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(54) **CYCLING TRAINING DEVICE**
ZIRKELTRAININGSVORRICHTUNG
DISPOSITIF D'ENTRAÎNEMENT CYCLISTE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a Cycling Training Device (CTD) for use with a bicycle.

BACKGROUND

[0002] Virtual reality or terrain simulation cycling devices are available for stationary or indoor use, and are commonly used when weather outdoors is undesirable. However, many of these devices are used for terrain simulation or ride replication, when outside weather may be pleasurable but the terrain does not suit the types of training desired.

[0003] For an improvement to be made, athletes must push themselves to a high percentage of their VO_2 max to achieve performance gains. Cyclists training for an improvement in physiology may face many problems when situated in areas of dense population.

[0004] As technology and training methodologies improve, athletes are beginning to reach speeds that are unsafe or unviable to train at, in highly populated areas. As such, many athletes commute to outer suburbs or mountain ranges before beginning training. The push to maintain performance improvements has created drawbacks including adding time taken to travel to areas of favourable terrain or, in more extreme scenarios, unsafe riding practices.

[0005] It has been noted that recently there have been a number of incidents where a cyclist travelling at high speed on a bike path has hit and killed a pedestrian. Other cases of life altering accidents have occurred when cyclists travelling at high speeds in opposite directions have collided with each other, leaving one or both of the riders in a quadriplegic condition. Excessive speed in the pursuit of performance has been a factor in both cases.

[0006] Unfavourable terrain and culture of outdoor activities has collided with the pursuit of athletic excellence with less than desirable side effects.

[0007] Previous devices have attempted to increase rolling resistance or reducing the speed of a bicycle through increases in friction forced acting on the bicycle. This poses significant engineering limitations and a less than desirable user experience. Current indoor applications that have been retrofitted for an outdoor application, are found to be wanting, as all require a friction roller. Experience has shown that the friction roller is likely to fail when exposed to sand, dirt or water present in outdoor conditions.

[0008] Other attempts to slow a moving bicycle for training purposes have had their own significant drawbacks. These include: unmeasurable resistance levels, the inability to vary and to switch on or off resistance, and ultimately undesirable resistance curves that may be of detriment to the athlete.

[0009] One previous attempt to slow the speed of a

bicycle for training purposes comprised a device known as the "slow wheel". There are many design flaws and limitations to this device, the largest being that resistance is achieved through mechanical friction, with only a few levels of mechanical resistance.

[0010] The present invention attempts to overcome at least in part the aforementioned disadvantages of previous bicycle resistance devices. Document GB-A-2485216 describes an electric pedal cycle and document US-A-2003/0073546 describes a self-powered variable resistance bicycle trainer.

SUMMARY OF THE INVENTION

[0011] In accordance with one aspect of the present invention there is provided a cycling training device comprising an electronic control unit and a variable resistance unit as claimed in claim 1. The additional features are defined in the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0012] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a top view of the electronic control unit and associated display in accordance with one aspect of the present invention.

Figure 2 is a block diagram of the electrical components of variable resistance unit in accordance with another aspect of the preferred invention.

Figure 3 is a block diagram of the cycling training device in accordance with a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] Referring to the Figures, there is shown a Cycling Training Device (CTD) 10 for use with a bicycle. The CTD 10 comprises an electronic control unit 14 and a variable resistance unit 16.

[0014] The electronic control unit 14 is preferably arranged to be mounted on a bicycle where it is easily seen and interacted with by a rider of the bicycle. In accordance with one preferred embodiment of the present invention the electronic control unit 14 is afforded a mounting so as to be mounted on the handle bars of the bicycle.

[0015] The electronic control unit 14 preferably comprises a display 18, a plurality of buttons 19 for user input as well as control electronics for controlling the operation of the CTD.

[0016] The electronic control unit 14 preferably also comprises an electronic communication means, preferably the communication means is capable of both wireless and/or wired forms of communication. Preferred wireless forms of communication may comprise but not be limited to Ant+, Bluetooth or 802.11X networks. Pre-

ferred wired forms of communication may comprise USB, serial or parallel connections.

[0017] In accordance with another preferred embodiment of the present invention the electronic control unit may be a mobile computing device such as a smart phone. The control may be achieved or accessed through an app or other software operating on the mobile computing device.

[0018] In accordance with yet another preferred embodiment of the present invention, the display 18 and the buttons 19 may be integrated into a touch screen device.

[0019] The communication means may be arranged to communicate with a plurality of biometric sensor means 38. The biometric sensor means 38 being arranged to provide biometric information from the rider of the bicycle. The types of biometric information to be relayed to the electronic control unit 14 include but are not limited to heart rate, blood pressure, respiration rates and hydration levels.

[0020] Figure 2 shows a block diagram of the variable resistance unit 16 in accordance with a preferred embodiment of the present invention. The variable resistance unit 16 comprises a means for imparting Electro-Magnetic Force (EMF) in this case an alternator 25, a 3-phase rectifier 26, a DC filter 28, a DC/DC converter 30, a Pulse Width Modulation (PWM) controller 32 and a load 34. The variable resistance unit 16 is connected to the electronic control unit 14, via the communications means, the operation of the variable control unit 16 being affected by the electronic control unit 14.

[0021] Preferably, the variable resistance unit 16 further comprises a plurality of sensor means 36. The sensor means 36 are arranged to be able to determine physical and electrical characteristics of the variable resistance unit 16. The sensor means 36 preferably are arranged to sense at least one of, the electrical resistance of the variable resistance unit, the electrical impedance, temperature, voltage output, current output, rotational speed and rotational moment.

[0022] The sensor means 36 may further comprise at least one strain gauge, the strain gauge being arranged to measure the instantaneous torque or moment being generated by the user. The instantaneous torque and the rotational speed of the variable resistance unit 16 may be used to determine the instantaneous power output of the user.

[0023] The variable resistance unit 16 is preferably capable of acting as a generator during part of its normal operation as well as being capable as acting as a motor during other parts of its operation.

[0024] The variable resistance unit 16 is preferably arranged within the hub of a wheel of the bicycle. However, any known arrangement of an electrically driven wheel may be suitable. The variable resistance unit 16 may be arranged on either the front or rear wheel of the bicycle.

[0025] It should be appreciated that the alternator may be replaced with any controllable means for imparting EMF capable of effecting the rolling resistance of the

wheel to which it is engaged. Such means include but are not limited to magnetic braking, DC motors, eddy current brakes, homopolar generators, choke devices or slotted or unslotted motors.

[0026] In accordance with another preferred embodiment of the present invention the variable resistance unit 16 comprises an eddy current brake. The eddy current brake operates in unison with a disc attached to the wheel of a bicycle. The eddy current brake when powered acts to inhibit the motion of the disc through the brake, therein effectively controlling the rolling resistance of the wheel to which it is attached.

[0027] In use, the CTD is fitted to a bicycle, preferably the variable resistance device 16 being arranged on the hub of the front wheel. The electronics control unit 14 is arranged such that the user can see the display 18 and access the plurality of buttons 19, normally on the handle bars of the bicycle.

[0028] The user then may select the mode of operation of the CTD 10 using the buttons 19 to select from the various menu options shown on the display 18. The user would first select a user profile which is associated with each separate user of the CTD. The user would then select from the training programme which is currently available on the device. In accordance with the training programme chosen the electronic control unit 14 will communicate with the variable drive unit 16 to control its operation, varying the effective rolling resistance of the bicycle.

[0029] In accordance with a preferred embodiment of the present invention, the effective rolling resistance of the variable resistance unit 16 is varied in accordance with a user profile for an interval training programme. The training programme may be varied in terms of the interval time, the interval gradient, recovery time, recovery gradient, number of repetitions.

[0030] Preferably, the training programme will be varied in response to biometric parameters detected by the biometric sensor means 38. For example, if the heart or respiration rate of the user are detected as being outside of an acceptable range, the effective rolling resistance will be varied to ensure that the user is exercising in the targeted zone.

[0031] Preferably, the training programme will be varied in accordance with the number of times it has been completed.

[0032] In accordance with another preferred embodiment of the present invention, the effective rolling resistance of the variable resistance unit 16 is varied in accordance with a user profile for a terrain profile training programme. The effective rolling resistance is varied such that the user experiences the same pedal load as they would if they were actually riding the bicycle along the terrain represented in the profile.

[0033] As the rider completes sections of the terrain profile, their relative position along the terrain profile is displayed on the display unit 18.

[0034] Preferably, the terrain profile may match the ter-

rain profile of a real world location, such that the user could for example ride the first stage of the Tour de France, by simulating the terrain profile.

[0035] In accordance with another preferred embodiment of the present invention, the effective rolling resistance of the variable resistance unit 16 is varied in accordance with a user profile for a computer generated training programme. The rider is able to enter their performance goals and current abilities, before a computer generated programme is generated for them.

[0036] In accordance with another preferred embodiment of the present invention, the effective rolling resistance of the variable resistance unit 16 is varied in accordance with a user profile for the user's heart rate. The biometric sensor means 38 provide biometric data on the user's current heart and respiration rates. The control means 14 varies the effective rolling resistance of the variable resistance unit 16 to ensure that the user's heart and respiration rates are within a targeted range.

[0037] In accordance with another preferred embodiment of the present invention, the effective rolling resistance of the variable resistance unit 16 is varied in accordance with a user profile for a resistance curve. The resistance curve being programmable by the user and may be based upon at least one of wattage, speed, approach graph, linear, logarithmic, exponential, polynomial graph parameters.

[0038] In accordance with another preferred embodiment of the present invention, the effective rolling resistance of the variable resistance unit 16 is varied in accordance with a user profile and a spin scan analysis. The sensor mean 36 are used to determine the instantaneous power produced throughout the revolution of the pedals of the bicycle. A common problem in cyclists is pedalling dominance, where one leg becomes more powerful than the other, leading to imbalance in the cycle.

[0039] By varying the effective rolling resistance during the pedal cycle pedalling dominance can be altered to ensure that the user is supplying even power through their cycle. Advantageously, this has the effect of reducing injuries to the rider.

[0040] The user will then engage the CTD and start their training session. The user triggers operation of the CTD through the plurality of buttons 19 on the control unit 14. Once the CTD is activated, the electronic control unit 14 will control the operation of the variable resistance unit 16.

[0041] The variable resistance unit 16 operates by having the alternator, generate electrical power. The alternator generates an alternating electrical current (AC) through the motion in its internal components. The AC output of the alternator passes through a 3 phase rectifier 26 which converts the AC power into direct current (DC). The resulting DC power is then filtered by DC filter 28. Some of the DC power is transferred to a DC/DC converter 30 and finally to the electronic control unit 14. The remaining DC power is transferred to PWM control circuit 32 and finally the load 34.

[0042] As will be apparent to the skilled addressee, the amount of power drawn by the alternator can vary in accordance to changes in the electrical characteristics of the load 34.

[0043] In accordance with a preferred embodiment of the present invention, the load 34 comprises a heat sink with additional current generated being 'sunk' into the heat sink when excessive charge is generated.

[0044] The power drawn by the alternator will cause the user of the CTD to experience increased resistance over and above that experienced during the normal operation of the bicycle. The effective rolling resistance that the user encounters during operation of the bicycle with a CTD will match the output profile in accordance with the terrain profile or the user's training schedule.

[0045] In accordance with a preferred embodiment of the present invention, the effective resistance of the load 34 is constantly calculated by the sensor means 36 within the load 34. The effective resistance of the load 34 is temperature dependent and therefore must constantly be determined to ensure that the effective rolling resistance and the effective power are correctly calculated.

[0046] In accordance with a preferred embodiment of the present invention the load 34 further comprises a means for the storing of electrical energy. The means for storing electrical energy may be configured to act as a power source for the variable resistance unit 16 as required.

[0047] As will be apparent to the skilled addressee there will be situations wherein the actual rolling resistance that the user encounters during the normal operation of the bicycle is greater than the effective rolling resistance required at that point in the terrain profile or the training schedule.

[0048] In these instances power is drawn from the load 34 to power the variable resistant unit as a motor. The motor effectively acts to reduce the effective resistance the user of the CTD 10 is experiencing.

[0049] In this manner the effective rolling resistance that the user of the CTD 10 experiences changes in accordance with the terrain profile or training schedule uploaded to the control unit, with the CTD 10 being able to change the effective resistance regardless of the effective resistance that the user would actually encounter due to the terrain that they are actually travelling over.

[0050] In accordance with a preferred embodiment of the present invention the electronic control unit 14 will display to the user if they are meeting the required output in accordance with the terrain profile or training schedule loaded into the unit. The electronic control unit 14, and more specifically the display 18, display to the user if their present output matches the required output to meet their training schedule.

[0051] The display unit 18 may also display other metrics about the user's performance. In accordance with other preferred embodiments of the present invention, the electronic control unit 14 may comprise additional sensors 38 that allow biometric feedback from the user

to be displayed such as the user heart rate, respiration rate or the number of calories that have been consumed in the present training session.

[0052] In accordance with one embodiment of the present invention, information regarding previous training sessions may also be transferred to a personal computer allowing for analysis of the user's previous performance. Once the required information is transferred to the CTD 10 the user may terminate the connection between the communication means and the personal computer.

[0053] In accordance with a preferred embodiment of the present invention, the CTD 10 may be connected to a personal computer via the communication means. Additional training programmes may be downloaded to the CTD 10. Further, the personal computer may be used to generate training programmes based on the previous performance of the user.

[0054] Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

Claims

1. A cycling training device comprising an electronic control unit (14) and a variable resistance unit (16) for a bicycle **characterised in that** the variable resistance unit comprises an electrical load (34) and the electrical load (34) comprises a heat sink, and the variable resistance unit (16) is mountable in a wheel of the bicycle, such that the effective rolling resistance of the bicycle is electronically variable whilst the bicycle is ridden a physical distance on a real terrain.
2. A cycling training device in accordance with claim 1, **characterised in that** the effective rolling resistance is varied in accordance with a user's training programme.
3. A cycling training device in accordance with claim 1 or 2, **characterised in that** the electronic control unit (14) further comprises a communication means.
4. A cycling training device in accordance with claim 3, **characterised in that** the communication means further comprises a wireless means of communicating with the variable resistance unit (16).
5. A cycling training device in accordance with claim 3, **characterised in that** the communication means further comprises a wireless means of communicating with a personal computer.
6. A cycling training device in accordance with any one of the preceding claims, **characterised in that** the electronic control unit (14) is a mobile computing device.
7. A cycling training device in accordance with any one of the preceding claims, **characterised in that** the cycling training device further comprises at least one biometric sensor means (38) arranged to capture biometric data from the user such as heart rate or respiration data.
8. A cycling training device in accordance with claim 1, **characterised in that** the variable resistance unit (16) comprises a means of imparting Electro-Magnetic Force (EMF) capable of affecting the rolling resistance of the wheel.
9. A cycling training device in accordance with claim 8, **characterised in that** the means of imparting EMF comprises an alternator (25) or an eddy current brake.
10. A cycling training device in accordance with claim 8, **characterised in that** the variable resistance unit (16) further comprises means for rectifying alternating current.
11. A cycling training device in accordance with claim 8, **characterised in that** the variable resistance unit (16) further comprises a DC filter (28) or a DC converter.
12. A cycling training device in accordance with claim 8, **characterised in that** the variable resistance unit (16) further comprises a Pulse Width Modulation (PWM) controller (32).
13. A cycling training device in accordance with claim 8, **characterised in that** the variable resistance unit (16) further comprises a sensor means (36) arranged to measure physical and electrical characteristics of the variable resistance unit (16).
14. A cycling training device in accordance with claim 8, **characterised in that** the variable resistance unit (16) is arranged to generate electricity or to act as a motor during part of its normal operation.
15. A cycling training device in accordance with claim 12, **characterised in that** the electrical load (34) comprises a means for storing electrical energy.
16. A cycling training device in accordance with claim 13, **characterised in that** the sensor means (36) are arranged to measure at least one of: electrical resistance, electrical impedance, voltage output and current output.
17. A cycling training device in accordance with claim 13, **characterised in that** the sensor means (36) are arranged to measure at least one of: temperature, rotational speed and rotational moment.

18. A cycling training device in accordance with claim 16, **characterised in that** the sensor means (36) is connected to a calculation means that constantly calculates the electrical resistance of the load the electrical resistance of the load then being communicated to the electronic control unit (14) to ensure correct operation of the variable resistance unit (16).
19. A cycling training device in accordance with any one of the preceding claims, **characterised in that** the variable resistance unit (16) is arranged on a rear wheel of the bicycle.

Patentansprüche

1. Fahrradtrainingsvorrichtung, die eine elektronische Steuereinheit (14) und eine variable Widerstandseinheit (16) für ein Fahrrad umfasst, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit eine elektrische Last (34) umfasst und die elektrische Last (34) eine Wärmesenke umfasst und die variable Widerstandseinheit (16) in einem Rad des Fahrrads montierbar ist, sodass der effektive Rollwiderstand des Fahrrades elektronisch variabel ist, während das Fahrrad in einem realen Gelände eine physische Distanz zurücklegt.
2. Fahrradtrainingsvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der effektive Rollwiderstand in Übereinstimmung mit dem Trainingsprogramm eines Benutzers variiert wird.
3. Fahrradtrainingsvorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die elektronische Steuereinheit (14) weiter ein Kommunikationsmittel umfasst.
4. Fahrradtrainingsvorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** das Kommunikationsmittel weiter ein drahtloses Mittel zum Kommunizieren mit der variablen Widerstandseinheit (16) umfasst.
5. Fahrradtrainingsvorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** das Kommunikationsmittel weiter ein drahtloses Mittel zum Kommunizieren mit einem Personal-Computer umfasst.
6. Fahrradtrainingsvorrichtung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die elektronische Steuereinheit (14) eine mobile Rechenvorrichtung ist.
7. Fahrradtrainingsvorrichtung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Fahrradtrainingsvorrichtung weiter min-

destens ein biometrisches Sensormittel (38) umfasst, das angeordnet ist, um biometrische Daten von dem Benutzer, wie Herzfrequenz- oder Atmungsdaten, zu erfassen.

8. Fahrradtrainingsvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit (16) ein Mittel zum Übertragen einer elektromagnetischen Kraft (EMF) umfasst, das in der Lage ist, den Rollwiderstand des Rads zu beeinflussen.
9. Fahrradtrainingsvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** das Mittel zum Übertragen von EMF einen Wechselstromgenerator (25) oder eine Wirbelstrombremse umfasst.
10. Fahrradtrainingsvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit (16) weiter Mittel zum Gleichrichten von Wechselstrom umfasst.
11. Fahrradtrainingsvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit (16) weiter ein Gleichstromfilter (28) oder einen Gleichstromwandler umfasst.
12. Fahrradtrainingsvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit (16) weiter eine Pulsweitenmodulations-(PWM)-Steuerung (32) umfasst.
13. Fahrradtrainingsvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit (16) weiter ein Sensormittel (36) umfasst, das angeordnet ist, um physikalische und elektrische Eigenschaften der variablen Widerstandseinheit (16) zu messen.
14. Fahrradtrainingsvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit (16) angeordnet ist, um Elektrizität zu erzeugen oder während eines Teils ihres normalen Betriebs als Motor zu wirken.
15. Fahrradtrainingsvorrichtung nach Anspruch 12, **dadurch gekennzeichnet, dass** die elektrische Last (34) ein Mittel zum Speichern von elektrischer Energie umfasst.
16. Fahrradtrainingsvorrichtung nach Anspruch 13, **dadurch gekennzeichnet, dass** die Sensormittel (36) angeordnet sind, um mindestens einen der folgenden Werte zu messen: elektrischer Widerstand, elektrische Impedanz, Spannungsausgang und Stromausgang.
17. Fahrradtrainingsvorrichtung nach Anspruch 13, **da-**

durch gekennzeichnet, dass die Sensormittel (36) angeordnet sind, um mindestens eines von Folgendem zu messen: Temperatur, Drehzahl und Drehmoment.

18. Fahrradtrainingsvorrichtung nach Anspruch 16, **dadurch gekennzeichnet, dass** das Sensormittel (36) mit einem Berechnungsmittel verbunden ist, das konstant den elektrischen Widerstand der Last berechnet, wobei der elektrische Widerstand der Last dann an die elektronische Steuereinheit (14) übermittelt wird, um einen korrekten Betrieb der variablen Widerstandseinheit (16) zu gewährleisten.
19. Fahrradtrainingsvorrichtung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die variable Widerstandseinheit (16) an einem Hinterrad des Fahrrades angeordnet ist.

Revendications

1. Dispositif d'entraînement cycliste comprenant une unité de commande électronique (14) et une unité à résistance variable (16) pour une bicyclette, **caractérisé en ce que** l'unité à résistance variable comprend une charge électrique (34) et la charge électrique (34) comprend un dissipateur de chaleur, et l'unité à résistance variable (16) peut être montée dans une roue de la bicyclette, de sorte que la résistance au roulement effective de la bicyclette peut être modifiée électroniquement tandis que la bicyclette est montée sur une distance physique sur un terrain réel.
2. Dispositif d'entraînement cycliste selon la revendication 1, **caractérisé en ce que** la résistance au roulement effective est modifiée conformément à un programme de d'entraînement d'utilisateur.
3. Dispositif d'entraînement cycliste selon la revendication 1 ou 2, **caractérisé en ce que** l'unité de commande électronique (14) comprend en outre des moyens de communication.
4. Dispositif d'entraînement cycliste selon la revendication 3, **caractérisé en ce que** les moyens de communication comprennent en outre un dispositif de communication sans fil avec l'unité à résistance variable (16).
5. Dispositif d'entraînement cycliste selon la revendication 3, **caractérisé en ce que** les moyens de communication comprennent en outre un dispositif de communication sans fil avec un ordinateur personnel.
6. Dispositif d'entraînement cycliste selon l'une quel-

conque des revendications précédentes, **caractérisé en ce que** l'unité de commande électronique (14) est un dispositif de calcul mobile.

7. Dispositif d'entraînement cycliste selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le dispositif d'entraînement cycliste comprend en outre au moins des moyens de capteur biométrique (38) agencés pour capturer des données biométriques de l'utilisateur telles que des données de fréquence cardiaque ou de respiration.
8. Dispositif d'entraînement cycliste selon la revendication 1, **caractérisé en ce que** l'unité à résistance variable (16) comprend des moyens pour imprimer une force électromagnétique (EMF) capables d'affecter la résistance au roulement de la roue.
9. Dispositif d'entraînement cycliste selon la revendication 8, **caractérisé en ce que** les moyens pour imprimer une EMF comprennent un alternateur (25) ou un frein à courant de Foucault.
10. Dispositif d'entraînement cycliste selon la revendication 8, **caractérisé en ce que** l'unité à résistance variable (16) comprend en outre des moyens pour redresser un courant alternatif.
11. Dispositif d'entraînement cycliste selon la revendication 8, **caractérisé en ce que** l'unité à résistance variable (16) comprend en outre un filtre CD (28) ou un convertisseur CD.
12. Dispositif d'entraînement cycliste selon la revendication 8, **caractérisé en ce que** l'unité à résistance variable (16) comprend en outre un dispositif de commande (32) à modulation de largeur d'impulsion (PWM).
13. Dispositif d'entraînement cycliste selon la revendication 8, **caractérisé en ce que** l'unité à résistance variable (16) comprend en outre des moyens de capteur (36) agencés pour mesurer des caractéristiques physiques et électriques de l'unité à résistance variable (16).
14. Dispositif d'entraînement cycliste selon la revendication 8, **caractérisé en ce que** l'unité à résistance variable (16) est agencée pour générer de l'électricité ou pour agir comme un moteur pendant une partie de son fonctionnement normal.
15. Dispositif d'entraînement cycliste selon la revendication 12, **caractérisé en ce que** la charge électrique (34) comprend des moyens pour stocker de l'énergie électrique.
16. Dispositif d'entraînement cycliste selon la revendication 12, **caractérisé en ce que** la charge électrique (34) comprend des moyens pour stocker de l'énergie électrique.

cation 13, **caractérisé en ce que** les moyens de capteur (36) sont agencés de façon à mesurer au moins un élément parmi : une résistance électrique, une impédance électrique, une sortie de tension et une sortie de courant.

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17. Dispositif d'entraînement cycliste selon la revendication 13, **caractérisé en ce que** les moyens de capteur (36) sont agencés pour mesurer au moins un élément parmi : la température, la vitesse de rotation et le moment de rotation. 10
18. Dispositif d'entraînement cycliste selon la revendication 16, **caractérisé en ce que** les moyens de capteur (36) sont connectés à des moyens de calcul qui calculent constamment la résistance électrique de la charge, la résistance électrique de la charge étant ensuite communiquée à l'unité de commande électronique (14) pour assurer un fonctionnement correct de l'unité à résistance variable (16). 15 20
19. Dispositif d'entraînement cycliste selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'unité à résistance variable (16) est disposée sur une roue arrière de la bicyclette. 25

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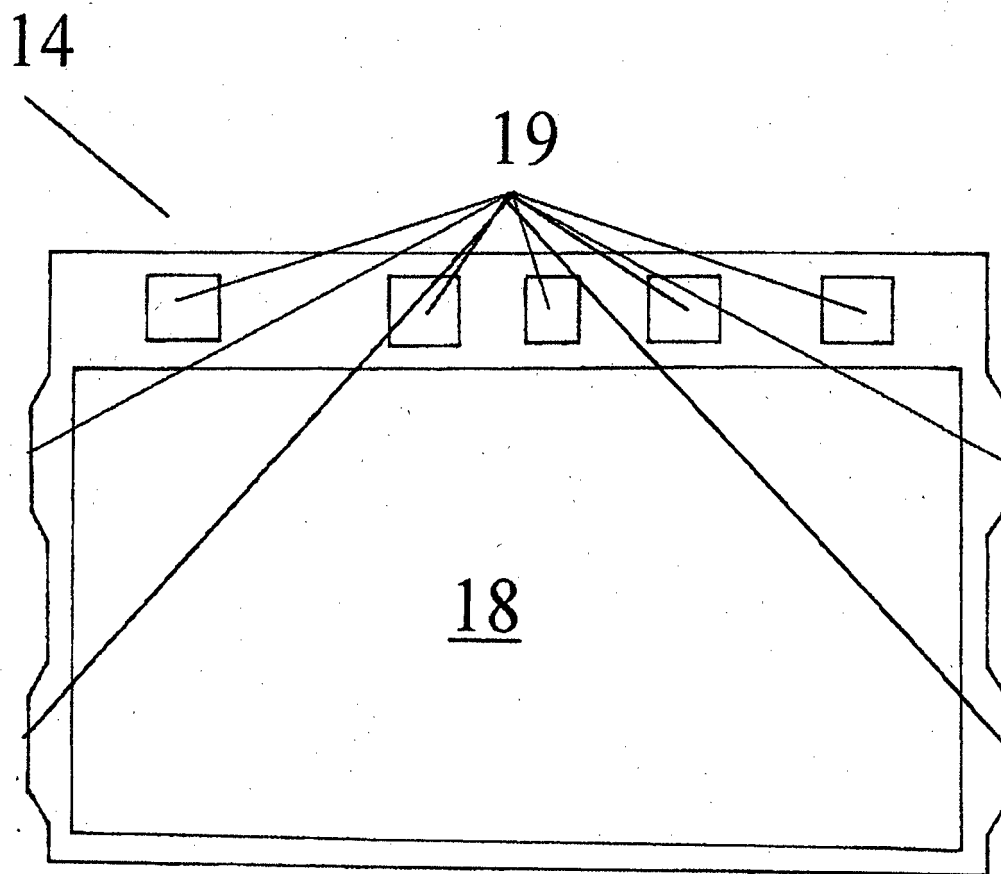


Figure 1

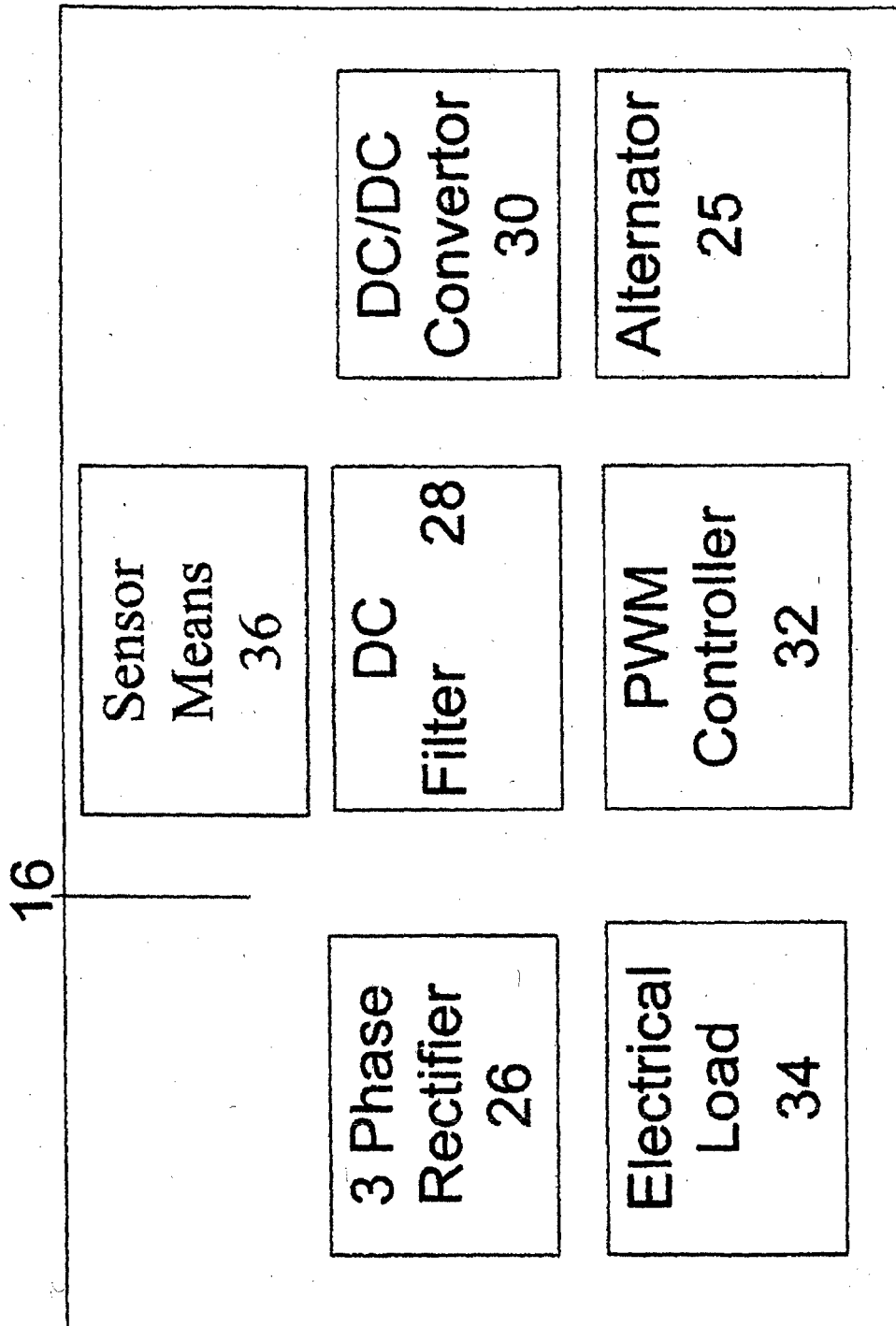


Figure 2

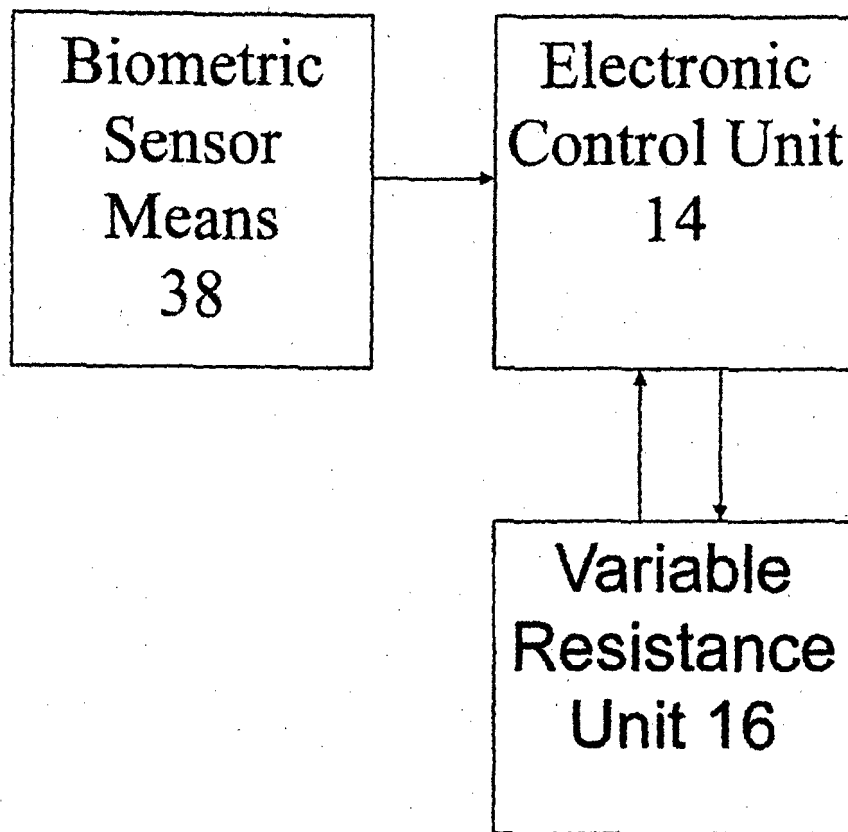


Figure 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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