment of a two-wheel, self-balancing vehicle **200** with independently movable platform sections in accordance with the present invention is shown. Vehicle **200** may include first and second platform section **210**,**230** that are formed of bottom **211**,**231** and top **212**,**232** housing sections, similar to those in vehicle **100** above.

Each platform section *110,130* includes a wheel **215**,**235** which is respectively driven by a motorized hub **217**,**237** and an associated position sensor **220**,**240**. Control logic **250** receives the sensed position information and drives the associated wheel toward self-balancing. As discussed above, the control logic **250** may be independent, provided in each platform section, or centralized, provided in one section. Regardless, the driving of each wheel is based on the position sensed by the sensor associated with that wheel.

A pivoting shaft or other arrangement may be used to movably/rotatably join the two platform sections.

Referring to FIGS. **4-5**, a top perspective view and a bottom perspective view of another embodiment of a two-wheel, self-balancing vehicle with independently movable platform sections **300** in accordance with the present invention is shown. Vehicle **300** is similar to the other vehicles herein, yet instead of a pivoting or rotating connection between platform sections, the frame or housing is made of a sturdy yet sufficiently flexible material that the two foot placement sections are effectively first and second platform sections that move independently with respect to each other for independent control of wheels **315**,**335**.

Vehicle **300** may include a bottom **311** and a top **312** housing sections. These may be made of a flexible steel or durable flexible plastic or the like. The two sections are preferably configured to receive the internal components. They are preferably complementary in shape and may be secured by fasteners from below. The top housing may include or have attached to it a rubber coating or surface or the like in the foot placement areas **313**,**333** to increase traction and/or comfort with the foot of a user.

The internal components may include position sensors for both sections **320**,**340**, hub motors **317**,**337**, and control logic **350** for independently driving wheels **315**,**335** toward a self-balancing position based on position information **[**sensor**]** *sensed* by their respective sensors **320**,**340**. These

components may be the same or similar to those discussed above for vehicles **100** and **200** (FIGS. **1-3**).

While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as fall within the scope of the invention and the limits of the appended claims.

The invention claimed is:

1. A two-wheel, self-balancing vehicle device, comprising:

a first foot placement section and a second foot placement section that are coupled to one another and are independently **[**movable with respect to one another**]** *rotatable along an axis passing through a first wheel and a second wheel*;

[a**]** *said* first wheel associated with the first foot placement section and **[**a**]** *said* second wheel associated with the second foot placement section, the first and second wheels being spaced apart and substantially parallel to one another;

a first position sensor and a first drive motor configured to drive the first wheel, a second position sensor and a second drive motor configured to drive the second wheel; and

control logic that drives the first wheel toward self-balancing the first foot placement section in response to position data from the first sensor and that drives the second wheel toward self-balancing the second foot placement section in response to position data from the second foot placement section.

[2. The device of claim **1**, wherein the first foot placement section and the second foot placement section are rotatably coupled to one another.**]**

3. The device of claim **1**, wherein the first foot placement section and the second foot placement section are positioned substantially linearly between the first and second wheel.

4. The device of claim **1**, wherein said first and second foot placement sections are mounted to a frame that is sufficiently flexible that the first and second foot placement platforms can move independently with respect to one another under the weight of a user.

5. The device of claim **1**, further comprising:

a first housing section on which the first foot placement section is provided, the first housing section housing the first sensor and first drive motor; and

a second housing section on which the second foot placement section is provided, the second housing section housing the second sensor and second drive motor.

6. The device of claim **5**, wherein the control logic include a first control logic controlling the first drive motor located in the first housing section and a second control logic controlling the second drive motor located in the second housing section.

7. The device of claim **5**, wherein the first drive wheel extends from the first housing section on an end substantially opposite where the first housing section is coupled to the second housing section, and the second drive wheel extends from the second housing section on an end substantially opposite where the second housing section is coupled to the first housing section.

8. The device of claim **1**, further comprising a platform sensor provided at at least one of the first and second foot placement sections that detects when a user is standing on that foot placement section.

9. The device of claim **1**, further comprising a bias mechanism for returning the two independently movable first and second foot placement sections toward alignment in the absence of a force by a user displacing the two foot placement sections from alignment.

10. A two-wheel self-balancing vehicle device, comprising:

a first foot placement section and a second foot placement section that are coupled to one another and are independently rotatable along an axis passing through a first wheel and a second wheel;

said first wheel associated with the first foot placement section and said second wheel associated with the second foot placement section, the first and second wheels being spaced apart and substantially parallel to one another;

a first position sensor and a first drive motor configured to drive the first wheel a second position sensor and a second drive motor configured to drive the second wheel; and

control logic that drives the first wheel toward self-balancing the first foot placement section in response to position data from the first sensor and that drives the second wheel toward self-balancing the second foot placement section in response to position data from the second sensor.

11. The device of claim 10, wherein the first foot placement section and the second foot placement section are positioned substantially linearly between the first and second wheel.

12. The device of claim 10, wherein said first and second foot placement sections are mounted to a frame that is sufficiently flexible that the first and second foot placement platforms can move independently with respect to one another under the weight of a user.

13. The device of claim 10, further comprising:

a first housing section on which the first foot placement section is provided, the first housing section housing the first sensor and first drive motor; and

a second housing section on which the second foot placement section is provided, the second housing section housing the second sensor and second drive motor.

14. The device of claim 13, wherein the control logic include a first control logic controlling the first drive motor located in the first housing section and a second control logic controlling the second drive motor located in the second housing section.

15. The device of claim 13, wherein the first drive wheel extends from the first housing section on an end substantially opposite where the first housing section is coupled to the second housing section, and the second drive wheel extends from the second housing section on an end substantially opposite where the second housing section is coupled to the first housing section.

16. The device of claim 10, further comprising a platform sensor provided at at least one of the first and second foot placement sections that detects when a user is standing on that foot placement section.

17. The device of claim 10, further comprising a bias mechanism for returning the two independently movable first and second foot placement sections toward alignment in

the absence of a force by a user displacing the two foot placement sections from alignment.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : RE46,964 E
APPLICATION NO. : 15/165654
DATED : July 24, 2018
INVENTOR(S) : Chen

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification

At Column 1, under the heading "CROSS REFERENCE TO RELATED APPLICATIONS," at Line 16 (approx.), please replace "The present application," with the following:

--*NOTICE: More than one reissue application has been filed for the reissue of U.S. Patent No. 8,738,278 B2. The reissue applications are U.S. Reissue Patent Application Serial No. 16/000,535, filed on June 5, 2018, and U.S. Reissue Application Serial No. 15/986,713, filed on May 22, 2018, now abandoned, each of which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 15/165,654 (the present application), filed on May 26, 2016, now U.S. Reissue Patent No. RE46,964 E, issued July 24, 2018, which is a reissue application of U.S. Patent Application Serial No. 13/764,781, filed on February 11, 2013, now U.S. Patent No. 8,738,278 B2, issued May 27, 2014, which--

Signed and Sealed this
Twenty-third Day of March, 2021

Drew Hirshfeld
Performing the Functions and Duties of the
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office

US00RE46964C1

(12) EX PARTE REEXAMINATION CERTIFICATE (11975th)

United States Patent

Chen

(10) Number: US RE46,964 C1

(45) Certificate Issued: Dec. 30, 2021

(54) **TWO-WHEEL SELF-BALANCING VEHICLE WITH INDEPENDENTLY MOVABLE FOOT PLACEMENT SECTIONS**

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Related U.S. Patent Documents

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Filed: **Feb. 11, 2013**

(51) **Int. Cl.**
B62K 11/00 (2006.01)

(52) **U.S. Cl.**
CPC ***B62K 11/007*** (2016.11)

(58) **Field of Classification Search**
None
See application file for complete search history.

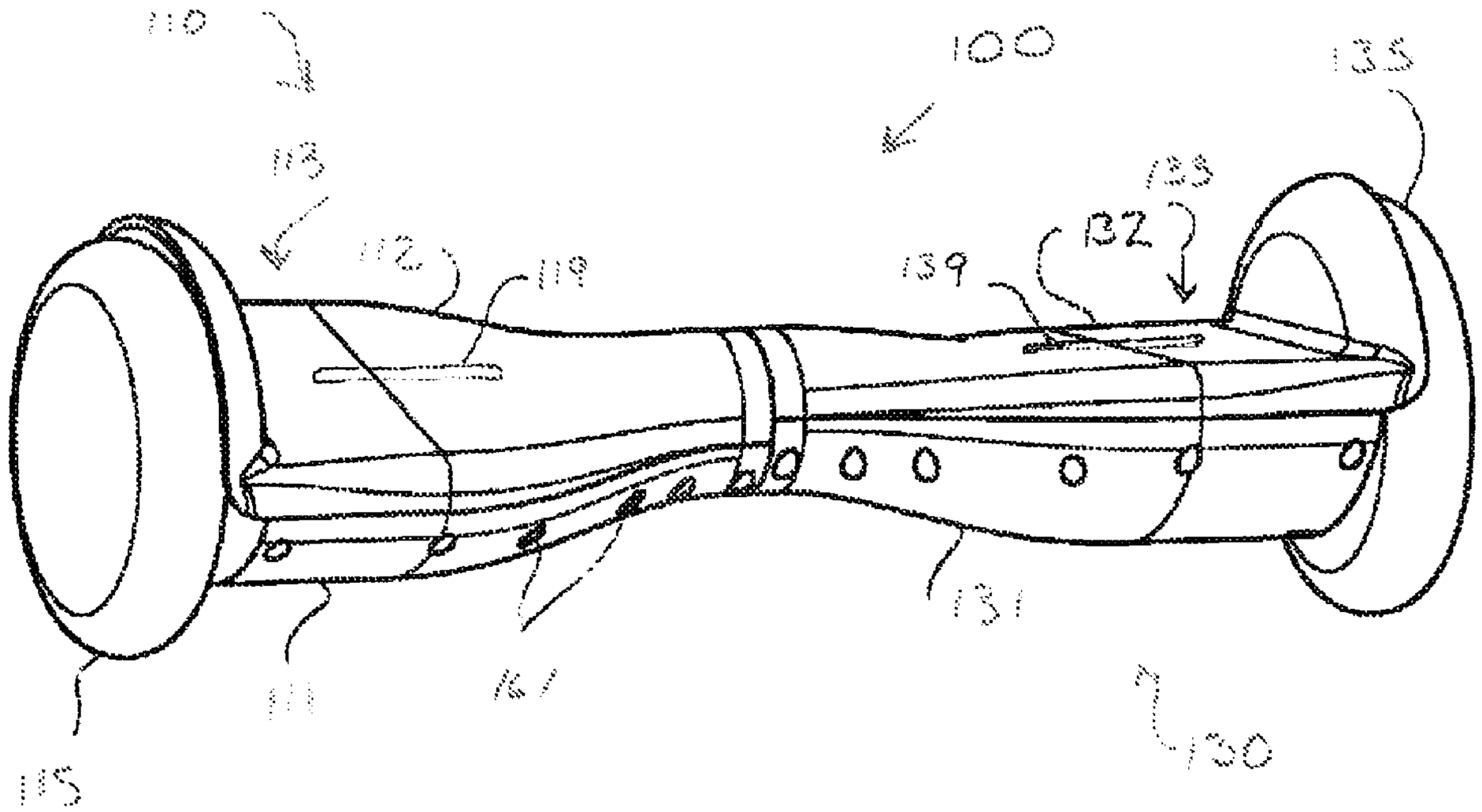
(56) **References Cited**

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/014,765, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner — Eron J Sorrell

(57) **ABSTRACT**

A two-wheel, self-balancing personal vehicle having independently movable foot placement sections. The foot placement sections have an associated wheel, sensor and motor and are independently self-balancing which gives the user independent control over the movement of each platform section by the magnitude and direction of tilt a user induces in a given platform section. Various embodiments are disclosed including those with a continuous housing, discrete platform sections and/or tapering platform sections.



EX PARTE REEXAMINATION CERTIFICATE

NO AMENDMENTS HAVE BEEN MADE TO THE PATENT

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **1**, **3**, **5-11** and **13-17** is confirmed.

Claim **2** was previously cancelled.

Claims **4** and **12** were not reexamined.

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