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Inventor(s)	HWANG; Yongsuk et al.

DRIVE SYSTEM FOR ELECTRIC BICYCLE

Abstract

A drive system for an electric bicycle is disclosed, which includes: a motor providing a rotational force to a driving wheel; a battery supplying power to the motor; and an alternator providing a pedal reaction force to a driver, and converting kinetic energy of a pedal into electric energy, and supplying the electric energy to at least any one of the motor and the battery.
The drive system for an electric bicycle according to the present disclosure has an effect in that a limit of the pedal reaction force by electromagnetic force is overcome to effectively prevent the ‘slip through’ phenomenon from occurring.

Inventors: **HWANG; Yongsuk (Pyeongtaek-si, KR), SEO; Jaeman (Pyeongtaek-si, KR), LEE; Dongmin (Pyeongtaek-si, KR), PARK; Jinseok (Pyeongtaek-si, KR), AN; Soomin (Pyeongtaek-si, KR)**

Applicant: **HL MANDO CORPORATION** (Pyeongtaek-si, KR)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority of Korean Patent Application Nos. 10-2024-0019305 filed on Feb. 8, 2024, and 10-2024-0094636 filed on Jul. 17, 2024, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

Technical Field

[0002] The present disclosure relates to a drive system for an electric bicycle, and more particularly, to a drive system for an electric bicycle which provides a pedal reaction force to a driver without a mechanical connection between a pedal crank shaft and a driving wheel, and converts pedal kinetic energy of the driver into electric energy.

Description of the Related Art

[0003] In general, a bicycle is configured in which a front wheel which is a steering wheel and a rear wheel which is a driving wheel are disposed in a straight line in front and rear sides of a frame, and a rider steps on a pedal which is in conjunction with the rear wheel to rotate the rear wheel to allow the bicycle to move forward.

[0004] A power transmission device such as a chain or a bevel gear is installed in the bicycle in order to transmit power generated by the pedal to the rear wheel. In particular, the chain-scheme power transmission device is constituted by a driving sprocket wheel installed at one side of the pedal, a driven sprocket wheel having a smaller diameter than the driving sprocket wheel, and installed in the rear wheel which is the driving wheel, and a chain connecting the driving sprocket wheel and the driven sprocket wheel.

[0005] In such a configuration, when the driver steps on the pedal, the driving sprocket wheel installed integrally with the pedal rotates, and at the same time, the rear wheel connected to the driven sprocket wheel rotates jointly by the chain to move the bicycle forward.

[0006] Meanwhile, the power transmission device installed in the bicycle as such has a large occupancy and a complex structure, and there is a problem in that a hem of a driver is caught or contaminated between the driving sprocket wheel and the chain. In particular, when a multi-stage shift device is installed in the driven sprocket wheel, there is also a problem in that the chain is often left out of the sprocket wheel during shifting.

[0007] Considering such a problem, an electric bicycle without the power transmission device has been developed and used in recent years. The electric bicycle includes a motor rotating the rear wheel which is the driving wheel, a battery supplying power to the motor, and an electronic control device for controlling the motor and the battery, and the electric bicycle is driven by a scheme in which when the power is supplied to the motor by the electronic control device, the motor rotates a wheel.

[0008] Further, the electric bicycle includes an alternator that generates electricity by driving the pedal. The battery of the electric bicycle can be charged by using an external power supply or charged through an operation of rotating the alternator connected to the pedal with the pedal.

[0009] That is, the battery of the electric bicycle is enabled to be electrically charged by an alternator which is self-provided, and there are many cases in which the alternator is installed in the pedal to easily convert rotational force of the pedal into electric energy.

[0010] Meanwhile, in the electric bicycle without the power transmission device, when the driver steps on the pedal, a pedal load can be controlled so as to feel a pedal sense as if there is the chain, and as a result, a pedal effort is formed in the pedal when the pedal rotates, so the pedal sense can be felt.

[0011] Rotational force generated from electromagnetic elements (a rotator and a stator) installed inside the alternator provides appropriate pedal reaction force to the driver through a crank shaft and a crank arm, and a size of the reaction force is controlled by a controller.

[0012] However, since there is a limit (this is referred to as 'limited reaction force') in the size of the reaction force which can be provided by the electromagnetic elements inside the alternator by using the electric energy supplied from the battery, when the pedal effort of the driver exceeds the limited reaction force of the alternator, a feeling of turn-off or idling of the pedal is given to the driver regardless of driving of the electric vehicle, and such a feeling is conveyed to the driver very heterogeneous and unpleasant. Such a phenomenon is referred to as 'slip through'.

[0013] When a heavy load is loaded on the electric bicycle, when the electric bicycle starts on a steep slope, and in particular, when the driver steps on the pedal while holding a brake, a very large pedal effort of the driver is delivered to the pedal crank shaft while the motor and the driving wheel do not rotate, so there is a high risk of occurrence of the 'slip through' phenomenon.

BRIEF SUMMARY

[0014] As disclosed in the prior art documents described above, an existing alternator applied to an electric bicycle has a form in which a crank shaft connected to a pedal, and a torque transmission unit constituted by a transmission and a rotor are configured in a housing.

[0015] A relationship between a pedal effort of a driver and a reaction force generated from an electromagnetic element of the alternator in an existing alternator structure is illustrated in FIG. **2**. The alternator having such a structure has a structure which is difficult to prevent occurrence of the 'slip through' phenomenon as described above.

[0016] FIG. **3** is a graph for describing that a 'slip through' phenomenon occurs in an electric bicycle to which an existing alternator is applied. The graph shows a relationship between a crank shaft torque, a crank shaft rotating speed, a rotor shaft torque, and a rotor shaft rotating speed.

[0017] Referring to FIG. **3**, in a condition in which a driving motor and a driving wheel of the electric bicycle do not rotate, the reaction force to the pedal effort is provided and the crank shaft does not rotate within the limited reaction force of the alternator, but when a pedal effort which exceeds the limited reaction force provided by the alternator is input, the crank shaft and an internal rotor rotate, and the electric bicycle stops in place, but the driver feels that the pedal is turned off.

[0018] As described above, there is a limit in torque which may be generated by converting only limited electric energy supplied from the battery of the electric bicycle, but a technical object to be achieved by the present disclosure is to provide an alternator and a drive system for an electric bicycle including the same, which may effectively prevent a 'slip through' phenomenon by overcoming such a limit.

[0019] The technical objects of the present disclosure are not restricted to the aforementioned technical objects, and other objects of the present disclosure, which are not mentioned above, will become more apparent to one of ordinary skill in the art to which the present disclosure pertains by referencing the detailed description of the present disclosure given below.

[0020] In order to achieve the technical object, according to an aspect of the present disclosure, a drive system for an electric bicycle may be provided, which includes: a motor providing a rotational force to a driving wheel; a battery supplying power to the motor; and an alternator providing a pedal reaction force to a driver, and converting kinetic energy of a pedal into electric energy, and supplying the electric energy to at least any one of the motor and the battery, in which the alternator includes a housing, a crank shaft installed to penetrate the housing, and having the petal installed therein, a gear unit installed inside the housing, and speed-increasing or speed-decreasing the rotational force of the pedal, an alternation unit installed inside the housing, and receiving the rotational force of the pedal speed-increased or speed-decreased by the gear unit, and generating the electric energy, an elastic member installed between the housing and the gear unit, and elastically supporting the housing and the gear unit, and a frictional member which is installed in the housing to maintain a predetermined gap from the gear unit, and which some components of the gear unit contact by moving in an axial direction when a pedal effort larger than a limited

reaction force which is a peak value of the pedal reaction force provided by the alternator is input.
[0021] A brake torque may be generated by the contact between some components of the gear unit, and the frictional member.
[0022] At least some of a plurality of gears constituting the gear unit may be provided as a Helical gear, and some components of the gear unit may move in an axial direction by an axial force generated by the gear provided as the Helical gear.
[0023] The elastic member may be interposed between the housing or a component coupled to the housing, and the gear unit.
[0024] The alternation unit may include a rotor coupled to an output side of the gear unit, and rotating, and a stator electromagnetically interacting with the rotor.
[0025] In an exemplary embodiment, the gear unit may include a carrier fixed to the crank shaft, a plurality of planetary gears supported by the carrier, and revolving and rotating with the crank shaft as a central axis by rotation of the carrier, and a sun gear installed on a circumference of the crank shaft, and rotating by engaging with the plurality of planetary gears.
[0026] Further, the gear unit may further include a ring gear provided on an inner wall of the housing, and rotating by engaging with the plurality of planetary gears.
[0027] The planetary gear, the sun gear, and the ring gear may be provided as the Helical gear.
[0028] When an axial force generated between the planetary gear and the ring gear is larger than an elastic force of the elastic member, the planetary gear and the ring gear may move in the axial direction on the crank shaft.
[0029] The elastic member may be interposed between the housing or the component coupled to the housing, and the carrier.
[0030] The frictional member may be installed on an inner surface of the housing facing the carrier.
[0031] In another exemplary embodiment, the gear unit may include a driving gear fixed to the crank shaft, an idle gear installed on an intermediate shaft provided apart from the crank shaft, and rotating by engaging with the driving gear, and a driven gear rotating by engaging with the idle gear.
[0032] At least some of the driving gear and the idle gear engaged with the driving gear may be provided as the Helical gear.
[0033] When an axial force generated between the driving gear and the idle gear is larger than the elastic force of the elastic member, the driving gear and the idle gear may move in the axial direction on the crank shaft and the intermediate shaft, respectively.
[0034] The elastic member may be interposed between the housing or the component coupled to the housing, and the idle gear.
[0035] The frictional member may be installed on the inner surface of the housing facing the idle gear.
[0036] Meanwhile, in order to achieve the technical object, according to another aspect of the present disclosure, the drive system for an electric bicycle may be provided, in which the electric bicycle includes an alternator converting kinetic energy of a pedal into electric energy, and supplying the electric energy to at least any one of a motor and a battery, in which the alternator includes a gear unit including at least one input gear installed on a crank shaft in which the pedal is installed to speed-increase or speed-decrease a rotational force of the pedal, and an alternation unit including a rotor rotating by the gear unit and a stator electromagnetically interacting with the rotor to produce electricity, the alternator provides a pedal reaction force to a driver by using the rotational force of the alternation unit, and when a pedal effort larger than a limited reaction force which is a peak value of the pedal reaction force provided by the alternator is input, a location of the crank shaft is maintained by a brake torque generated as some components of the gear unit including the input gear move in the axial direction and contact the frictional member installed on an inner wall of the housing.
[0037] According to another aspect of the present disclosure, the drive system for an electric

vehicle may further include an elastic member interposed between the housing or the component coupled to the housing, and the gear unit to elastically support the housing and the gear unit.
[0038] The frictional member may be installed to be positioned spaced apart from the gear unit when a pedal effort smaller than the limited reaction force provided by the alternator is input.
[0039] When an axial force generated by some components of the gear unit is larger than the elastic force of the elastic member by the pedal effort, some components of the gear unit may move in the axial direction, and contact the frictional member.
[0040] The drive system for an electric bicycle according to the present disclosure has an effect in that a limit of the pedal reaction force by electromagnetic force is overcome to effectively prevent the ‘slip through’ phenomenon from occurring. This means that a comfortable pedal sense may be provided to a driver of the electric bicycle, so the merchantability of the electric bicycle may also be significantly enhanced.
[0041] Further, the present disclosure has an advantage in that the sizes of the electromagnetic elements (the rotor and the stator) may be excluded from being unnecessarily increased in order to prevent the ‘slip through’ phenomenon only with the electromagnetic force.
[0042] Moreover, according to the present disclosure, since a location of the crank shaft is maintained by a brake torque, the electromagnetic force may be reduced to reduce current consumption and reduce heat dissipation, and a driving distance of the electric bicycle may also be enhanced due to reduced electric energy consumption.
[0043] The effects of the present disclosure are not limited to the aforementioned effects, and other effects, which are not mentioned above, will be apparently understood to a person having ordinary skill in the art from the following description.
[0044] The objects to be achieved by the present disclosure, the means for achieving the objects, and the effects of the present disclosure described above do not specify essential features of the claims, and, thus, the scope of the claims is not limited to the disclosure of the present disclosure.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS
[0045] The above and other aspects, features and other advantages of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:
[0046] FIG. **1** is a diagram illustrating an electric bicycle;
[0047] FIG. **2** is a diagram schematizing and illustrating a relationship between a pedal effort of a driver and a reaction force generated from an electromagnetic element of an alternator in an electric bicycle having an alternator in related art;
[0048] FIG. **3** is a graph for describing that a ‘slip through’ phenomenon occurs in an electric bicycle to which an existing alternator is applied;
[0049] FIG. **4** is a diagram illustrating a structure of an alternator according to a first exemplary embodiment of the present disclosure applied to an electric bicycle;
[0050] FIG. **5** is an enlarged view of a part marked with ‘A’ in FIG. **4**;
[0051] FIG. **6** is a diagram illustrating a state in which an axial force is generated from the alternator according to the first exemplary embodiment of the present disclosure, and some components of a gear unit move in an axial direction;
[0052] FIG. **7** is a diagram illustrating a structure of an alternator according to a second exemplary embodiment of the present disclosure applied to an electric bicycle;
[0053] FIG. **8** is a diagram illustrating a state in which the axial force is generated from the alternator according to the second exemplary embodiment of the present disclosure, and some components of the gear unit move in the axial direction;

[0054] FIG. **9** is a diagram schematizing and illustrating a relationship between a pedal effort of a driver and a reaction force generated from an electromagnetic element of an alternator in an electric bicycle having an alternator according to the present disclosure; and

[0055] FIG. **10** is a graph for describing that a 'slip through' phenomenon of the electric bicycle is prevented according to the application of the alternator according to the present disclosure.

DETAILED DESCRIPTION

[0056] Hereinafter, the present disclosure will be described in detail with reference to the accompanying drawings. The following exemplary embodiment is to fully present the idea of the present disclosure to those skilled in the art to which the present disclosure pertains. The present disclosure is not limited to exemplary embodiments described presented herein and may be embodied in other forms. In the drawings, illustration of parts not related to the description to clarify the present disclosure is omitted, and the size of a component may be slightly exaggerated and expressed to help understanding.

[0057] FIG. **4** is a diagram illustrating a structure of an alternator according to a first exemplary embodiment of the present disclosure applied to an electric bicycle, FIG. **5** is an enlarged view of a part marked with 'A' in FIG. **4**, and FIG. **6** is a diagram illustrating a state in which an axial force is generated from the alternator according to the first exemplary embodiment of the present disclosure, and some components of a gear unit move in an axial direction. FIG. **7** is a diagram illustrating a structure of an alternator according to a second exemplary embodiment of the present disclosure applied to an electric bicycle, and FIG. **8** is a diagram illustrating a state in which the axial force is generated from the alternator according to the second exemplary embodiment of the present disclosure, and some components of the gear unit move in the axial direction. FIG. **9** is a diagram schematizing and illustrating a relationship between a pedal effort of a driver and a reaction force generated from an electromagnetic element of an alternator in an electric bicycle having an alternator according to the present disclosure, and FIG. **10** is a graph for describing that a 'slip through' phenomenon of the electric bicycle is prevented according to the application of the alternator according to the present disclosure.

[0058] As illustrated in FIG. **1**, the electric bicycle according to the present disclosure may have a structure in which there is no mechanical power connection means between a pedal driving unit and a driving wheel. Referring to FIG. **1**, the electric bicycle according to the present disclosure may be configured to include: a frame **100** constituting a vehicle body; a motor **200** installed on the frame **100**, and providing rotational force to the driving wheel; a battery **300** supplying power to the motor **200**; an alternator **400** providing a pedal reaction force to a driver, and converting pedal kinetic energy of the driver into electric energy, and returning the electric energy to the motor **200** and/or the battery **300**; and a controller **500** separately or integrally controlling the motor **200** and the alternator **400**.

[0059] The frame **100** may be configured to include a front frame **110**, a middle frame **120**, and a rear frame **130**.

[0060] A front wheel is rotatably mounted on the front frame **110**. Further, a handle stem may be provided on one end of the front frame **110**, and a handle unit for steering the electric bicycle may be coupled to an upper portion of the handle stem.

[0061] A pedal housing for installing the pedal and the alternator **400** may be provided at a lower end of the middle frame **120**, and a saddle tube for installing a saddle may be provided at an upper end. The alternator **400** may be mounted inside the pedal housing, and the pedals may be rotatably mounted on both sides of the alternator **400**. At this time, a housing **410** of the alternator **400** to be described below may also constitute the pedal housing as itself.

[0062] A rear wheel is rotatably mounted on the rear frame **130**. The motor **200** for advancing the electric bicycle by rotating the rear wheel may be mounted on the center of the rear wheel.

[0063] The front frame **110**, the middle frame **120**, and the rear frame **130** are coupled by a hinge shaft (not illustrated) penetrating the frame at one end of each frame, and a plurality of frames **110**,

120, and **130** is folded to each other by rotation of the hinge shaft to enhance storage and portability. Unlike this, the front frame **110**, the middle frame **120**, and the rear frame **130** are integrally provided to simplify a structure and a manufacturing process, and at the same time, enhance the rigidity of the bicycle body.

[0064] The motor **200** may operate by receiving the power from the battery **300**, and drives the rear wheel which is the driving wheel of the electric bicycle as much as a requirement by pedaling of the driver. In the exemplary embodiment, it is described as an example that the rear wheel of the electric bicycle is the driving wheel, but the front wheel may also be provided as the driving wheel, and in this case, the motor **200** will be installed at the front wheel.

[0065] The battery **300** may be mounted inside the middle frame **120**. However, the present disclosure is not limited thereto, and the battery **300** may be mounted inside the front frame **110** or the rear frame **130**, or is mounted outside the frame **100** via a bracket (not illustrated) to achieve smooth maintenance, of course.

[0066] The alternator **400** is provided to convert the rotational force of the pedal generated by the pedal effort of the driver into the electric energy. The electric energy converted by the alternator **400** may be supplied as driving power of the motor **200**, or charged in the battery **300**.

[0067] The controller **500** may separately control or integrally control the motor **200** and the alternator **400**. In the exemplary embodiment, the controller **500** may include a first electronic control unit **510** connected to the motor **200** and a second electronic control unit **520** connected to the alternator **400**.

[0068] The motor **200** may be electrically connected to the first electronic control unit **510** embedded inside the rear frame **130** and the alternator **400** may be electrically connected to the second electronic control unit **520** embedded inside the middle frame **120**. Here, installation locations of the first electronic control unit **510** and the second electronic control unit **520** are not particularly limited as described above. All of the respective frames **110**, **120**, and **130** constituting the electric bicycle according to the present disclosure have accommodation spaces therein, so components such as the battery **300** or the electronic control units **510** and **520** may be moved to and placed in frames at locations different from the locations illustrated in the drawing, of course.

[0069] Further, the controller **500** of the exemplary embodiment may not be separated into two electronic control units **510** and **520**, but integrally provided. Even when the controller **500** is provided in an integrated form, any one of the front frame **110**, the middle frame **120**, and the rear frame **130** may be appropriately selected and placed.

[0070] Further, the controller **500** of the exemplary embodiment may also be separately configured outside the motor **200** or the alternator **400**, but is also possible to be configured in a form in which the controller **500** is included in the motor **200** or the alternator **400**. This may be individually applied to two electronic control units **510** and **520** constituting the controller **500**. For example, the first electronic control unit **510** connected to the motor **200** may be configured inside or outside the motor **200**, and the second electronic control unit **520** connected to the alternator **400** may configured inside or outside the alternator **400**.

[0071] Meanwhile, in the electric bicycle according to the present disclosure, there is a technical object to prevent the ‘slip through’ phenomenon from occurring by overcoming the limited reaction force provided by the electromagnetic element in the alternator **400**, so hereinafter, the structure and the operation of the alternator **400** according to the present disclosure will be described in detail for each exemplary embodiment.

[0072] FIG. **4** is a diagram illustrating a structure of an alternator according to a first exemplary embodiment of the present disclosure applied to an electric bicycle, FIG. **5** is an enlarged view of a part marked with ‘A’ in FIG. **4**, and FIG. **6** is a diagram illustrating a state in which an axial force is generated from the alternator according to the first exemplary embodiment of the present disclosure, and some components of a gear unit move in an axial direction.

[0073] Referring to FIGS. **4** to **6**, the alternator **400** according to the first exemplary embodiment of the present disclosure may be configured to include a housing **410**, a crank shaft **420** installed to penetrate the housing **410**, and having both ends with pedals, and a gear unit **430** and an alternation unit **440** accommodated inside the housing **410**.

[0074] The housing **410** may be provided in a cylindrical shape having a hollow therein, and mounted on the inside of the pedal housing provided at one end of the middle frame **120**. The housing **410** of the alternator **400** may be provided integrally with the pedal housing as described above. That is, the housing itself of the alternator **400** constitutes the pedal housing to reduce component elements and simplify the structure.

[0075] The housing **410** may include a hollow body **411** of which both ends are opened, and a pair of covers **412** and **413** closing both opened side surfaces of the body **411**.

[0076] The crank shaft **420** may be installed to penetrate the housing **410**, and the pedals may be rotatably installed at both ends of the crank shaft **420** protruding to the outside of the housing **410**.

[0077] A bearing is provided between the housing **410** and the crank shaft **420** to achieve smooth rotation of the crank shaft **420** to the housing **410**, and reduce abrasion between the component elements. More specifically, bearings are mounted on covers **412** and **413** constituting both side surfaces of the housing **410**, respectively to support the crank shaft **420** to be relatively rotatable.

[0078] The gear unit **430** increases or decreases the rotational force of the pedal to increase alternation efficiency of the alternation unit **440** which generates electricity by the rotational force of the gear unit **430**.

[0079] The gear unit **430** and the alternation unit **440** may be continuously placed on a circumference of the crank shaft **420** in an internal space of the housing **410** in an axial direction. The gear unit **430** may be provided to be speed-increased or speed-decreased with an input side connected to the crank shaft **420**, and the alternation unit **440** may be connected to an output side of the gear unit **430** which is speed-increased or speed-decreased compared to a rotational speed of the input side of the gear unit **430**.

[0080] As an example, the gear unit **430** of the exemplary embodiment may include a first speed-increase unit **431** constituted by a first carrier **431***a*, a first planetary gear **431***b*, a first sun gear **431***c*, and a first ring gear **431***d*, and a second speed-increase unit **432** constituted by a second carrier **432***a*, a second planetary gear **432***b*, a second sun gear **432***c*, and a second ring gear **432***d*. The first speed-increase unit **431** and the second speed-increase unit **432** may be placed on the crank shaft **420** in series.

[0081] The first speed-increase unit **431** may include the first carrier **431***a* fixed to the crank shaft **420** and transmitting the rotational force of the pedal, a plurality of first planetary gears **431***b* supported by the first carrier **431** a, and revolving and rotating with the crank shaft **420** as a central axis by the rotation of the first carrier **431** a, the first sun gear **431***c* installed on the circumference of the crank shaft **420**, engaging with the plurality of first planetary gears **431***b* and rotating jointly with the rotation of the first planetary gear **431***b*, and the first ring gear **431***d* provided on an inner wall of the housing **410**, and engaging with the first planetary gear **431***b*, and rotating jointly with the revolving of the first planetary gear **431***b*.

[0082] The first carrier **431***a* is fixed and installed on the circumference of the crank shaft **420**, and when the driver steps on and rotates the pedal, the crank shaft **420** and the first carrier **431***a* fixed thereto rotate jointly. The first carrier **431***a* also serves to support the plurality of first planetary gears **431***b* engaged between the first sun gear **431***c* and the first ring gear **431***d* at the same interval.

[0083] A plurality of first planetary gears **431***b* may be provided to constitute one set, and the plurality of first planetary gears **431***b* are engaged between the first sun gear **431***c* and the first ring gear **431***d* to revolve and rotate with the crank shaft **420** as the central axis. The first planetary gear **431***b* is in outer contact with the first sun gear **431***c*, and in inner contact with the first ring gear **431***d*.

[0084] A hollow is formed at the center of the first sun gear **431***c* to be penetrated by the crank shaft **420**. An outer periphery of the first sun gear **431***c* is engaged with the plurality of first planetary gears **431***b*, so the first sun gear **431***c* rotates on the crank shaft **420**. The bearing may be interposed between the crank shaft **420** and the first sun gear **431***c*.

[0085] As described in the exemplary embodiment, the first planetary gear **431***b*, the first sun gear **431***c*, and the first ring gear **431***d* may be provided as Helical gears.

[0086] The second speed-increase unit **432** may include the second carrier **432***a* fixed to the first sun gear **431***c* and transmitting the rotational force, a plurality of second planetary gears **432***b* supported by the second carrier **432***a*, and revolving and rotating with the crank shaft **420** as the central axis by the rotation of the second carrier **432***a*, the second sun gear **432***c* installed on the circumference of the crank shaft **420**, engaged with the plurality of second planetary gears **432***b* and rotating jointly with the rotation of the second planetary gear **432***b*, and the second ring gear **432***d* provided on the inner wall of the housing **410**, and engaged with the second planetary gear **432***b*, and rotating jointly with the revolving of the second planetary gear **432***b*.

[0087] The second carrier **432***a* is installed on the circumference of the crank shaft **420**, and rotates jointly depending on the rotation of the first sun gear **431***c*. The second carrier **432***a* may be provided as in integrated configuration in a form of protruding on the circumference of the first sun gear **431***c*. The second carrier **432***a* also serves to support the plurality of second planetary gears **432***b* engaged between the second sun gear **432***c* and the second ring gear **432***d* at the same interval.

[0088] A plurality of second planetary gears **432***b* may be provided to constitute one set, and the plurality of second planetary gears **432***b* are engaged between the second sun gear **432***c* and the second ring gear **432***d* to revolve and rotate with the crank shaft **420** as the central axis. The second planetary gear **432***b* is in outer contact with the second sun gear **432***c*, and in inner contact with the second ring gear **432***d*.

[0089] The hollow is formed at the center of the second sun gear **432***c* to be penetrated by the crank shaft **420**. An outer periphery of the second sun gear **432***c* is engaged with the plurality of second planetary gears **432***b*, so the second sun gear **432***c* rotates on the crank shaft **420**. The bearing may be interposed between the crank shaft **420** and the second sun gear **432***c*.

[0090] In the gear unit **430** of the exemplary embodiment, the first carrier **431***a* which rotates by the crank shaft **420** in the first speed-increase unit **431** constitutes the input side, and the first sun gear **431***c* which rotates between the plurality of first planetary gears **431***b* constitutes the output side. When the first carrier **431***a* of the first speed-increase unit **431** rotates, the plurality of first planetary gears **431***b* revolves and rotates along an inner periphery of the first ring gear **431***d*, and as a result, the first sun gear **431***c* engaged with the first planetary gear **431***b* speed-increases and rotates.

[0091] In the second speed-increase unit **432**, the second carrier **432***a* which rotates by the first sun gear **43 1***c* constitutes the input side, and the second sun gear **432***c* which rotates between the plurality of second planetary gears **432***b* constitutes the output side. When the second carrier **432***a* of the second speed-increase unit **432** rotates, the plurality of second planetary gears **432***b* revolves and rotates along an inner periphery of the second ring gear **432***d*, and as a result, the second sun gear **432***c* engaged with the second planetary gear **432***b* speed-increases and rotates.

[0092] That is, the first speed-increase unit **431** and the second speed-increase unit **432** are connected to each other in series in two stages so as to be provided to speed-increase the rotational force input by the pedal. When a larger speed-increase is desired, the gear unit **430** of the exemplary embodiment may also be configured to include three or more plural speed-increase units connected in series. Of course, the gear unit **430** may also be configured as a single stage including only the first speed-increase unit **431**.

[0093] Meanwhile, in the exemplary embodiment, it is described that the alternator **400** is provided in a form of a speed increaser in which an output RPM increases compared to an input RPM (pedal RPM), but the alternator **400** of the exemplary embodiment may also be provided in a form of a speed reducer in which the output RPM decreases compared to the input RPM (pedal RPM).

[0094] The alternation unit **440** of the exemplary embodiment may include a rotor **441** which is coupled to the output side of the gear unit **430**, and rotates, and a stator **442** which electromagnetically interacts with the rotor **441**.

[0095] The rotor **441** may be provided to rotate by the gear unit **430**, and to this end, the rotor **441** of the exemplary embodiment may be coupled (axially connected) to the second sun gear **432***c* which is a final output side of the gear unit **430**. The rotor **441** may include a plurality of permanent magnets on an inner periphery thereof, and may be configured to surround a radial outer circumference of the stator **442**.

[0096] The stator **442** may include multiple winded coils. The stator **442** may be installed on the circumference of the crank shaft **420**, and the bearing may be interposed between the crank shaft **420** and the stator **442**.

[0097] As described above, the alternator **400** according to the exemplary embodiment is configured to include a power transmission structure in which the crank shaft **420**, the gear unit **430**, and the alternation unit **440** are connected. Hereinafter, an operation of the alternator **400** according to the exemplary embodiment, which generates electricity by using a rotational force of the pedal will be described in brief.

[0098] First, when the driver steps on and rotates the pedal, the first carrier **431***a* rotates by the rotation of the crank shaft **420**. When the first carrier **431***a* rotates, the first planetary gear **431***b* revolves and rotates along the inner periphery of the first ring gear **431***d*, and as a result, the first sun gear **431***c* engaged with the first planetary gear **431***b* rotates. Through such a process, a rotational speed of the pedal primarily increases.

[0099] Subsequently, the second carrier **432***a* of the second speed-increase unit **432** rotates by the rotation of the first sun gear **431***c* of the first speed-increase unit **431**. When the second carrier **432***a* rotates, the second planetary gear **432***b* revolves and rotates along the inner periphery of the second ring gear **432***d*, and as a result, the second sun gear **432***c* engaged with the second planetary gear **432***b* rotates. Through such a process, the rotational speed of the pedal secondarily increases.

[0100] Subsequently, the second sun gear **432***c* rotates the rotor **441** of the alternation unit **440**, and as a result, electricity may be generated by an electromagnetic interaction between the rotor **441** and the stator **442**. The generated electricity may be supplied as driving power of the motor **200**, or charged in the battery **300**.

[0101] The alternator **400** according to the first exemplary embodiment as a component for preventing the 'slip through' phenomenon may further include a frictional member **450** installed at the housing **410** side, and an elastic member **460** installed at the gear unit **430** side facing an inner surface of the housing **410**.

[0102] The frictional member **450** may be attached and installed onto the inner surface of the housing **410**, more preferably, one surface of the cover **412** installed to face the first carrier **431***a* in the housing **410**.

[0103] The frictional member **450** may be installed at each of an upper side and a lower side based on the crank shaft **420**. Two or more plural frictional members **450** may be provided, and installed on the inner wall of the housing **410** along the circumference of the crank shaft **420**, or are also possible to be provided as a ring-shaped integrated member of which the center is penetrated, and installed on the inner wall of the housing **410**.

[0104] The frictional member **450** may generate a brake torque by frictional force when some components of the gear unit **430** move and contact in the axial direction as described below.

[0105] Since the frictional member **450** is a component that intends to generate the frictional force in contact with a gear made of a metallic or plastic material, by considering this, the frictional member **450** may be provided as a rubber material. However, since the frictional member **450** is not good if the frictional member **450** is too soft, it is recommended that the frictional member **450** has hardness of a predetermined level or higher, and wear and heat resistance characteristics are also formed at a predetermined level or higher, so it will be desirable that the frictional member **450** of the exemplary embodiment is made a complex material.

[0106] The frictional member **450** of the exemplary embodiment may be provided as a material such as a synthetic rubber or a rubber cork friction material, and is also possible to be configured as a form in which a friction sheet having a friction coefficient, and heat and wear resistance characteristics at a predetermined level or higher is attached to a rigid core having hardness of a predetermined level or higher.

[0107] As the name suggests, the elastic member **460** may be provided as a material having an elastic force, and interposed between the housing **410** or the component (e.g., bearing) coupled to the housing **410**, and the gear unit **430**.

[0108] The elastic member **460** may be installed in at least one of the components constituting the gear unit **430**. In the exemplary embodiment, it is described as a preferred exemplary embodiment that the elastic member **460** is attached and installed onto the surface of the first carrier **431***a* constituting the input side in the gear unit **430**.

[0109] In the exemplary embodiment, the housing **410**, and the first carrier **431***a* of the gear unit **430** may be elastically supported in the axial direction by the elastic member **460**. As described above, the component of the gear unit **430** supported by the clastic member **460** or a member fixed to the component may be initially set to maintain a predetermined gap from the frictional member **450** in the axial direction. Referring to FIG. **5**, a state in which a body surface of the first carrier **431***a* maintains a predetermined gap from the frictional member **450** may be seen.

[0110] Here, when a torque transmitted to the crank shaft **420** becomes larger than a predetermined value, for example, when a pedal effort which exceeds the limited reaction force provided by the alternator **400** is input while the pedal of the electric bicycle does not rotate, some components of the gear unit **430** move in an axial direction by an axial force generated from a gear type component provided as a Helical gear among the components of the gear unit **430**, and contacts the frictional member **450** as illustrated in FIG. **6**, and the brake torque is generated due to the contact between the component of the gear unit **430**, and the frictional member **450**.

[0111] A relationship between the pedal effort of the driver and the reaction force generated by the electromagnetic element in the alternator structure according to the first exemplary embodiment of the present disclosure, which has the above structure is schematized in FIG. **9**.

[0112] FIG. **10** is a graph for describing that a ‘slip through’ phenomenon of the electric bicycle is prevented according to the application of the alternator according to the present disclosure. The graph shows a relationship between a crank shaft torque, a crank shaft rotating speed, a rotor shaft torque, a rotor shaft rotating speed, and a brake torque generated by the contact with the frictional member **450**.

[0113] Referring to FIGS. **4** to **6**, and **10**, under a condition in which the driving motor and the driving wheel of the electric bicycle do not rotate, when a torque transmitted to the crank shaft **420** by the pedal effort of the driver becomes larger than a predetermined value, some components of the gear unit **430** move by the axial force generated from the gear type component provided as the Helical gear among the components of the gear unit **430** (the state of FIG. **5** is changed to the state of FIG. **6**), and contact the frictional member **450**, and the brake torque is generated due to the contact between the component of the gear unit **430**, and the frictional member **450**.

[0114] More specifically, when the axial force generated between the first planetary gear **431***b* and the first ring gear **431***d* of the gear unit **430** becomes larger than the elastic force of the elastic member **460**, the first planetary gear **431***b* and the first carrier **431***a* move in the axial direction, and compress the elastic member **460**, and the brake torque is generated from a time point when the first carrier **431***a* contacts the frictional member **450**.

[0115] At this time, as the torque by the pedal effort becomes larger, the axial force also becomes larger, so as the axial force becomes larger by a relationship of “friction coefficient x vertical drag force”, the brake torque generated between the frictional member **450** and the first carrier **431***a* also increases accordingly, and as a result, it becomes possible to maintain a location of the crank shaft **420** without an increase in torque by the electromagnetic force.

[0116] Accordingly, since a lacking reaction force which may not be provided by the alternator **400** may be provided by a brake torque generated by friction of the first carrier **431***a* and the frictional member **450** from a motor torque limit point (represented by 'P'), the 'slip through' phenomenon of the electric bicycle may be effectively prevented.

[0117] Thereafter, when the torque acting on the crank shaft **420** by the pedal effort of the driver is reduced, the brake torque is also reduced and released again while the components of the gear unit **430** including the first carrier **431***a* returns to the original location by the elastic force of the elastic member **460**.

[0118] FIG. **7** is a diagram illustrating a structure of an alternator according to a second exemplary embodiment of the present disclosure applied to an electric bicycle, and FIG. **8** is a diagram illustrating a state in which the axial force is generated from the alternator according to the second exemplary embodiment of the present disclosure, and some components of the gear unit move in the axial direction.

[0119] The alternator **400** according to the first exemplary embodiment of the present disclosure has a coaxial structure in which the alternation unit **440** including the rotor **441** and the stator **442** is placed on the crank shaft **420** jointly with the gear unit **430**, while the alternator **400′** according to the second exemplary embodiment of the present disclosure is provided in a bi-axial structure in which the alternation unit **440** including the rotor and the stator is not directly coupled to the crank shaft **420**.

[0120] Referring to FIGS. **7** and **8**, the alternator **400′** according to the second exemplary embodiment of the present disclosure may be configured to include a housing **410**, a crank shaft **420** installed to penetrate the housing **410**, and having both ends with pedals, and a gear unit **430** and an alternation unit **440** accommodated inside the housing **410**. At this time, the alternator **400′** according to the second exemplary embodiment of the present disclosure further includes an intermediate shaft **436** provided apart from the crank shaft **420**, and is different from the first exemplary embodiment in that the alternation unit **440** is connected to a gear step provided on the intermediate shaft **436** rather than the gear directly coupled to the crank shaft **420**.

[0121] In the exemplary embodiment, the housing **410** and the crank shaft **420** may be provided similarly to the first exemplary embodiment described above, so a redundant description is omitted. However, in the exemplary embodiment, since the configuration and the arrangement of the gear unit **430** and the alternation unit **440** accommodated inside the housing **410** are different, the internal/external shape of the housing **410** may be differently configured accordingly.

[0122] The gear unit **430** may be provided to be speed-increased or speed-decreased with an input side connected to the crank shaft **420**, and the alternation unit **440** may be connected to an output side of the gear unit **430** which is speed-increased or speed-decreased compared to a rotational speed of the input side of the gear unit **430**. As described above, the gear unit **430** speed-increases or speed-decreases the rotational force of the pedal to increase alternation efficiency of the alternation unit **440** which generates electricity by the rotational force of the gear unit **430**.

[0123] More specifically, the gear unit **430** of the exemplary embodiment may include a driving gear **433** fixed to the crank shaft **420** and transmitting the rotational force of the pedal, an idle gear **434** installed on the intermediate shaft **436** provided apart from the crank shaft **420**, and rotating by engaging with the driving gear **433**, and a driven gear **435** rotating by engaging with the idle gear **434**.

[0124] The driving gear **433** is fixed and installed onto the circumference of the crank shaft **420**, and when the driver steps on and rotates the pedal, the crank shaft **420** and the driving gear **433** fixed thereto rotate jointly.

[0125] The idle gear **434** may include a small gear **434***a* engaged with the driving gear **433**, and a large gear **434***b* engaged with the driven gear **435** to be described below. The small gear **434***a* and the large gear **434***b* are configured as an integrated member, and the large gear **434***b* may have a larger diameter than the small gear **434***a*.

[0126] In the exemplary embodiment, the idle gear **434** may be installed on the intermediate shaft **436** provided apart from the crank shaft **420**. The intermediate shaft **436** may be supported on the inner wall of the housing **410**, and the bearing is provided between the housing **410** and the intermediate shaft **436** to reduce abrasion between component elements.

[0127] The driven gear **435** may rotate by engaging with the large gear **434***b* of the idle gear **434**. The driven gear **435** may be coupled (axially connected) to the rotor which is a component of the alternation unit **440** to be described below.

[0128] In the gear unit **430** of the exemplary embodiment, the driving gear **433** coupled to the crank shaft **420** and rotating constitutes the input side, and the driven gear **435** constitutes the output side.

[0129] In the exemplary embodiment, the driving gear **433**, and the small gear **434***a* of the idle gear **434** engaged therewith may be provided as the Helical gear, and the large gear **434***b* of the idle gear **434**, and the driven gear **435** engaged therewith may be provided as a Spur gear.

[0130] The alternation unit **440** may include a rotor which is coupled to the driven gear **435** as the output side of the gear unit **430**, and rotates, and a stator which electromagnetically interacts with the rotor. The rotor and the stator which are the electromagnetic elements constituting the alternation unit **440** may be configured similarly to the first exemplary embodiment described above, so a redundant description is omitted, and illustration is also simplified.

[0131] Hereinafter, an operation of the alternator **400′** according to the exemplary embodiment, which generates electricity by using the rotational force of the pedal will be described in brief.

[0132] First, when the driver steps on and rotates the pedal, the driving gear **433** rotates by the rotation of the crank shaft **420**. The rotational force of the driving gear **433** is transmitted to the driven gear **435** via the idle gear **434**, and finally, the rotor of the alternation unit **440** coupled to the driven gear **435** rotates. At this time, the rotational speed of the pedal is increased according to a gear ratio of the driving gear **433** and the small gear **434***a*, and a gear ratio of the large gear **434***b* and the driven gear **435**, and transmitted to the alternation unit **440** side.

[0133] The alternator **400′** according to the second exemplary embodiment as a component for preventing the ‘slip through’ phenomenon may further include a frictional member **450** installed at the housing **410** side, and an elastic member **460** installed at the gear unit **430** side facing an inner surface of the housing **410** similarly to the first exemplary embodiment.

[0134] The frictional member **450** may be attached and installed onto the inner surface of the housing **410**, more preferably, one surface facing the idle gear **434** in the housing **410**. As illustrated, the frictional member **450** may be installed on the inner wall near the intermediate shaft **436** installed in the housing **410**. The accompanying drawing, which is simplified and illustrated, illustrates that only one frictional member **450** is installed, but the frictional member **450** may be installed at each of an upper side and a lower side based on the intermediate shaft **436**. Two or more plural frictional members **450** may be provided, and installed on the inner wall of the housing **410** along the circumference of the intermediate shaft **436**, or are also possible to be provided as a ring-shaped integrated member of which the center is penetrated, and installed on the inner wall of the housing **410**.

[0135] The frictional member **450** may generate a brake torque by frictional force when some components of the gear unit **430** move and contact in the axial direction as described below.

[0136] The elastic member **460** may be provided as a material having an clastic force, and installed between the housing **410** or the component (e.g., bearing) coupled to the housing **410**, and the gear unit **430**.

[0137] As illustrated, in the exemplary embodiment, the elastic member **460** may be installed between the bearing interposed between the housing **410** and the intermediate shaft **436**, and the idle gear **434** of the gear unit **430**. However, the exemplary embodiment is not particularly limited thereto, and when a separate structure for supporting the elastic member **460** is provided on the inner wall of the housing **410**, the elastic member **460** may be configured to be directly supported on the housing **410**.

[0138] In the exemplary embodiment, the housing **410**, and the idle gear **434** of the gear unit **430** may be elastically supported in the axial direction by the clastic member **460**. As described above, the component of the gear unit **430** supported by the elastic member **460** or a member fixed to the component may be initially set to maintain a predetermined gap from the frictional member **450** in the axial direction. Referring to FIG. **7**, a state in which a surface of the large gear **434***b* constituting the idle gear **434** maintains a predetermined gap from the frictional member **450** may be seen.

[0139] Here, when a torque transmitted to the crank shaft **420** becomes larger than a predetermined value, for example, when a pedal effort which exceeds the limited reaction force provided by the alternator **400** is input while the pedal of the electric bicycle does not rotate, some components of the gear unit **430** move in an axial direction by an axial force generated from a gear type component provided as a Helical gear among the components of the gear unit **430**, and contact the frictional member **450** as illustrated in FIG. **8**, and the brake torque is generated due to the contact between the component of the gear unit **430**, and the frictional member **450**.

[0140] The alternator **400**′ according to the second exemplary embodiment of the present disclosure may also obtain an effect of preventing the ‘slip through’ phenomenon of the electric bicycle according to the generation of the brake torque as it is with the same principle as described in the first exemplary embodiment.

[0141] Referring to FIGS. **7**, **8**, and **10**, under a condition in which the driving motor and the driving wheel of the electric bicycle do not rotate, when a torque transmitted to the crank shaft **420** by the pedal effort of the driver becomes larger than a predetermined value, some components of the gear unit **430** move in an axial direction by the axial force generated from the gear type component provided as the Helical gear among the components of the gear unit **430** (the state of FIG. **7** is changed to the state of FIG. **8**), and contact the frictional member **450**, and the brake torque is generated due to the contact between the component of the gear unit **430**, and the frictional member **450**.

[0142] More specifically, when the axial force generated between the driving gear **433** and the idle gear **434** of the gear unit **430** becomes larger than the clastic force of the clastic member **460**, the driving gear **433** and the idle gear **434** move in the axial direction, and compress the elastic member **460**, and the brake torque is generated from a time point when the idle gear **434** contacts the frictional member **450**.

[0143] At this time, as the torque by the pedal effort becomes larger, the axial force also becomes larger, so as the axial force becomes larger by a relationship of “friction coefficient×vertical drag force”, the brake torque generated between the frictional member **450** and the idle gear **434** also increase accordingly, and as a result, it becomes possible to maintain a location of the crank shaft **420** without an increase in torque by the electromagnetic force.

[0144] Accordingly, since a lacking reaction force which may not be provided by the alternator **400** may be provided by a brake torque generated by friction of the idle gear **434** and the frictional member **450** from a motor torque limit point (represented by ‘P’), the ‘slip through’ phenomenon of the electric bicycle may be effectively prevented.

[0145] Thereafter, when the torque acting on the crank shaft **420** by the pedal effort of the driver is reduced, the brake torque is also reduced and released again while the components of the gear unit **430** including the idle gear **434** returns to the original location by the elastic force of the elastic member **460**.

[0146] The second exemplary embodiment of the present disclosure has an advantage in that since the brake torque is generated in the gear step in which the torque is reduced rather than the gear directly coupled to the crank shaft **420** unlike the first exemplary embodiment described above, it is

possible to implement a function of preventing the ‘slip through’ phenomenon from occurring even with a smaller brake torque compared to the first exemplary embodiment.
[0147] The drive system for an electric bicycle according to the present disclosure, which includes the first and second exemplary embodiments has an effect in that a limit of the pedal reaction force by electromagnetic force is overcome to effectively prevent the ‘slip through’ phenomenon from occurring. This means that a comfortable pedal sense may be provided to a driver of the electric bicycle, so the merchantability of the electric bicycle may also be significantly enhanced.
[0148] Further, the present disclosure has an advantage in that the sizes of the electromagnetic elements (the rotor and the stator) may be excluded from being unnecessarily increased in order to prevent the ‘slip through’ phenomenon only with the electromagnetic force.
[0149] Moreover, according to the present disclosure, since a location of the crank shaft is maintained by the brake torque, the electromagnetic force may be reduced to reduce current consumption and reduce heat dissipation, and a driving distance of the electric bicycle may also be enhanced due to reduced electric energy consumption.

Claims

1. A drive system for an electric bicycle, comprising: a motor providing a rotational force to a driving wheel; a battery supplying power to the motor; and an alternator providing a pedal reaction force to a driver, and converting kinetic energy of a pedal into electric energy, and supplying the electric energy to at least any one of the motor and the battery, wherein the alternator includes a housing, a crank shaft installed to penetrate the housing, and having the petal installed therein, a gear unit installed inside the housing, and speed-increasing or speed-decreasing the rotational force of the pedal, an alternation unit installed inside the housing, and receiving the rotational force of the pedal speed-increased or speed-decreased by the gear unit, and generating the electric energy, an elastic member installed between the housing and the gear unit, and elastically supporting the housing and the gear unit, and a frictional member which is installed in the housing to maintain a predetermined gap from the gear unit, and in which some components of the gear unit contact by moving in an axial direction when a pedal effort larger than a limited reaction force which is a peak value of the pedal reaction force provided by the alternator is input.
2. The drive system for an electric bicycle according to claim 1, wherein a brake torque is generated by the contact between the some components of the gear unit, and the frictional member.
3. The drive system for an electric bicycle according to claim 1, wherein at least some of a plurality of gears constituting the gear unit are provided as a Helical gear, and the some components of the gear unit move in the axial direction by an axial force generated by the gear provided as the Helical gear.
4. The drive system for an electric bicycle according to claim 1, wherein the elastic member is interposed between the housing or a component coupled to the housing, and the gear unit.
5. The drive system for an electric bicycle according to claim 1, wherein the alternation unit includes a rotor coupled to an output side of the gear unit, and rotating, and a stator electromagnetically interacting with the rotor.
6. The drive system for an electric bicycle according to claim 1, wherein the gear unit includes a carrier fixed to the crank shaft, a plurality of planetary gears supported by the carrier, and revolving and rotating with the crank shaft as a central axis by rotation of the carrier, and a sun gear installed on a circumference of the crank shaft, and rotating by engaging with the plurality of planetary gears.
7. The drive system for an electric bicycle according to claim 6, wherein the gear unit further includes a ring gear provided on an inner wall of the housing, and rotating by engaging with the plurality of planetary gears.
8. The drive system for an electric bicycle according to claim 7, wherein the planetary gear, the sun

gear, and the ring gear are provided as the Helical gear.
9. The drive system for an electric bicycle according to claim 8, wherein when an axial force generated between the planetary gear and the ring gear is larger than an elastic force of the elastic member, the planetary gear and the ring gear move in the axial direction on the crank shaft.
10. The drive system for an electric bicycle according to claim 6, wherein the elastic member is interposed between the housing or a component coupled to the housing, and the carrier.
11. The drive system for an electric bicycle according to claim 10, wherein the frictional member is installed on an inner surface of the housing facing the carrier.
12. The drive system for an electric bicycle according to claim 1, wherein the gear unit includes a driving gear fixed to the crank shaft, an idle gear installed on an intermediate shaft provided apart from the crank shaft, and rotating by engaging with the driving gear, and a driven gear rotating by engaging with the idle gear.
13. The drive system for an electric bicycle according to claim 12, wherein at least some of the driving gear and the idle gear engaged with the driving gear are provided as the Helical gear.
14. The drive system for an electric bicycle according to claim 13, wherein when an axial force generated between the driving gear and the idle gear is larger than an elastic force of the elastic member, the driving gear and the idle gear move in the axial direction on the crank shaft and the intermediate shaft, respectively.
15. The drive system for an electric bicycle according to claim 12, wherein the elastic member is interposed between the housing or a component coupled to the housing, and the idle gear.
16. The drive system for an electric bicycle according to claim 15, wherein the frictional member is installed on an inner surface of the housing facing the idle gear.
17. The drive system for an electric bicycle, in the electric bicycle including an alternator converting kinetic energy of a pedal into electric energy, and supplying the electric energy to at least any one of a motor and a battery, wherein the alternator includes a gear unit including at least one input gear installed on a crank shaft in which the pedal is installed to speed-increase or speed-decrease a rotational force of the pedal, and an alternation unit including a rotor rotating by the gear unit and a stator electromagnetically interacting with the rotor to produce electricity, the alternator provides a pedal reaction force to a driver by using the rotational force of the alternation unit, and when a pedal effort larger than a limited reaction force which is a peak value of the pedal reaction force provided by the alternator is input, a location of the crank shaft is maintained by a brake torque generated as some components of the gear unit including the input gear move in an axial direction and contact a frictional member installed on an inner wall of the housing.
18. The drive system for an electric bicycle according to claim 17, further comprising: an elastic member interposed between the housing or a component coupled to the housing, and the gear unit to elastically support the housing and the gear unit.
19. The drive system for an electric bicycle according to claim 18, wherein the frictional member is installed to be positioned spaced apart from the gear unit when a pedal effort smaller than the limited reaction force provided by the alternator is input.
20. The drive system for an electric bicycle according to claim 19, wherein when an axial force generated by the some components of the gear unit is larger than the elastic force of the elastic member by the pedal effort, the some components of the gear unit move in the axial direction, and contact the frictional member.