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EUROPEAN QUALIFYING EXAMINATION 2023

Paper C

Part 2

This paper contains:

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Mr Fietsenmaker
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9 February 2023

Dear Mr Fietsenmaker,

The European Patent Register is back online. I have now obtained the remaining parts of EP 3 620 508 B1 (Annex 1): paragraphs [23] to [25] and claims 4 to 7. To ensure you have a good overview of all documents, please find enclosed the complete version of EP 3 620 508 B1 (Annex 1), as well as Annexes 2 to 7. By mistake, Annex 6 was not sent with the previous letter.

Please now prepare the second part of the notice of opposition so that we can combine it with the first part already prepared.

According to the now available file history of Annex 1, claim 6 was added during the examination phase. No further amendments were made to the application during the examination phase.

Kind regards,

M. Vos

Enclosures:

- Annex 1: EP 3 620 508 B1
- Annex 2: Cycling Today, page 20, October 2019 edition
- Annex 3: US 2018/0178879 A1
- Annex 4: DE 10 2016 118 903 A1
- Annex 5: Screen capture from facebike.com
- Annex 6: Scholarly article: Application of CFRP in Cycling
- Annex 7: EP 3 181 439 A1

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(11) **EP 3 620 508 B1**

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(54) **Road racing pedal**

Straßenrennradpedal

Pédale de cyclisme sur route

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[0001] The present application concerns a road racing pedal for improving pedalling efficiency and a pedalling efficiency improving system comprising the mentioned pedal in combination with a control system in the form of a bicycle computer.

[0002] Road racing bicycles generally comprise (see Fig. 1) a frame 120, a front wheel 150 and a rear wheel 160, a handlebar 130, a saddle 140, a chain drive 180 and a set of left and right clipless pedals 170 attached to crank arms 105. A chain drive comprises front chainrings 117 and rear sprockets 119 connected by a roller chain 118 (see Fig. 2). Other known road racing drive transmission types, e.g. belt drives, shaft drives, are beyond the scope of the present invention.

[0003] Road racing cyclists are constantly looking for ways to improve their performance. One way to improve performance is by improving pedalling efficiency.

[0004] In cycling, a pedal stroke (see Fig. 3) is defined as a revolution of the pedal body 101 around the rotation axle X. The pedal stroke is divided into a downstroke 115 (when the pedal moves forward from the uppermost point 111 to the lowermost point 113; see Fig. 3) and an upstroke 116. Power varies during the stroke. When one of the pedals is around the uppermost point 111 and the other pedal is around the lowermost point 113, minimum power is produced. These points of minimum power 111 and 113 are called “structural dead spots”. Maximum power during the stroke is produced when the crank arms 105 are at points 112 and 114, around 90° from the uppermost point 111.

[0005] During the downstroke, when the cyclist pushes the pedal down, the cyclist's heel is ideally in a heel-down position. During the upstroke, when the cyclist pulls the pedal up, the heel is ideally in a heel-up position. Most cyclists, however, deviate from the ideal heel movement during a pedal stroke, due to irregular up and down movements of the heel around the transition points between the heel-down and heel-up positions. These irregular heel movements result in a lower power output than would ideally be produced. These spots of lower power output, typically occurring on initiation of the upstroke, but also, albeit less frequently, of the downstroke, are called "instantaneous dead spots". Thus, by measuring irregular heel movements in the pedal stroke, instantaneous dead spots can be identified.

[0006] There are several ways to improve pedalling efficiency. Some bicycle sensors are able to measure and determine the position of instantaneous dead spots within a pedal stroke so that the cyclist can check and improve his or her pedalling technique. There are several methods for measuring instantaneous dead spots, using a plurality of sensors. One of the most common is the measurement of the heel-up, heel-down movement disclosed here above. This is very simple to measure as it only requires a pedal angle sensor. Thus, by providing an angle sensor, recognition of instantaneous dead spots and, therefore, a pedalling efficiency measurement can be provided.

[0007] Other solutions for improving pedalling efficiency in the form of oval chainrings or variable length crank arms are also well known in the art. However, these solutions are complex and rarely used.

[0008] The present invention solves the problem of improving pedalling efficiency by providing a pedal system that identifies the presence of instantaneous dead spots in the pedal stroke and, once they have been identified, increases or decreases rotation resistance of the pedal body around the pedal spindle depending on the pedal's position during the pedal stroke.

[0009] The present invention will be illustrated with reference to the following figures:

Fig. 1 shows a side view of a road bicycle;
Fig. 2 shows the different components of a chain drive;
Fig. 3 shows the points of maximum and minimum effort during a cyclist's pedal stroke;
Fig. 4 shows a road racing pedal according to the present invention;
Fig. 5 shows a pedalling efficiency improving system according to the present invention.

[0010] Fig. 4 discloses a road racing pedal according to the present invention. Road racing pedals are clipless pedals for on-road racing. A clipless pedal is built such that a cleat affixed to the sole of a cycling shoe can engage with the pedal. Without the need for an additional toe clip on the pedal, the shoe becomes firmly attached. These pedals differ from regular platform pedals, to which a shoe cannot be attached. Road racing pedals need to be sealed to protect the internal components from the elements.

[0011] The road racing pedal according to the present invention comprises a pedal body 101 with a pedal cavity 102 and a pedal spindle 103, placed within the pedal cavity 102. The pedal spindle 103 attaches the pedal body to a bicycle crank arm 105.

[0012] The pedal body 101 rotates around the pedal spindle 103 with the help of sealing bearings. Two sets of two bearings 104 enclose and seal the pedal cavity 102. To identify the instantaneous dead spots during the pedal stroke, a pedal spindle drive 106 is installed within the pedal cavity 102.

[0013] The pedal spindle drive 106 comprises four permanent magnets 107 placed on the pedal body, inside the pedal cavity 102 and distributed evenly around the circumference of the pedal cavity 102. The pedal spindle drive 106 further comprises four electromagnets 108 which are placed on and distributed evenly around the circumference of the pedal spindle 103 as counterparts to the four permanent magnets 107.

[0014] The electromagnets 108 (functioning as stators) and the permanent magnets 107 (functioning as rotors) constitute an electric motor that can apply torque on the pedal spindle 103 when an electric current is applied to the electromagnets 108.

[0015] The pedal spindle drive 106 is actuated by a pedal controller 109 placed on one end of the pedal spindle 103. Thus, by selectively applying current to the electromagnets 108, the rotation resistance of the pedal body 101 around the pedal spindle 103 can be adjusted at will.

[0016] This resistance adjustment has the advantage of signalling to the cyclist the crossing of certain positions around the pedal stroke, e.g. points of maximum ankle extension. Using this information, the upstroke or downstroke can be specifically trained or certain muscles rehabilitated.

[0017] Additionally, and independently of the resistance adjustment, the pedal spindle drive 106 can function as a pedal angle sensor when the electromagnets 108 are not activated (switched on). In this mode of operation, the interaction of the magnetic fields between rotor and stator can be measured, which allows the exact position of the pedal body 101 with respect to the crank arm 105 during the pedal rotation to be inferred. When the cycling shoe and the clipless pedals are engaged, they move as a single entity and the angle described by the pedal thus corresponds substantially to the angle described by the heel of the cyclist. Using this information, the position of the heel of the cyclist throughout the pedal stroke can be determined. Wherever the real heel-up, heel-down movement during the pedal stroke differs from the ideal heel-up, heel-down movement, an instantaneous dead spot is identified.

[0018] The sensed angle of the heel is then sent by the pedal controller 109 to a bicycle computer 110 (see Fig. 5). The bicycle computer 110 calculates in real time, according to any of the many well-known algorithms, the heel-up, heel-down movement of the cyclist with respect to the pedal position along the pedal stroke and, additionally, a pedalling efficiency metric.

[0019] These heel-up, heel-down movements provide the basis for identifying the position of instantaneous dead spots around the pedal stroke. When an irregular heel movement is detected, an instantaneous dead spot is identified and the bicycle computer 110 can show its position on the display for the cyclist to see.

[0020] The bicycle computer 110 is additionally able to send information to the pedal controller 109. This permits transmission of the information on the instantaneous dead spot to the pedal controller 109.

[0021] The bicycle computer 110 can instruct the pedal controller 109 to actuate the pedal spindle drive 106 when the pedal crosses the measured instantaneous dead spot. Thus, the cyclist "senses" the pedal crossing the instantaneous dead spot by suddenly feeling an increased rotation resistance around the pedal spindle 103, which forces the cyclist to reduce the irregular heel-up, heel down movement around the instantaneous dead spot. By using our efficiency improving system, the cyclist will learn to maintain a regular heel-up, heel-down movement and, over time, will achieve an almost ideal pedal stroke with few or no instantaneous dead spots. Outside of the instantaneous dead spots, the bicycle computer 110 will not actuate the pedal spindle drive 106 and thus the cyclist will not feel any rotation resistance different from that normally encountered.

[0022] The bicycle computer 110 communicates with the pedal controller 109 using standard BOT transmission technology and is thus also compatible with other power meters, speed sensors, rotation sensors and other cycling sensors available on the market. The bicycle computer 110 is therefore able to calculate instantaneous dead spots even when connected to different types of sensors, so long as pedal angle information is provided to the bicycle computer 110 by said sensors.

[0023] Additionally, the bicycle computer 110 will also display a graphic icon for the cyclist, depending on the pedalling efficiency metric achieved at that moment. An angry emoticon can be shown when the pedalling efficiency is below a certain value, such as 80%, and a heart icon when the efficiency is at or above that value.

[0024] The sealing pedal bearings 104 of the present invention are ceramic bearings. They comprise ceramic ball bearings made of zirconia combined with ceramic races and provide reduced friction and an increased life span as compared with standard steel bearings. Zirconia ball bearings and ceramic races need to be combined to achieve the above-mentioned improvements. These bearings 104 hermetically seal the internal cavity 102.

[0025] The pedal body 101 is made of carbon fibre reinforced plastic (CFRP), which provides a stiff, strong and lightweight pedal body 101 that is capable of absorbing the high loads produced by the cyclist but still has a very low weight. CFRP is a composite material comprising carbon fibres embedded in a resin matrix. For road cycling purposes, we have found out that carbon fibre tows (bundles of carbon fibre strands) of between 6 000 and 8 000 strands provide an optimum balance between strength and weight. Each tow has a tensile elastic modulus of between 350 GPa and 600 GPa. As a resin, we have used a carbon nanotube-reinforced epoxy as it provides an improved fracture toughness with respect to conventional epoxy.

Claims:

1. A road racing pedal comprising a pedal body (101) with a pedal cavity (102), a pedal spindle (103) for attaching the pedal body (101) to a bicycle crank arm (105) and a sensor for detecting dead spots in the pedal stroke.

2. A road racing pedal according to claim 1, wherein the pedal spindle (103) is placed within the pedal cavity (102) and the sensor comprises a pedal spindle drive (106), with at least four electromagnets (108) placed on the pedal spindle (103) and at least four permanent magnets (107) placed on the pedal body (101) within the pedal cavity (102) and facing the electromagnets (108), the road racing pedal further comprising a pedal controller (109) for actuating the spindle drive (106).

3. A pedal system comprising a road racing pedal according to claim 2 and further comprising a bicycle computer (110) adapted to receive pedal angle information and to identify instantaneous dead spots in the pedal stroke and further showing the position of said dead spots on a display of said computer.

Claims 4 to 7 only available on screen

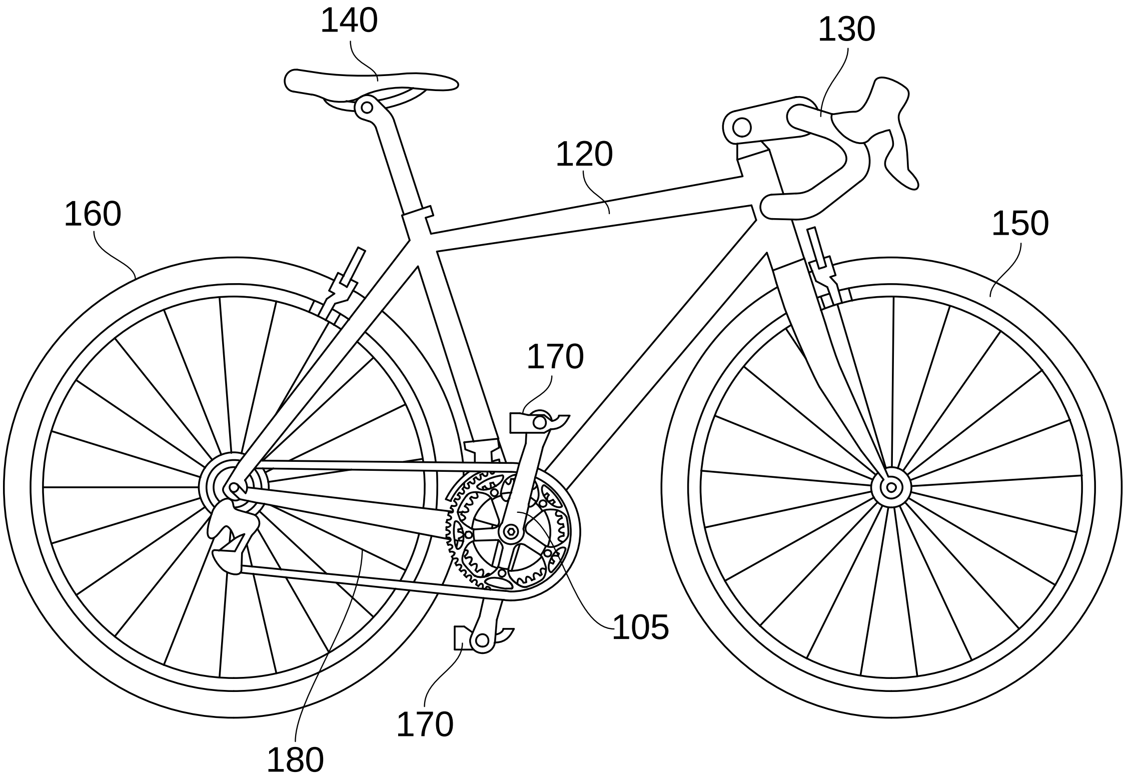


Fig. 1

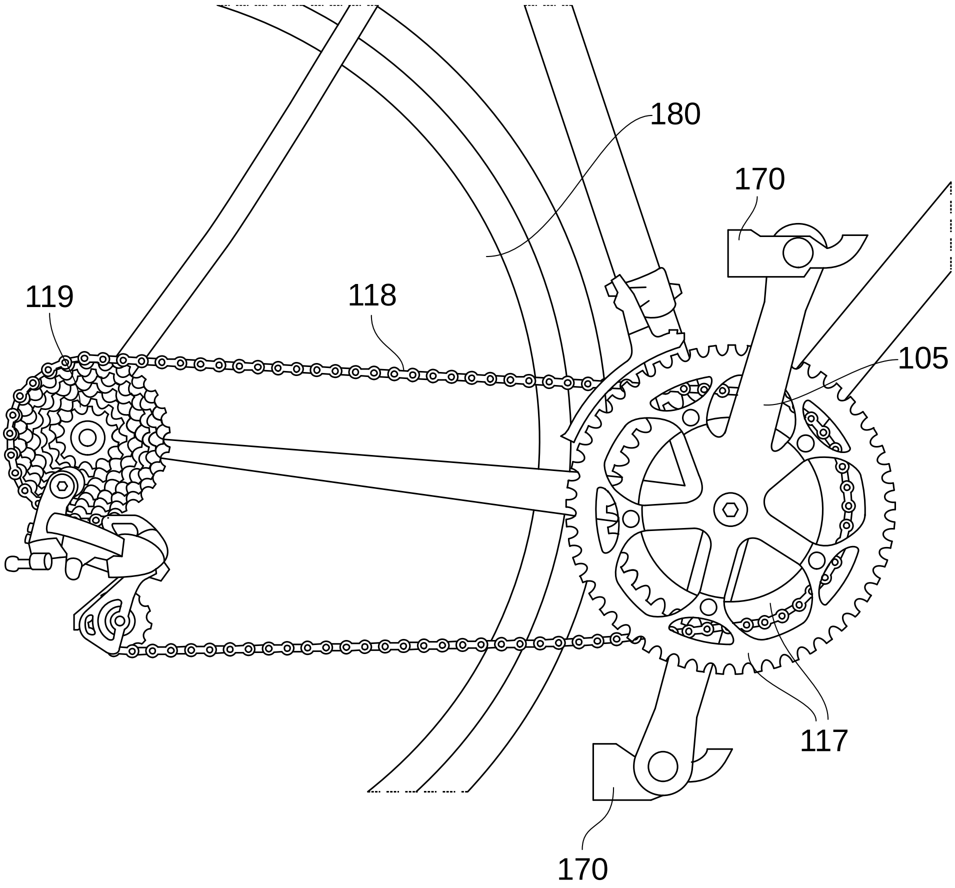


Fig. 2

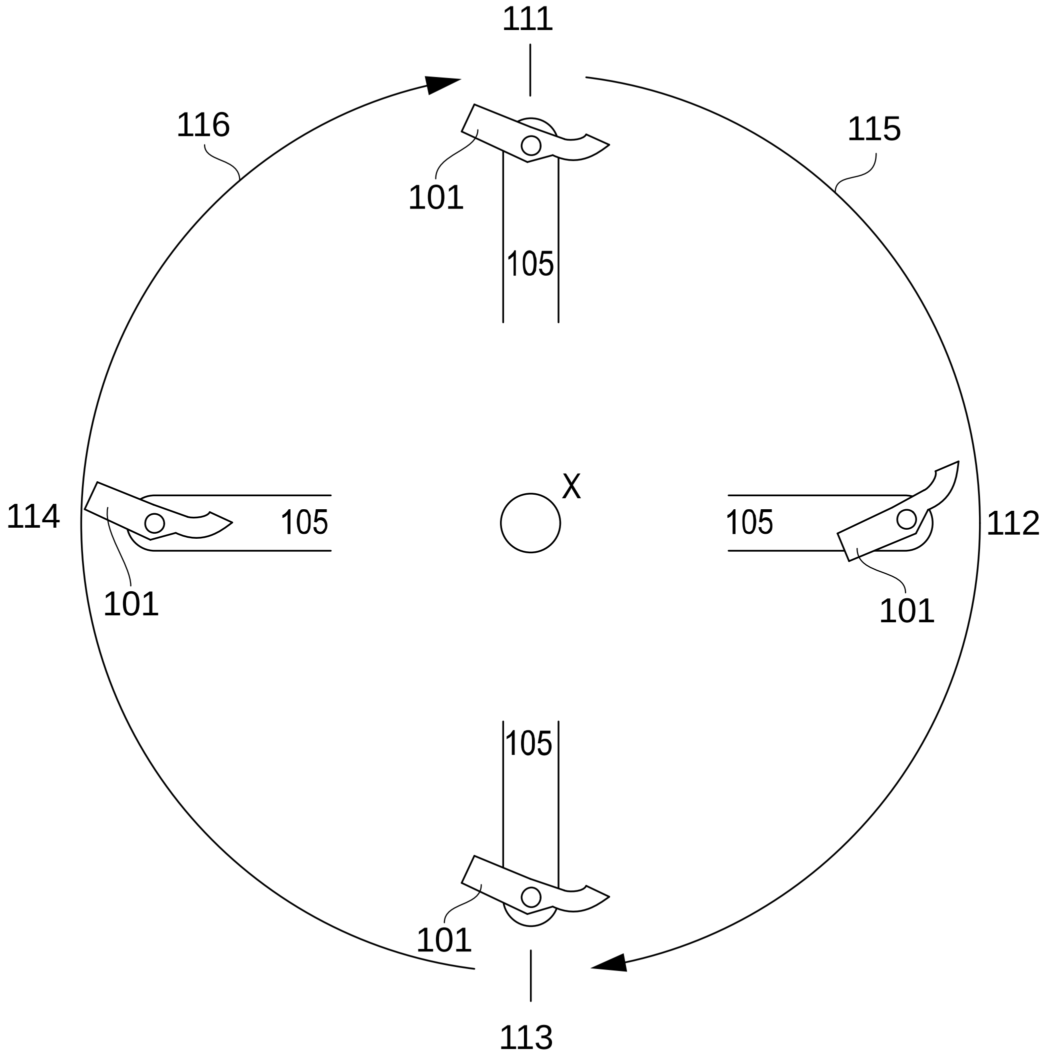


Fig. 3

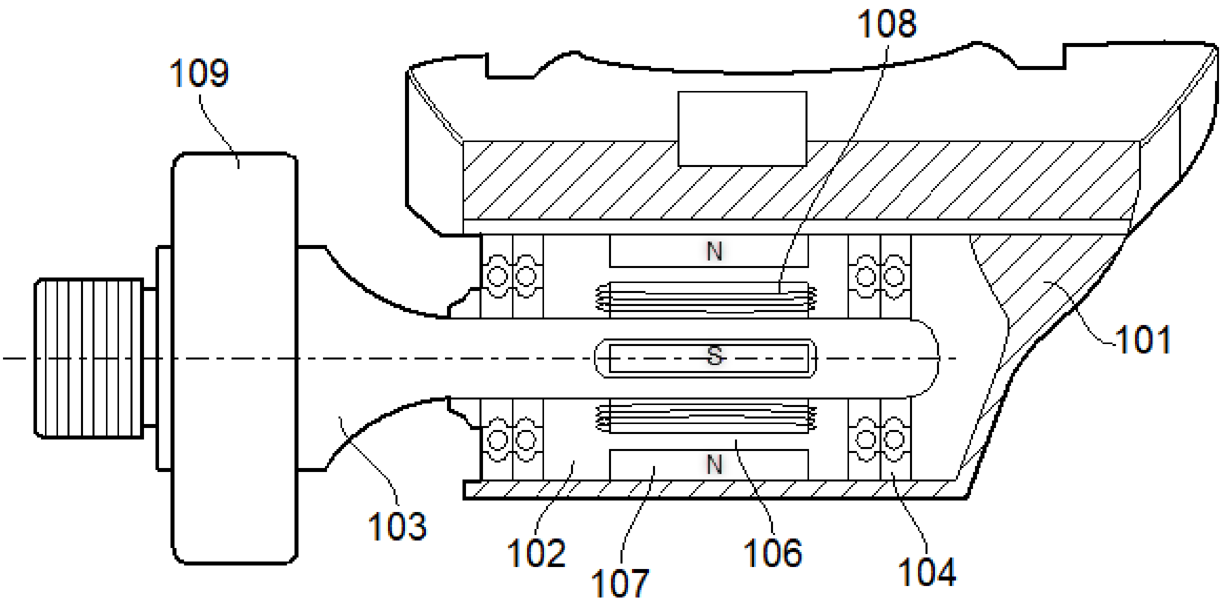


Fig. 4

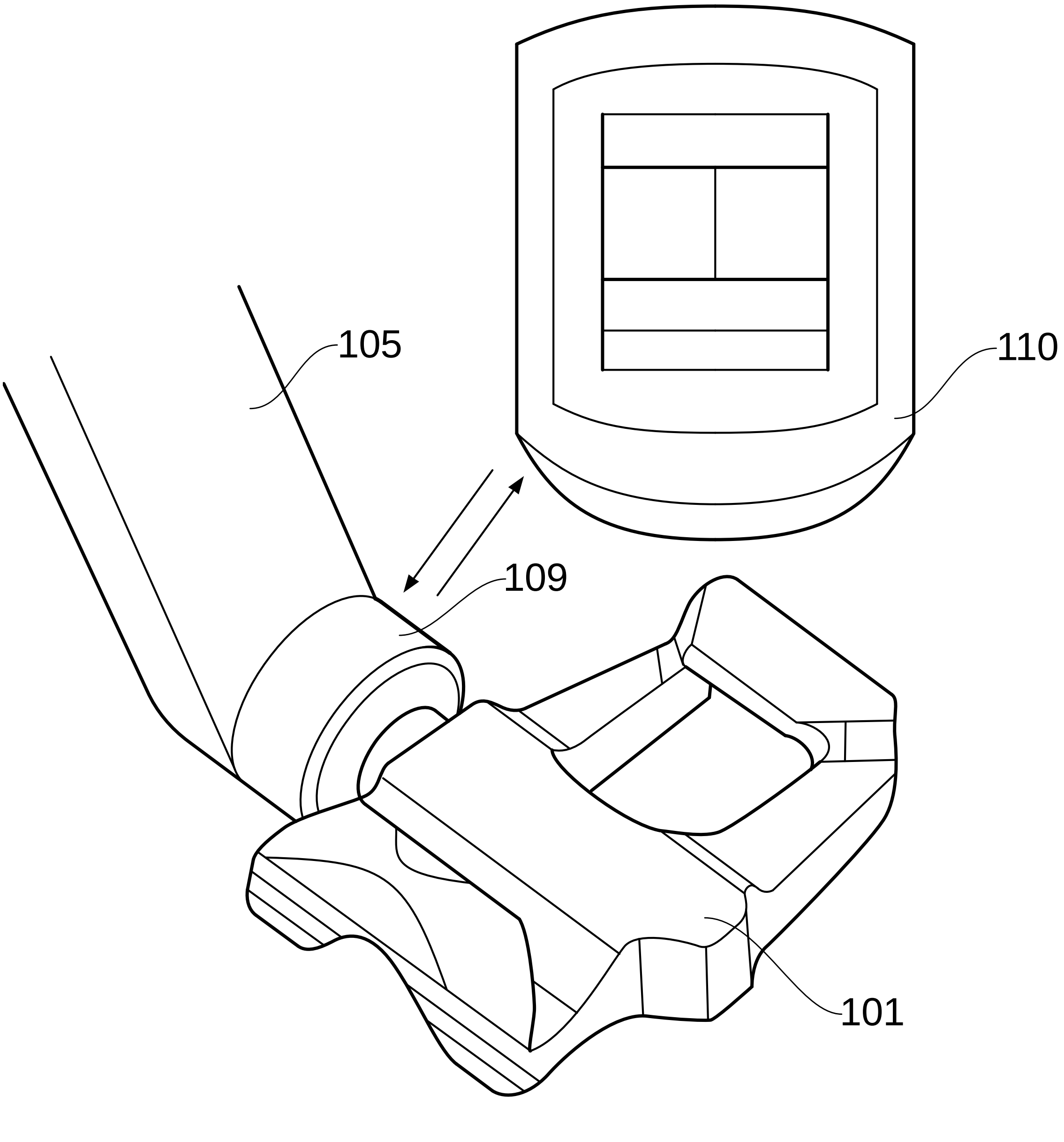


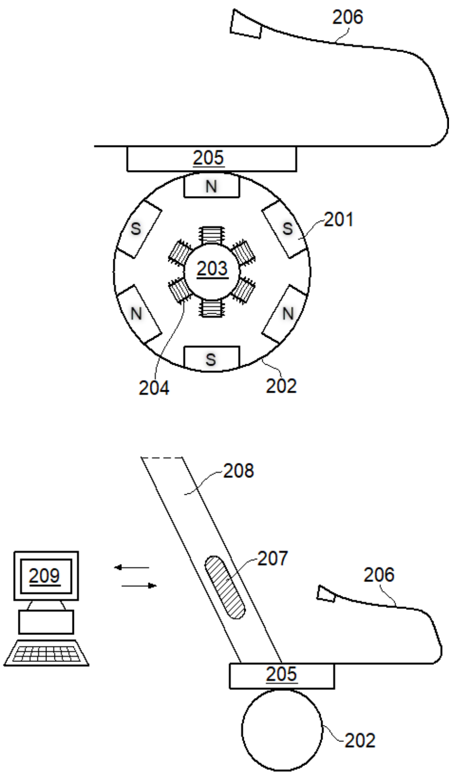
Fig. 5

“il Pirata“

[0001] At “il Pirata - bike fitting and training services”, we offer you a complete bike fitting and training experience to improve your cycling performance. The pedal system we have developed in house will help you achieve your ideal pedal stroke. Our pedal system is able to directly measure the heel position of the cyclist throughout the whole pedal stroke and identify the position of the dead spots. Once they have been identified, the pedal rotation resistance at these dead spots is increased in order to force the cyclist to correct the pedalling technique. How do we do it? Four years ago, we started developing a novel but still rudimentary pedal. It was an instant hit at Eurobike 2017.

[0002] Our pedal is provided with an electric motor placed around the pedal axle. It comprises a rotor with 6 permanent magnets (201) evenly spaced out on the interior wall of an open cylinder (202). It further comprises a stator with 6 electromagnets (204) evenly spaced around and enclosing the pedal shaft (203). The pedal body (205) with a toe clip (206) that holds the foot in place is glued at its bottom surface on to the top of the cylinder (202). The pedal is conventionally connected to the crank arm (208) through the pedal shaft (203). This rudimentary motor is connected to a controller (207), placed on the crank arm (208), which communicates with our PC workstation (209) using the industry-standard BOT protocol. By analysing the angle position signals from the motor, the dead spots are directly identified at the PC workstation, which uses our proprietary instantaneous dead spot identification algorithm. When the dead spots are identified, their position is sent back to the controller, which in turn switches the electric motor on and off whenever the pedal is about to pass a dead spot. By increasing pedal rotation resistance at the dead spots, the system signals to the cyclist the position of the dead spots in the stroke such that the cyclist will recognise their position and get used to a smoother stroke around these points, minimising instantaneous dead spot formation and increasing pedalling efficiency.

[0003] As our system is obviously still a work in progress, we are looking for partners in the pedal industry to integrate it into high-end clipless pedals for road racing bicycles – something our visitors at Eurobike 2017 were very much asking for. However, until we find a suitable partner, our pedals will remain stationary-bicycle pedals as they are clearly not ready to endure road conditions such as water, dirt or bumps.



Schematic figures disclosing the pedals, as shown on the posters displayed on our booth at Eurobike 2017 (above).

Cycling Today, page 20, October 2019 edition

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(19) United States Patent Office (USPTO)

(21)	Application number:	**15/759,757**
(11)	Publication number:	**US 2018/0178879 A1**
(40)	Publication date:	**Jun. 28, 2018**
(22)	Filing date:	**Sept. 17, 2015**

Bike computer and performance display apparatus

[0001] The present invention discloses the measurement of a cyclist's performance by way of a bicycle computer for use in connection with a bicycle having at least one pedal sensor. A bicycle computer is a small computing device mounted on a bicycle that calculates and displays trip information, effort level and other performance metrics. The present invention specifically deals with the display of a dead spot score, determined on the basis of pedal angular movement. The bicycle computer will calculate and display the information so that the cyclist can reduce the dead spots.

[0002] Fig. 1 illustrates the present invention.

[0003] The present invention utilizes one or more sensors to determine the power exerted by a cyclist’s foot and the presence of dead spots in the pedal stroke.

[0004] Referring to Fig. 1, a bicycle computer 310 according to the present invention is disclosed. This computer, mounted on the handlebar, is configured to display bicycle performance characteristics. The bicycle comprises angle measuring sensors 322, fixedly welded on the corresponding left and right crank arms. Additionally, power meters 324 and two platform pedals 320 are provided.

[0005] Power meters 324 are configured to measure power exerted by the cyclist on the left and right platform pedals 320. The power meters 324 comprise a plurality of strain gauges placed on the pedal axle or pedal spindle. Strain gauges are thin metal film sensors whose electrical resistance varies with applied force. The angle measuring sensors 322 measure the angle of the pedal with respect to the crank arm. This information is combined by the controller (not shown), which is in communication with the bicycle computer 310.

[0006] The bicycle computer 310 is configured to receive this information from the controller and display the power measurement data. Additionally, the bicycle computer 310 is able to analyze the power measurements provided by the power meters 324 and provide a real-time imbalance score showing the power output difference between left and right pedal 320.

[0007] The bicycle computer 310 can furthermore analyze the data provided by the angle measuring sensors 322 and, based on this data, provide an up-and-down movement profile of the pedal 320, and thus of the cyclist's heel, throughout the pedal stroke. Using this profile, dead spots in the pedal stroke are identified. This information can be displayed in real time to the cyclist so that the cyclist can modify the pedal stroke accordingly to reduce the occurrence of dead spots and so improve the pedaling efficiency. The bicycle computer 310 is further able to provide a dead spot score or efficiency parameter, which will also be displayed in real time, for example in percentage form or in any other known manner. When the pedaling efficiency is below a certain level, i.e. 80%, the bicycle computer will display an upward pointing arrow to indicate that pedaling efficiency needs to be improved.

[0008] The communication between bicycle computer 310 and the controller is bi-directional. Not only does the controller provide the bicycle computer 310 with angle sensor and measured power data, but the bicycle computer 310 communicates back the calculated parameters such as power imbalance, position of the dead spots and cadence. For the communication between the sensors, the controller and the bicycle computer 310, the widely used wireless protocol BOT is employed, ensuring interoperability with pedals from different brands. Thus, the present bicycle computer 310 will work with all other BOT pedal and sensor systems.

Claim:

1. A bicycle computer comprising a control unit and a display unit, the control unit being able to receive power meter signals from at least one pedal sensor and angle measuring signals from at least one further sensor and calculate, based on said signals, dead spots in the pedal stroke of the at least one pedal, cadence of the at least one pedal and power imbalance between the left and right side pedal output.

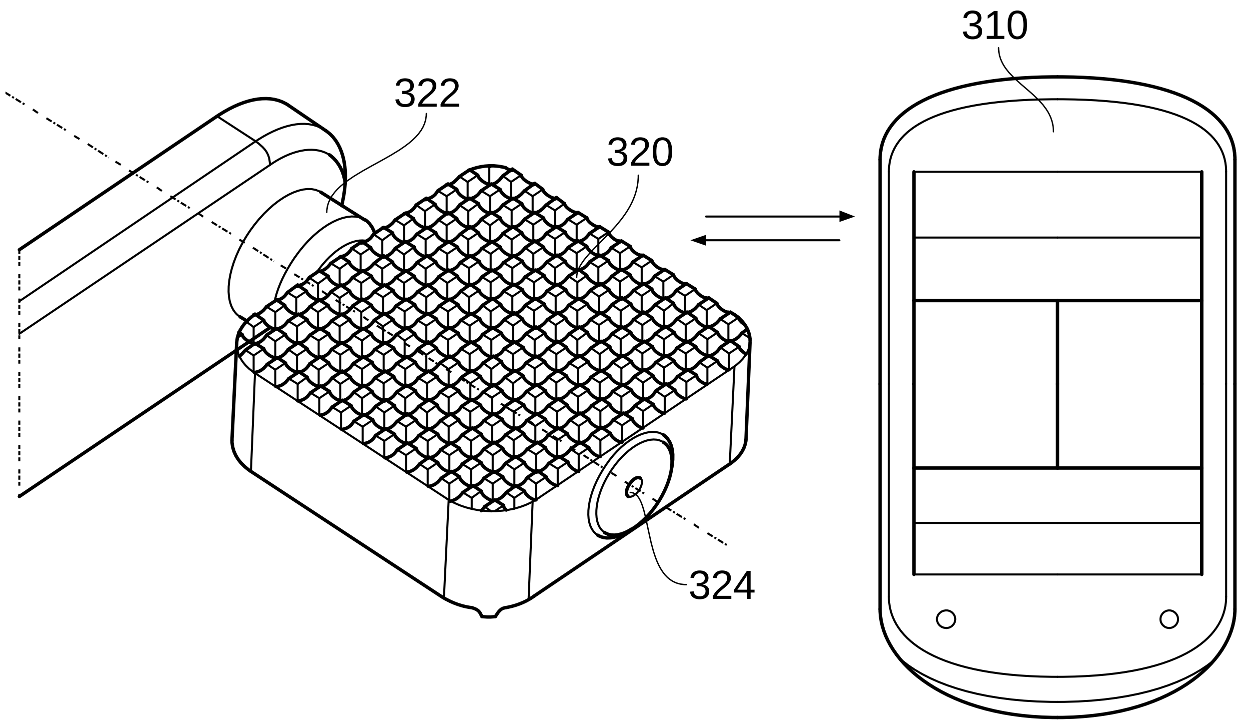


Fig. 1

(19) German Patent and Trademark Office (DPMA)

(21)	Application number:	**DE 10 2016 118 903.4**
(11)	Publication number:	**DE 10 2016 118 903 A1**
(40)	Publication date:	**13 April 2017**
(22)	Filing date:	**26 August 2016**
(30)	Priority:	**12 July 2016 TW105210460**

Lightweight retrofit ready pedal

[0001] This invention relates generally to a pedal for a bicycle and more specifically to a clipless bicycle pedal.

[0002] Clipless pedals releasably engage a cleat secured to the cyclist's shoe. This type of pedal generally comprises an axle mounted on the crank of the bicycle, a pedal body rotating around the pedal axle or pedal spindle, and a cleat engagement mechanism placed on the pedal body. In order to engage the pedal, the cyclist steps onto the pedal and the mechanism automatically grips the cleat which is secured to the bottom of the cyclist’s shoe.

[0003] Nowadays, many cyclists use more and more sensors of various types, such as speed, cadence, heart rate and power sensors. However, one drawback of this increased use of sensors is that, in order to keep up with technology, the cyclist has to replace the sensors very often, and sometimes, in the case of integrated sensors, this even means replacing whole components. This is especially the case with bicycle pedals. In view of the high price of pedals, this is a costly endeavour.

[0004] It is an object of the present invention to provide a clipless bicycle pedal that is lightweight and allows for the provision of different sensors to the same pedal according to the cyclist's needs.

[0005] The aforementioned object can be achieved by providing a clipless pedal for on-road racing with several cavities or chambers which, during the lifetime of the pedal, can be retrofitted with different types of pedal sensors according to the user's needs. This way, the pedals can be used as the backbone of the measuring system and, when new sensors appear on the market, the cyclist will only have to replace the sensors, thus saving the cost of purchasing a new pedal body.

[0006] Fig. 1 shows a pedal according to the invention and Fig. 2 shows a cross-sectional view of the pedal according to the invention.

[0007] The bicycle pedal comprises a pedal axle 410, adapted to be coupled to a crank arm (not shown in the figures), and a pedal body 420 for supporting a cyclist’s foot.

[0008] The pedal body 420 or pedal housing is made of lightweight but sturdy aluminium. In order to allow for retrofitting of pedal sensor elements, the pedal body is provided with a posterior cavity 460 and with an interior cavity 480 around the pedal axle 410. The interior cavity 480 is provided around the pedal axle to provide enough space for the provision of strain gauges on the pedal axle. Zirconia bearings 490 enclose the cavity.

[0009] Future uses are allowed by the provision of the large interior cavity 480. It is, for example, well known that manufacturers of bicycle components are trying to reduce the reliance of pedals and other components on batteries. Therefore, stator and rotor charging systems for providing energy to the sensors are currently being discussed in the technical field. Such a large space would clearly allow for the installation of such a system without the need to replace the pedal as a whole, yet still ensure a low weight. Further uses, such as measuring and signalling the pedal position along the stroke, currently in development, could also be envisioned for this cavity.

[0010] The posterior cavity 460 can furthermore be used to retrofit one or more of a cadence sensor, a GPS sensor or other type of sensor. This posterior cavity 460 is big enough to fit, additionally, a BOT enabled pedal controller, a wireless signal transmitter or receiver or any other communication module allowing the sensors to communicate with a bicycle computer, a smartphone or any other suitable device.

[0011] A further embodiment of the present invention is thus a pedal system or a cycling training system with a bicycle computer and the present pedal.

Claims:

1. A lightweight aluminium pedal comprising a pedal body (420), a pedal axle (410), adapted to be coupled to a crank arm, a cleat engaging mechanism (430) and at least one sensor fitting cavity (460, 480).
2. A pedal according to claim 1, wherein the sensor fitting cavities (460, 480) consist of a posterior cavity (460) and an interior cavity (480).

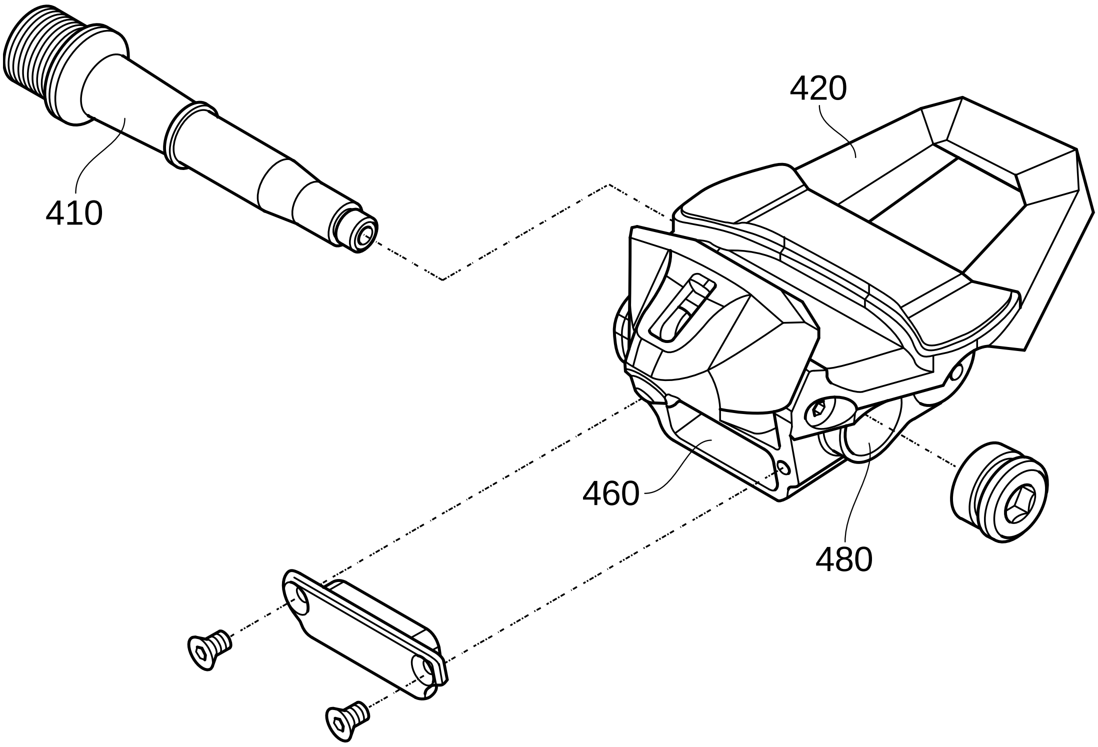


Fig. 1

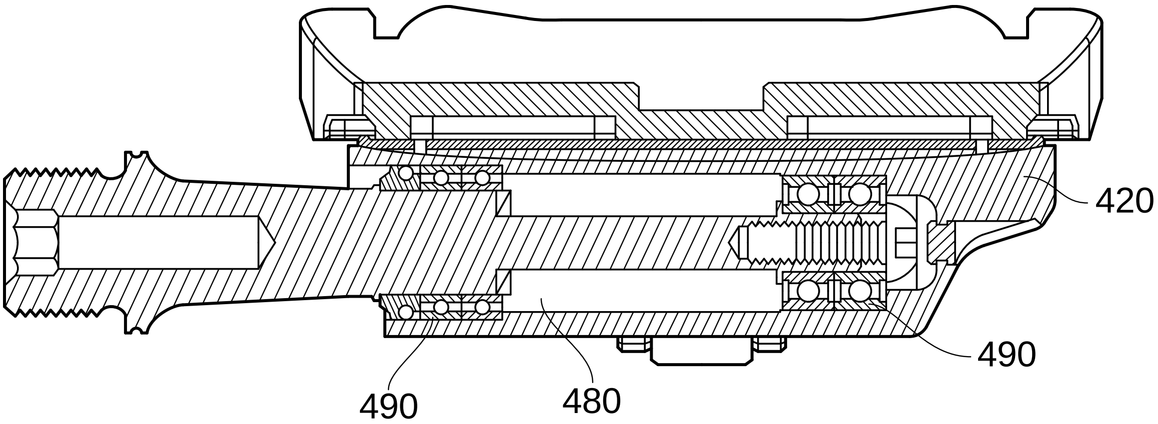
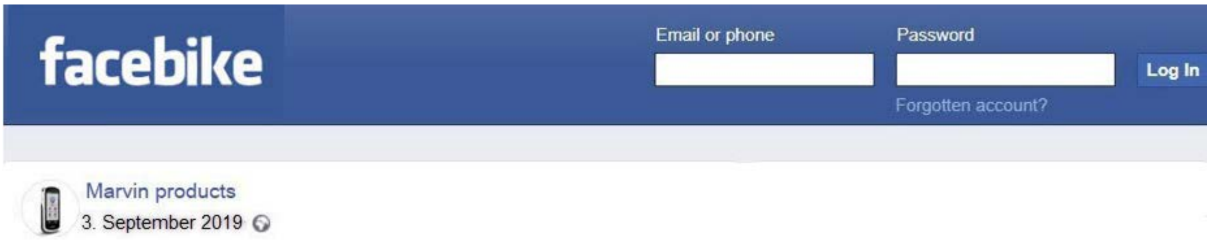


Fig. 2

Screen capture from facebike.com, downloaded and printed on 8 February 2023.

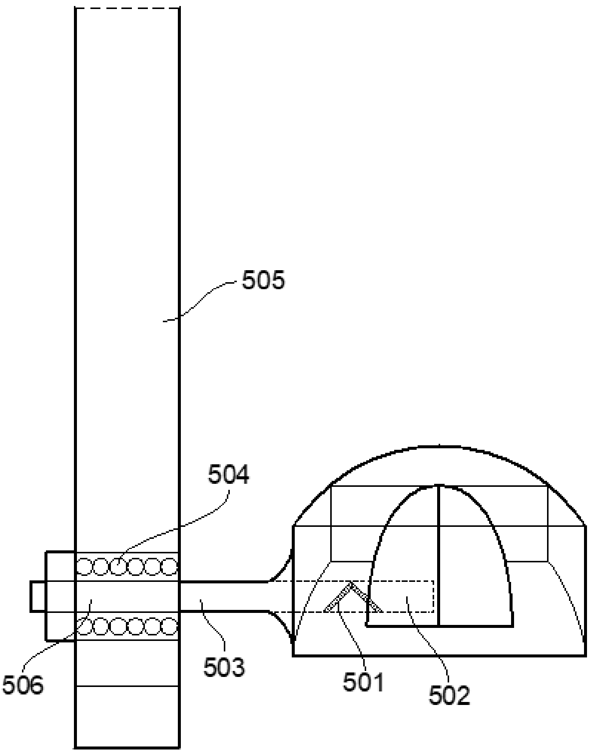


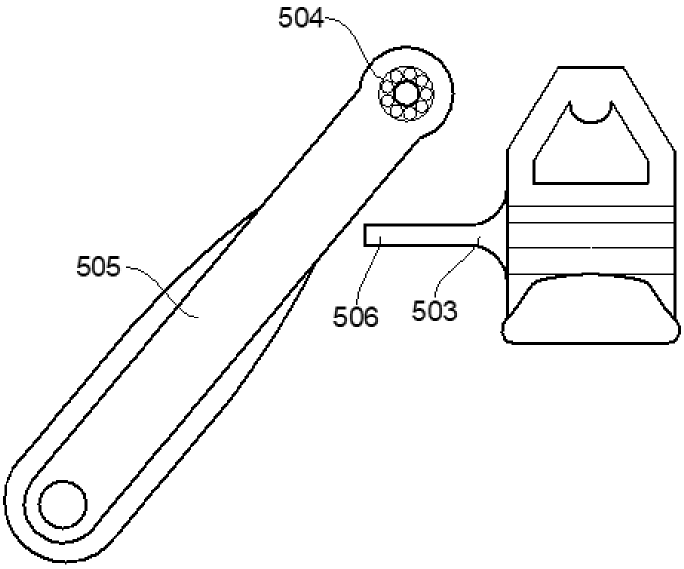
[0001] Marvin products is proud to present tomorrow, on time for the grand opening of Eurobike 2019, the new Arrow 6 crank-pedal set – a completely redesigned lightweight clipless pedal that includes our proprietary ultra-accurate power meter with its corresponding new Arrow 6 crank arm.

[0002] Unlike previous versions of our clipless pedals, the new Arrow 6 crank-pedal set is extremely lightweight, yet still provides all the information that cyclists require to improve their performance. The Arrow 6 measures total power produced, left-right balance, cadence, and pedal angle around the pedal stroke, as well as other advanced cycling dynamic parameters.

[0003] The new Arrow 6 features a slim design, with the lowest weight in its category. At just 100 g per pedal, the Arrow 6 is lighter than any other pedal with a power meter and just a bit heavier than the lightest pedals on the market. The Arrow 6 allows for direct power measurement by using strain gauges (501) in our redesigned pedal axle system. The strain gauges can be replaced by accessing the pedal axle chamber (502) in the pedal housing.

[0004] In order to keep the weight of the pedal to the minimum, yet still provide stiffness and a smooth ride, the new Arrow 6 crank-pedal set proposes an innovative crank-pedal design. Instead of having an axle rotating inside the pedal body, the pedal axle, in the form of a pedal attachment arm (503), rotates inside the bearings (504) placed in the crank arm (505), at the attachment hole. The pedal angle measurement sensor (506) is placed at the tip of the pedal attachment arm. This design replaces the bearing arrangement in the pedal housing with a single bearing placed in the crank arm. This way, the pedal, including the pedal axle, can be manufactured as a single integral piece.





Most relevant ▾

Pieter Zagan: Are these pedals for indoor or outdoor use?

3. September 2019

Marvin products: Our pedals are designed for road racing cycling. For amateurs and pro cyclists alike.

3. September 2019

KAS Publishing
Composites and New Materials
Journal **01** (2019) 112004
https://doi.org/2019/112004

Application of Carbon Fibre Reinforced Plastic (CFRP) in Cycling

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[2] Sport Technology Department, ETH, Zürich, Switzerland

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Abstract

In recent years, CFRP has been added to cycling components of all kinds. Initially restricted to frames, which require high tensile strength and shock absorption but still need to be low in weight, its application is now spreading to components with lower stiffness requirements, too. Thus, CFRP is increasingly being used to manufacture the main body of the crank arm, cranks, chainrings, clipless pedals, seatposts, handlebars, brake levers and many other different components. This article briefly describes the main characteristics of carbon fibre and analyses its application in cycling.

Keywords: Carbon fibre, CFRP, composite materials, cycling

Journal **01** (2019) 112004 Peter Delgado *et al.*

New materials in cycling

Professional cycling is an opportunity for component manufacturers to put their newest technologies on public display for the world. Advanced and novel materials, such as CFRP, are swiftly adopted.

Carbon Fibre Reinforced Plastic (CFRP)

Strength, lightness and design flexibility are just some of the advantages of CFRP over traditional bicycle materials. Impact absorption is another known advantage that is of great importance for cycling components as most of them are subject to high loads which generally occur suddenly, for instance when hitting pot holes. Owing to all these advantageous properties, CFRP is being used in ever more bicycle parts, be it the frame or brake levers. CFRP is composed of two main components, carbon fibres and a resin forming a matrix.

1. Carbon fibres

Carbon fibres start their journey as a polymer. The polymer undergoes various heating steps to process it into long strands or filaments, which are then bundled together to form tows. The number of filaments has an effect on the stiffness and weight of the end product. Typical values vary from 1 000 filaments per tow (1K) to 48 000 filaments per tow (48K). In cycling, the number of filaments per tow generally used is in the range of 4K to 15K, preferably 7K to 9K for lower stiffness components and preferably 12K to 15K for frames. Furthermore, actual strength and stiffness of the individual fibres or tows vary, too, with the stiffness being described in tensile elastic modulus in GPa. A higher modulus of the fibre is achieved by making the filaments smoother and thinner. These thinner filaments also sit more tightly together in a tow, and so increase the stiffness of the tow overall. However, because the filaments are thinner, a higher modulus is also associated with an increase in brittleness. It is generally assumed that, for cycling, tows having a tensile elastic modulus between 200 GPa and 800 GPa, and preferably in the range of 350 GPa to 500 GPa, offer a good compromise between stiffness and flexibility.

2. Resin

The carbon fibres must be bonded with a resin to turn the material into a carbon fibre reinforced plastic (CFRP). Whereas carbon fibres are extremely strong and light, resins are comparatively weak and heavy. The design process is therefore chosen with a view to using as little resin as possible to hold the carbon fibres in place. Typical resins on the market include in particular epoxy, which is by far the most used resin in CFRP, and thermoplastic. In cycling technology, regular epoxy resins are generally used. However, the very interesting properties of carbon nanotube-reinforced epoxy resins make them the most preferable and they are frequently chosen because they further increase fracture toughness of the composite.

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Pedalling improving system

[0001] The present invention relates to a pedalling improving system for bicycles with chainrings, sprockets and a roller chain. The present invention is concerned with the application of modified oval chainrings, power meters and cycling computers to improve the pedalling efficiency of the cyclist.

[0002] Pedalling efficiency can be increased by reducing or completely eliminating structural dead spots, by using non-circular, oval chainrings.

[0003] The reason oval chainrings have not been successful in the past is that no two cyclists pedal in the same way and therefore the orientation factor of the oval chainring, meaning the angle between the centreline of the cranks and the major diameter of the oval, varies from cyclist to cyclist.

[0004] It is therefore an object of the present invention to provide a bicycle with an oval chainring allowing a fine orientation adjustment for every cyclist.

[0005] It is a further object of the present invention to provide a system for determination of the optimal orientation comprising the above-mentioned oval chainring and further comprising a bicycle computer configured to display orientation optimisation instructions. A bicycle comprising this system and with corresponding sprockets for the rear wheel, crank spiders, crank arms with integrated power sensors, a roller chain connecting the chainring and the sprockets, and clipless pedals is thus able to calculate the perfect orientation of the oval chainring for each cyclist.

[0006] By additionally providing crank spiders, crank arms with integrated power meters, clipless pedals and a bicycle computer, an integral pedalling improving system is hereby disclosed.

[0007] All the components of the present pedalling improving system are made of lightweight metal as saving weight is a constant concern in cycling.

[0008] The Fig. shows an oval chainring 701, a crank spider 702 and a crank arm 703. The ovel chainring 701 is attached to the crank arm 703 by the crank spider 702, which is removable and thus allows for the adjustment of the chainring orientation.

[0009] The crank arms 703 are provided with integrated sensors for power and cadence (not shown in the figure), in the form of strain gauges for power measurement and an accelerometer for cadence measurement. These sensors measure total power output, left-right power balance and cadence. They communicate with the bicycle computer (not shown in the figures) using the BOT protocol technology.

[0010] The present system is able to determine the optimum orientation of the oval chainring in the following manner. In an initial setup, the chainring 701 is attached to the crank spider 702 and crank arms 703 of the bicycle, assuming the maximum power output is expected at 110°. Additionally, the orientation factor can be adjusted around this initial orientation by providing adjustment holes 704 at +5°, +10°, -5°, -10° around this initial orientation (see Fig.). In order to help the cyclist adjust the orientation of the chainring, attachment marks are provided at 5° intervals. After the initial installation, the bicycle computer will require the cyclist to connect the bicycle computer to the crank arm power and cadence sensors. The bicycle computer instructs the cyclist to ride the bicycle at a certain speed and cadence for several minutes. Based on this first ride, an average power profile along the stroke is determined. Next, the bicycle computer instructs the cyclist to change the orientation of the chainring from the top structural dead spot and a new ride is performed in order to establish an average power profile along the stroke for this second orientation. This process is repeated for all the adjustment holes. The power profiles at these five orientations are compared and the orientation with the highest average power output is chosen as the final optimal orientation.

[0011] The cyclist is assisted by the bicycle computer throughout the whole process of carrying out the above-mentioned steps. The bicycle computer will display instructions to the cyclist in order to determine the optimal orientation of the oval chainring 701. Once this position has been finally established, the bicycle computer further operates as a normal bicycle computer. The bicycle computer is compatible with all sensors using the BOT protocol and is able to show, depending on which sensors are connected to it, speed, cadence, average power, left-right power balance, maximum power, heart rate, etc.

Claims:

1. A chainring (701) for bicycles having an elliptical form, the chainring (701) further comprising a plurality of adjustment holes (704), the adjustment holes being placed at 110°, 115°, 120°, 105° and 100° with respect to the major axis of the ellipse in an anti-clockwise direction.
2. An orientation determination system comprising the chainring (701) according to claim 1 and further comprising a bicycle computer which is configured to display orientation optimisation instructions.

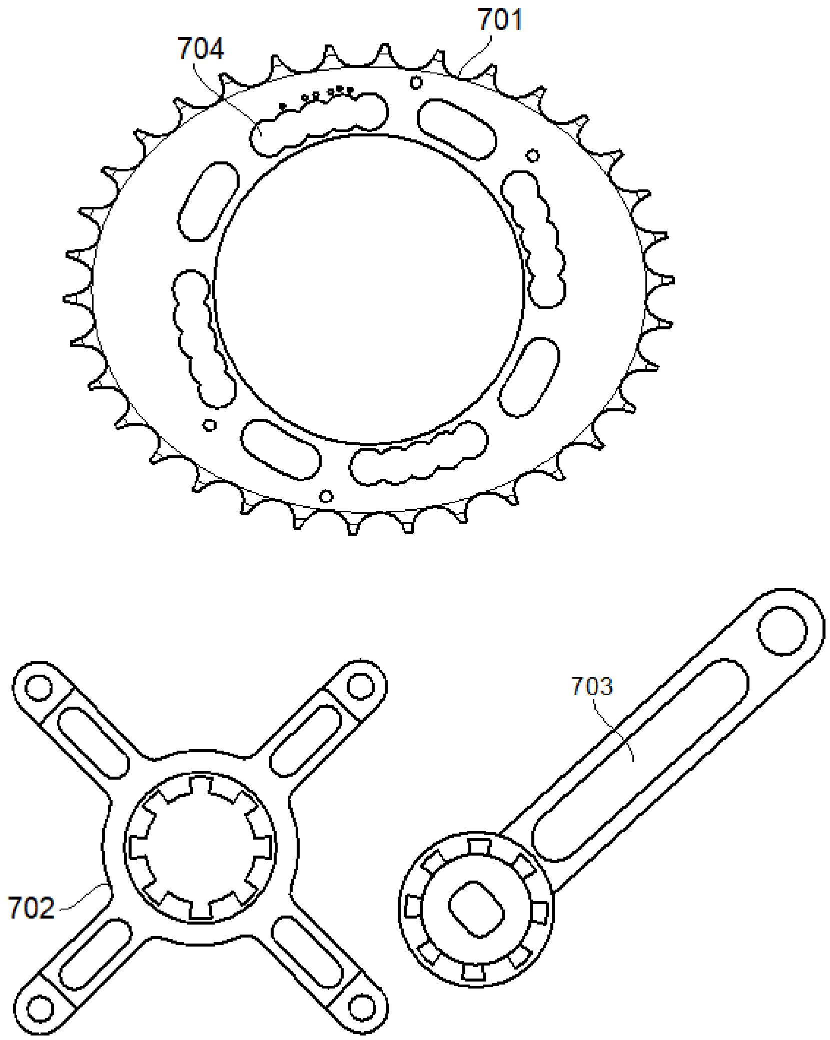

Fig.