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(54) BICYCLE WIRELESS ELECTRONIC DERAILLEUR

(57) A bicycle wireless electronic derailleur (200, 300), comprising a support body (202, 302), a movable body (204, 304), comprising a chain guide (204, 306), actuation means (208, 308) configured to move the movable body (204, 304) with respect to the support body (202, 302), comprising an electric motor (210, 310), a controller (240) of the electric motor (210, 310), a wireless communication device (242), part of or in communication with the controller (240), configured to receive gearshifting request signals from a wireless transmitter (252) and housed in a first casing (202, 208, 302, 413, 513), and a bicycle movement detector (10) configured to emit a wake signal (244) for the wireless communication device (242). The movement detector (10) is at least partially housed in at least one second casing (22, 22A) different from the first casing (202, 208, 302), and is in communication through at least one cable (320, 320A) with the wireless communication device (242).

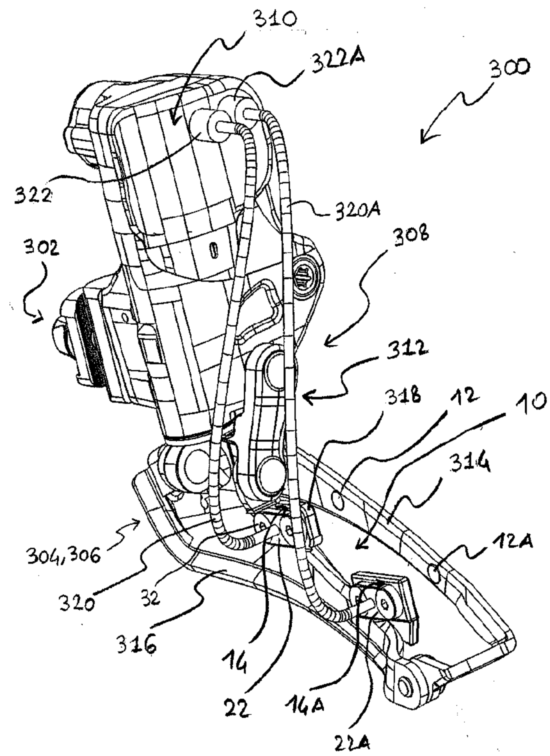

FIG. 10

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Description

[0001] The present invention relates to a bicycle wireless electronic derailleur.

[0002] With reference to FIG. 1, a motion transmission system in a bicycle 1000 comprises a chain 100 extending between toothed wheels 1002, 1004 associated with the axle of the pedal cranks 1006 and with the hub 1008 of the rear wheel 1010. When - as in the case shown - at at least one of the axle of the pedal cranks 1006 and the hub 1008 of the rear wheel 1010 there is an assembly of toothed wheels 1002, 1004 comprising more than one toothed wheel 1002, 1004, and the motion transmission system is therefore provided with a gearshift 1012, a front derailleur 1014 and/or a rear derailleur 1016 are provided for.

[0003] Hereinbelow in the present description and in the attached claims, the toothed wheels 1002 associated with the axle of the pedal cranks 1006 are also called chainrings, and the toothed wheels 1004 associated with the hub 1008 of the rear wheel 1010 are also called sprockets.

[0004] In case of an electronic gearshift, each derailleur 1014, 1016 comprises a guide element 1018, 1020, - also known as chain guide or, in case of a rear derailleur, rocker arm - movable to displace the chain 100 among the toothed wheels 1002, 1004 in order to change the gear ratio, and an electromechanical actuator to move the chain guide 1018, 1020.

[0005] Each electromechanical actuator in turn typically comprises a motor, typically a suitably powered electric motor, coupled with the chain guide 1018, 1020 through a linkage such as an articulated parallelogram, a rack system or a worm screw system. However, in principle the chain guide 1018, 1020 could also be directly connected to the electric motor.

[0006] Typically, the electric motor is provided with a gear reduction mechanism. The assembly of electric motor and gear reduction mechanism is referred to hereinafter as geared motor. The actuator typically further comprises a sensor or transducer of the position, speed, acceleration and/or direction of rotation, of the rotor of the motor or of any movable part downstream of the rotor, down to the chain guide 1018, 1020 itself. It is worthwhile emphasizing that slightly different terminology from that used in this context is also in use.

[0007] Control electronics changes the gear ratio automatically, for example based on one or more detected variables such as the travel speed, the cadence of rotation of the pedal cranks, the torque applied to the pedal cranks, the slope of the travel terrain, the heart rate of the cyclist and similar, and/or the gear ratio is changed based on commands manually input by the cyclist through suitable control members, for example levers and/or buttons, typically provided on one or two manual control devices 1022 mounted on the handlebars 1024 of the bicycle 1000.

[0008] Typically, the derailleur 1014, 1016 includes a support body 1026, 1028 that is configured to be attached to the frame of the bicycle 1000, and the chain guide 1018, 1020 connected to the support body 1026, 1028 by means of two connecting rods or arms, the ends of which are pivoted to the support body 1026, 1028 and to the chain guide 1018, 1020 to form the aforementioned articulated parallelogram.

[0009] The geared motor drives the articulated parallelogram open and closed and as a consequence the displacement of the chain guide 1018, 1020 among the toothed wheels 1002, 1004.

[0010] As an alternative or in addition to an electronic gearshift, modern bicycles are often provided with electric, electronic and electromechanical apparatuses, including suspensions, lighting systems, sensors of the travel speed, of the cadence of rotation of the pedal cranks, of the torque applied to the pedal cranks, of the slope of the travel terrain, of the heart rate of the cyclist and similar, satellite navigation systems, training devices, anti-theft systems, cycle computers capable of providing information about the status of the bicycle, of the cyclist and/or of the route, etc.

[0011] All of the aforementioned electric, electronic and electromechanical apparatuses consume electrical energy, supplied by one or more battery power supply units, possibly rechargeable. Although it is possible to exploit, for recharge, the movement of the bicycle itself through a dynamo, it is nevertheless important to save as much energy as possible. The aforementioned apparatuses are therefore in general provided not only with a proper on/off switch, but also with a standby mode.

[0012] Under wait or standby or sleep or low consumption mode, a condition in which an electric, electronic or electromechanical device is not operating, but is ready to switch from a temporary inactivity state to an operating mode is meant to be indicated; in standby mode, only those circuits that allow the device to start upon receiving commands that involve the actuation thereof are typically kept operating, thus there is a low consumption of electrical energy.

[0013] Vice-versa, in an operating mode, an electric, electronic or electromechanical device is ready to receive commands or in general inputs and to carry out tasks, even though it can be engaged only in waiting for commands and inputs, without carrying out any specific task.

[0014] The switching from a standby mode to an operating mode is indicated herein as wake of a device. More in general, under wake of a device it is meant to encompass maintaining a device in an operating mode, preventing it from entering a standby mode. A same signal or a similar signal can be used in both cases.

[0015] For bicycle apparatuses that can be reached by the cyclist, such as for example the manual control devices associated with the handgrips of the handlebars or cycle computers fixed to the handlebars or in the front part of the frame, the wake signal is easily associated with the pressing of a button or with the actuation of a lever by the cyclist.

[0016] For apparatuses arranged in parts of the bicycle remote from the hands of the cyclist, such as for example the derailleurs, brakes and suspensions, the wake signal can be a signal, specific or not, received from another on-board apparatus, for example one of the just mentioned ones. Thus, for example, the actuation of an upward gearshifting request lever by the cyclist can be used to generate a wake signal of the electronics of the manual control device of which the lever is part and/or of an electronic derailleur to which the signal is intended and is transmitted.

[0017] However, in case of apparatuses connected in a wireless network, there exists the problem that at least the wireless communication device of an apparatus must be in operating mode in order to be able to receive a signal from another apparatus. Therefore, it is not possible to exploit a remote signal as a wake signal.

[0018] In such an operating mode, the wireless communication device has a high consumption of electrical energy, and therefore it is desirable that such a mode is limited to when the bicycle is in use.

[0019] In particular, the wireless electronic derailleurs are provided with a wireless - for example radio or infrared - communication device that receives the gearshifting request signals from the manual control devices fixed to the handgrips of the handlebars and/or from a control unit that receives them from such manual control devices or that processes them automatically.

[0020] When the bicycle is in use, the wireless communication devices of the electronic derailleurs must therefore be always in operating mode in order to be ready to receive such gearshifting request signals at any moment. Only when the bicycle is stopped for a prolonged period, the wireless communication devices of the electronic derailleurs can enter standby mode.

[0021] It is therefore necessary for the wireless electronic derailleur to be itself equipped with a detector of the movement of the bicycle, so that the signal emitted therefrom can be used as a wake signal.

[0022] In order to distinguish a prolonged stop, for example in a parking slot or a garage, from a temporary stop, for example at a traffic light, it is possible to use a timer and/or to use the same signal emitted by the movement detector to prevent the standby mode to be entered, namely as an anti-sleep signal.

[0023] It should be understood that the other devices of the wireless electronic derailleurs, for example the controllers of the motors, can instead enter standby mode also during the use of the bicycle and be woken by a wake signal generated by the wireless communication devices when they receive the gearshifting request signals.

[0024] US2001/048211 A1 discloses a bicycle gearshift comprising a sensor of the rotation of a crank arm or of a pulley of a rear derailleur, said rotation being interpreted as a movement of the motion transmission chain from the crank arms to the rear wheel. In the case of the crank arm, the sensor is of a potentiometric type. In the case of the rear derailleur, the sensor comprises a C-shaped magnetic element fixed to the pulley and at least one Hall-effect sensor or a Reed relay mounted on a half-cage supporting the pulleys of the chain-tensioner of the rear derailleur.

[0025] US 8,909,424 B2, on which the preamble of claim 1 is based, discloses a bicycle wireless electronic derailleur, comprising a control unit which includes a wireless receiver that receives shift request signals from a wireless transmitter, wherein the control unit includes a CPU and a wake sensor operatively associated to the CPU. The derailleur includes a base part attachable to the bicycle, a movable part, a chain guide attached to the movable part and a linkage that interconnects the base part to the movable part to enable the movable part to move relative to the base part by means of a motor; the control unit with the wake sensor is housed within the movable part. The wake sensor is of a vibrational type, but the document generically discloses that magnetic reed switches configured to detect magnets attached to moving elements of the bicycle might be used.

[0026] The problem at the basis of the present invention is to implement improved wireless electric derailleur.

[0027] In an aspect the invention relates to a bicycle wireless electronic derailleur, comprising:

- a support body, configured to be mounted on a bicycle frame at an assembly of coaxial toothed wheels of the bicycle,
- a movable body, comprising a chain guide,
- actuation means configured to move the movable body with respect to the support body, comprising an electric motor,
- a controller of the electric motor,
- a wireless communication device, part of or in communication with the controller, configured to receive gearshifting request signals from a wireless transmitter, the wireless communication device being housed in a first casing,
- a bicycle movement detector configured to emit a wake signal for the wireless communication device,

characterized in that the movement detector is at least partially housed in at least one second casing different from the first casing, and is in communication through at least one cable with the wireless communication device.

[0028] In this manner, any intervention of check-up, adjustment and replacement of the movement detector can take place without having to break the integrity and the watertight seal of the casing housing the wireless communication device and possible other - electronic and not - components of the derailleur.

[0029] The wireless transmitter is external to the derailleur, in particular it is part of a manual control device that generates the gearshifting request signals or of a control unit that receives the gearshifting request signals from one or more manual control devices or that processes them automatically.

[0030] The at least one communication cable is preferably an electric cable, but it can also be a fiber optic cable.

[0031] Preferably, the communication through at least one cable between the wireless communication device and the movement detector is provided with at least one pair of matching removable connectors.

[0032] In this manner, the movement detector can be easily replaced without any kind of intervention on the wireless communication device or other electronic components of the derailleur.

[0033] Preferably, the movement detector comprises at least one magnet that generates a magnetic field and at least one magnetic field sensor, the magnetic field detected by the sensor being different depending on whether the bicycle is moving or stationary.

[0034] Preferably, both the magnet and the sensor are attached to the chain guide, at least the sensor being housed in the at least one second casing and being in communication through the at least one cable with the wireless communication device.

[0035] Preferably, the sensor is fixed to a first plate of the chain guide.

[0036] More preferably, when the derailleur is a front derailleur, the sensor is fixed to an inner plate of the chain guide.

[0037] In the present description and in the attached claims, under "inner", the side closest to the bicycle frame in the mounted condition of the derailleur is meant to be indicated, while under "outer", the side furthest from the bicycle frame in the mounted condition of the derailleur is meant to be indicated.

[0038] Vice-versa, when the derailleur is a rear derailleur, the sensor is preferably fixed to an outer plate of the chain guide.

[0039] Preferably, the sensor is fixed at a respective recessed seat or at a notch in the first plate of the chain guide.

[0040] Preferably, the magnet is fixed to a second plate of the chain guide, wherein the mutual position of the magnet and of the sensor is fixed, and the sensor is immersed in the magnetic field generated by the magnet, and wherein a length of a closed loop path intended for a motion transmission chain of the bicycle, at least at a predetermined gear ratio, is immersed in the magnetic field generated by the magnet, so that, if in said path length there is at least one actual chain portion, the sensor detects the magnetic field perturbed by said actual chain portion.

[0041] The motion transmission chain of a bicycle is typically made of a paramagnetic or ferromagnetic material, and its segments or portions following one another while the chain is moving perturb the magnetic field generated by the magnet, changing the field lines thereof, in a variable manner.

[0042] In this manner a direct check of the actual motion of the motion transmission chain - in turn indicative of the movement of the bicycle - is advantageously carried out, instead of inferring it from the movement of the members engaged therewith.

[0043] Preferably, the path length has a length different from the length of a chain link or of a multiple thereof.

[0044] In the present description and in the attached claims, under "chain link", the configuration of minimum length that is repeated in a transmission chain is meant to be indicated.

[0045] More preferably, the path length has a shorter length than the length of a chain link.

[0046] In such cases, in the path length there is, at each time, a chain portion corresponding to only one chain link segment, or to one or more entire links plus a link segment, respectively. Given that the chain links do not have a uniform mass distribution and therefore do not have a uniform magnetic permeance, if the chain moves in its intended closed loop path, the detected magnetic field is variable over time, while if the chain is stationary - or even absent, the detected magnetic field is constant. Vice-versa, if the path length were the same length as the length of a chain link or a multiple thereof, the chain portion actually in such a path length would always be the same as a whole, although with its subportions displaced, and the detected magnetic field would be nearly constant, making it more difficult to detect the movement of the chain.

[0047] More preferably, the path length is of a length comparable to the length of a joint element of a chain link.

[0048] In a particularly preferred manner, the path length passes through a space between the magnet and the sensor. Such a configuration is preferable because it maximizes the perturbation of the magnetic field generated by the magnet by the chain.

[0049] Preferably, the magnet and the sensor are aligned along a direction perpendicular to the tangent to said path length. In this manner, since the chain links and their segments detected at each time follow one another along such a tangent, the detection capability is optimal.

[0050] More preferably, the magnet and the sensor are aligned along a direction parallel to the rotation axes of the toothed members engaged by the chain. In this manner, the chain is left free to vibrate and/or to change the shape of the closed loop path.

[0051] Preferably, the magnet is fixed at a respective recessed seat or at a notch in the second plate of the chain guide.

[0052] Preferably, the magnet and the sensor are fixed at corresponding positions of opposite plates of the chain guide.

[0053] In embodiments, the derailleur is a rear derailleur and the chain guide comprises two pulley-carrying plates.

[0054] In this case, preferably the magnet and the sensor are fixed to said pulley-carrying plates at corresponding positions.

[0055] Preferably, the magnet and the sensor are fixed to the pulley-carrying plates at the toothing of a pulley, more preferably of the upper pulley of the chain tensioner.

[0056] In embodiments, the derailleur is a front derailleur.

[0057] In embodiments, the magnet and the sensor are so sized that at least one second length of a second closed loop path intended for the motion transmission chain of the bicycle, at a second predetermined gear ratio, is also immersed in the generated magnetic field.

[0058] In this manner, a same magnet/sensor pair can detect the movement of the chain also as the gear ratio changes, and therefore as the specific closed loop configuration that the chain takes up changes.

[0059] Alternatively, different magnet/sensor combinations for the various gear ratios can be provided for.

[0060] Preferably, therefore, the detector comprises a magnet/sensor combination for each chainring of the gearshift.

[0061] In this way it is possible to monitor a length of the specific closed loop path that the chain forms for each chainring engaged by the chain with a specific magnet/sensor combination. Such a path indeed changes quite remarkably as the engaged chainring changes. The engaged chainring being equal, the closed loop path of the chain changes depending on the engaged sprocket, however the change in the path length at the front derailleur is negligible.

[0062] Thus, in embodiments, the detector comprises at least one second magnet that generates a second generated magnetic field, and at least one second magnetic field sensor, wherein the mutual position of the second magnet and of the second sensor is fixed and the second sensor is immersed in the second generated magnetic field, wherein a second length of a second closed loop path followed by the motion transmission chain of the bicycle, at a second predetermined gear ratio, is immersed in the second generated magnetic field, so that, if in said second path length there is at least one actual chain portion, the second sensor detects the second magnetic field perturbed by said actual chain portion.

[0063] As an alternative or in addition, the detector comprises at least one second magnet that generates a second generated magnetic field, the mutual position of the second magnet and of said sensor is fixed, and the sensor is also immersed in the second generated magnetic field, wherein a second length of a second closed loop path followed by the motion transmission chain of the bicycle, at a second predetermined gear ratio, is immersed in the second generated magnetic field, so that, if in said second path length there is at least one actual chain portion, the sensor detects the second magnetic field perturbed by said actual chain portion.

[0064] As an alternative or in addition, the detector can possibly additionally comprise at least one second magnetic field sensor, wherein the mutual position of the magnet and of the second sensor is fixed, the second sensor is immersed in the generated magnetic field, wherein a second length of a second closed loop path followed by the chain, at a second predetermined gear ratio, is immersed in the generated magnetic field so that, if in said second path length there is at least one actual chain portion, the second sensor detects the magnetic field perturbed by said actual chain portion.

[0065] In other embodiments, when the derailleur is a rear derailleur and the chain guide comprises two pulley-carrying plates and two pulleys pivotally supported between the pulley-carrying plates, the magnet is fixed to a first pulley of the chain guide, and the sensor is fixed to a pulley-carrying plate in such a position as to be periodically immersed in the magnetic field generated by the magnet during the rotation of the first pulley.

[0066] In this manner, the sensor detects the magnet when the latter enters its detection field, and thus the movement of the motion transmission chain - in turn indicative of the movement of the bicycle - is monitored through the movement of the pulley.

[0067] The first casing can be part of or fixed to the support body.

[0068] Alternatively, the actuation means comprise an articulated parallelogram linkage, and the first casing is part of or is fixed to a connecting rod of the linkage.

[0069] Preferably, the first casing further houses the electric motor.

[0070] In other embodiments, the movement detector could comprise another kind of sensor for detecting the movement of the bicycle chain. For example, it could be an optical sensor such as a photoelectric cell, the light beam of which is blocked by the passage of the joints of the chain, but not by the passage of the inner and outer small plates of the chain links; or wherein a light beam generated by a source adjacent to the optical sensor is reflected by a small mirror fixed to a pulley of the rear derailleur only when the small mirror passes in front thereof.

[0071] More in general, it could be a movement detector not based on the detection of the movement of the chain, for example a clinometer, a gyroscope, a vibration sensor, etc.

[0072] The movement detector need not necessarily be fixed to the chain guide of the movable body of the derailleur, rather can be fixed to other parts of the derailleur, or be fixed to the bicycle frame.

[0073] In another aspect the invention relates to a wireless electronic derailleur of a bicycle gearshift, comprising:

- a support body, configured to be mounted on a bicycle frame at an assembly of coaxial toothed wheels of the gearshift,
- a movable body, comprising a chain guide,
- actuation means configured to move the movable

body with respect to the support body, comprising an electric motor,

- a controller of the electric motor,

- a wireless communication device, part of or in communication with the controller, configured to receive gearshifting request signals from a wireless transmitter, the wireless communication device being housed in a first casing,

- a bicycle movement detector configured to emit a wake signal for the wireless communication device, wherein the movement detector comprises at least one magnet that generates a magnetic field and at least one magnetic field sensor, the magnetic field detected by the sensor being different depending on whether the bicycle is moving or is stationary,

characterized in that both the magnet and the sensor are attached to the chain guide, the sensor being housed in a second casing different from the first casing and being in communication through at least one cable with the wireless communication device.

[0074] Further features and advantages of the present invention will become clearer from the following detailed description of some preferred embodiments thereof, made with reference to the attached drawings. The different features illustrated and described with reference to the individual configurations can be combined as desired. In the following description, for the illustration of the figures, identical or similar reference numerals are used to indicate constructive or functional elements with the same function of analogous function. In the drawings:

- FIG. 1, already described in detail, is a side view of a bicycle provided with a gearshift according to the prior art,

- FIG. 2 is a schematic representation of a detector used in some embodiments of the invention, and of its geometric relationship with the motion transmission chain of the bicycle,

- FIG. 3 is a perspective view of the detector and of a chain portion,

- FIG. 4 is a partial cross-sectional view across the detector and the chain portion of FIG. 3,

- FIGs. 5, 6 and 7, 8 are views corresponding to FIGs. 4 and 5 in two different positioning conditions of the chain,

- FIG. 9 illustrates the main components of a wireless electronic derailleur,

- FIG. 10 is a perspective view of a front derailleur according to an embodiment of the invention,

- FIGs. 11 and 12 are perspective views of a rear derailleur according to an embodiment of the invention,

- FIGs. 13 and 14 are partial cross-sectional views across the derailleur of FIGs. 11 and 12, corresponding to different positioning conditions of the chain,

- FIGs. 15 and 16 are perspective views of a rear derailleur according to another embodiment of the invention, and

- FIGs. 17 and 18 are partial cross-sectional views across the derailleur of FIGs. 15 and 16, corresponding to different positioning conditions of the chain.

[0075] First, a movement - as well as presence/absence - detector 10 of a motion transmission chain 100, used in some embodiments of the invention, is described, which detector is shown in an entirely schematic manner in FIG. 2.

[0076] The detector 10 comprises a magnet 12 and a magnetic field sensor 14. The magnet 12 generates a magnetic field, indicated herein as generated magnetic field. The magnet 12 can be a permanent magnet or an electromagnet.

[0077] The magnet 12 and the sensor 14 are arranged in a fixed mutual position. The sensor 14 is immersed in the magnetic field generated by the magnet 12.

[0078] The magnet 12 and the sensor 14 are arranged sufficiently close to a position where the chain 100 must pass, when it engages with a predetermined chainring 1002 and sprocket 1004. In greater detail, the motion transmission chain 100 of the bicycle 1000, at a predetermined gear ratio, is wound in a closed loop - as can be seen in FIG. 1, already described in the introductory part of the present description. The path that the chain 100 is intended to follow is shown schematically in FIG. 2 and indicated therein with reference numeral 130.

[0079] A length 140 of the closed loop path intended for or followed by the chain 100, at least at a predetermined gear ratio, is immersed in the magnetic field generated by the magnet 12.

[0080] If the chain 100 were absent, in said path length 140 there would no longer be any chain portion, and the sensor 14 would detect the magnetic field generated by the magnet 12, not perturbed. The output of the sensor 14 would therefore have a first constant value.

[0081] Vice-versa, when the chain extends between the predetermined chainring 1002 and sprocket 1004, in said path length 140 there is actually a chain portion indicated with 150, 152, 154 in FIGs. 3-8, respectively. It should be noted that only a portion 110 of the chain 100, although longer than the chain portion 150, 152, 154, is shown in FIGs. 3-8, in different positions.

[0082] Given that the chain 100 is typically made of a paramagnetic material - typically steel - or, less frequently, of a ferromagnetic material, the chain portion 150, 152, 154 actually arranged in the path length 140 perturbs the magnetic field generated by the magnet 12, changing the field lines thereof.

[0083] The sensor 14 therefore detects the magnetic field perturbed by the chain portion 150, 152, 154, of average intensity different from that of the generated magnetic field, not perturbed. The output of the sensor 14 therefore has a value different from the first constant value.

[0084] The amount of the perturbation of the magnetic field depends on which chain portion is actually in the path length 140 at a given moment, in particular on the magnetic permeance of the chain portion. By construction, the mass distribution and therefore the magnetic permeance is not uniform along the chain 100. Under "mass distribution", in the present description and in the attached claims, the way in which the material forming the chain portion changes and/or is arranged in space is meant to be indicated.

[0085] More in particular, the field lines of the magnetic field generated by the magnet 12 find a favored path in the paramagnetic or ferromagnetic material, having high magnetic permeance, and therefore the distribution of the field lines depends on the mass distribution of paramagnetic or ferromagnetic material in the space detected by the sensor 14; on the average, the sensor 14 however detects how much mass of paramagnetic or ferromagnetic material is present.

[0086] As an example, each of the links 160 of the chain 100 shown in FIGs. 3-8, wherein a link is understood as a configuration of minimum length that is repeated in the chain 100, comprises:

- a pair of metallic outer small plates 162, 164 or outer links, parallel and spaced apart by a first distance,
- a pair of metallic inner small plates 166, 168 or inner links, parallel and spaced apart by a second distance shorter than the first distance,
- an intra-link joint element 170, which connects first ends of the outer small plates 162, 164 and first ends of the inner small plates 166, 168,
- an inter-link joint element 172, which connects second ends of the outer small plates 162, 164 with second ends of inner small plates 166', 168' of an adjacent link or, vice-versa, which connects second ends of the inner small plates 166, 168 with second ends of outer small plates 162', 164' of an adjacent link.

[0087] The joint elements 170, 172 are typically equal to each other. Also for this reason, according to a different terminology each of the pairs of small plates - outer 162, 164 or inner 166, 168, respectively - could alone be called chain link.

[0088] Each joint element can comprise, for example, a bush formed by two collars 174, 176 extending towards one another about holes 178, 180 of the two inner small plates 166, 168, a rivet 182 extending in the bush and having riveted ends, and a possible rotatable roller 184 extending outside of the bush formed by the collars 174, 176 and having the function of reducing the friction with the teeth of the toothed members 1002, 1004 with which the chain 100 engages in the motion transmission system, teeth that consecutively insert in the space between the paired inner small plates 166, 168 and in the space between the paired outer small plates 162, 164.

[0089] The rivet 182 can be replaced by a pin as one piece with one of the outer small plates 162, 164 and having only one riveted end, and/or other configurations of the chain 100 can be provided.

[0090] As stated above, the intensity of the perturbed magnetic field, detected by the magnetic field sensor 14, depends on the distribution of mass and of magnetic permeance of the chain portion 100 actually present, at a given moment, in the path length 140. In particular, in the case of the chain 100 described above:

- when the chain portion 150 actually in the path length 140 is at a joint element 170, 172, as shown in FIGs. 3 and 4, the intensity of the perturbed magnetic field, detected by the sensor 14, is maximum and the output signal of the sensor 14 has a peak (or vice-versa a valley);
- when the chain portion 152 actually in the path length 140 is at the central region of a pair of metallic inner small plates 166, 168, as shown in FIGs. 5 and 6, the intensity of the perturbed magnetic field, detected by the sensor 14, is minimum and the output signal of the sensor 14 has a valley (or vice-versa a peak);
- when the chain portion 154 actually in the path length 140 is at the central region of a pair of metallic outer small plates 162, 164, as shown in FIGs. 7 and 8, the intensity of the perturbed magnetic field, detected by the sensor 14, has a value comparable to, although slightly greater than, the minimum, and the output signal of the sensor 14 again has a valley (or vice-versa a peak).

[0091] When the cyclist pedals, the chain 100 moves along the intended closed loop path 130: at the path length 140 there are, at subsequent moments, different chain portions corresponding, as far as the mass distribution and the magnetic permeance are concerned, to the portions 150, 152, 150, 154, the sequence endlessly repeating itself (neglecting the "false link" for closing the chain, slightly different from standard links).

[0092] The perturbed magnetic field detected by the sensor 14 is therefore variable over time. In particular, the perturbed magnetic field detected by the sensor 14 has a pattern that is substantially periodic and roughly oscillating between the aforementioned maximum value at the joint elements 170, 172 and the aforementioned minimum value at the central region of a pair of small plates 166, 168 or 162, 164, respectively (neglecting their different distribution of mass and magnetic permeance).

[0093] If, on the other hand, the chain 100 is stationary, the magnetic field detected by the sensor 14 is constant.

[0094] Therefore, the detector 10 can be advantageously used as a detector of the movement of the chain 100. Since it carries out a direct check of the actual movement of the motion transmission chain 100, instead of inferring it from the movement of the toothed members engaged therewith, such a movement detector 10 is extremely accurate.

[0095] Electronics of the detector 10 or associated therewith is configured to determine that the chain 100 is moving when the output signal of the sensor 14 is variable over time, and to determine that the chain 100 is stationary when the output signal of the sensor 14 has a second constant value different from the first constant value indicative of the absence of chain.

[0096] In the above it has been assumed that the path length 140 is of a length quite shorter than the length of a chain link 160, namely that the path length 140 or the sensor 14, respectively, is suitably sized based on the distribution of mass and magnetic permeance in a chain link 160.

[0097] However, this is not strictly necessary. If in the path length 140 there is, at each time, a chain portion that is longer than those described above, although shorter than a chain link 160, or a chain portion that is as long as one or more entire links plus a link segment, then the mass distribution - and the magnetic permeance - in the path length 140 is still variable over time when the chain 100 is moving, although with variations that are less easily distinguishable.

[0098] If the path length 140 were the same length as the length of a chain link 160 or of a multiple thereof, the mass distribution - and the magnetic permeance - in the path length 140 at each moment would always be equivalent, although displaced if the chain 100 is moving, and the magnetic field detected by the sensor 14 would be nearly constant, making it more difficult to detect the movement of the chain 100. In this case, the detector 10 could in any case be used, outside of the scope of the claimed invention, as a presence detector of the chain 10.

[0099] As discussed in the introductory part of the present description, the indication of the actual movement of the chain 100 provided by the detector 10 can be advantageously exploited to provide a wake signal. For this specific purpose, the detector 10 can in particular be used in a wireless electronic derailleur, as will be described hereinafter.

[0100] The indication of the actual movement of the chain 100 provided by the detector 10 can be advantageously exploited also, for example, to prevent an attempt to change gear ratio when the detector 10 detects that the chain 100 is absent or stationary, in order to protect the motion transmission system, as well as for any other purpose.

[0101] From what has been described above it can easily be understood that the variability of the perturbed magnetic field detected by the sensor 14 can also be exploited to estimate a speed of the movement of the chain 100 from a repetition period of the output signal of the sensor 14, or an approximation thereof, during an observation time window. Indeed, the higher is the speed of the movement of the chain 100, the higher will be the frequency of appearance of the aforementioned maximum values at the joint elements 170, 172, and of the aforementioned minimum or almost minimum values at the small plates 162-168 will be.

[0102] The aforementioned electronics can therefore be configured to calculate or estimate the speed of the movement of the chain 100. By operating directly on the chain 100, instead of inferring the speed thereof from the rotation speed of a toothed member engaged therewith, for example a pulley of the rear derailleur 1016, the movement detector 10 proves to be advantageously very accurate.

[0103] In a practical embodiment, the magnetic field sensor 14 can comprise, for example, a Hall effect sensor or a Reed relay. Magnetic field sensors of the aforementioned kind are well known.

[0104] The output of the sensor 14 can be a two-levels one depending on whether the magnetic field in which it is immersed is below or above a predetermined threshold, or the output of the sensor can be an analogue signal. The detector 10 can moreover possibly comprise preprocessing electronics of the output signal of such a sensor 14, for example for amplification, filtering and/or approximation, quantization, binarization, digitalization, inversion, etcetera.

[0105] Observing a characteristic configuration of the output signal of the sensor 14, such as for example a peak or a valley, for example a peak representative of the passage of the chain portion 150, the electronics can also estimate a stroke of the chain. The stroke is indeed a function of the position of such a characteristic configuration in a length of the output signal of the sensor 14 and/or a function of a displacement of the characteristic configuration during an observation time window of the output signal of the sensor 14.

[0106] Again with reference to FIG. 2, advantageously the path length 140 passes through a space between the magnet 12 and the sensor 14, so as to pass in between them as shown. Such a configuration maximizes the perturbation of the generated magnetic field by the chain portion 150, 152, 154 actually present in the space.

[0107] Preferably, the magnet 12 and the sensor 14 are aligned along a direction perpendicular to the tangent *t* to the path length 140. In this way, since the chain links 160 and their segments or portions 150, 152, 154 detected, at each time, follow one another along such a tangent t, the detection capability is optimal.

[0108] More preferably, the magnet 12 and the sensor 14 are aligned along a direction n parallel to the rotation axes of the toothed members engaged by the chain 100, such as the chainrings 1002, the sprockets 1004 and the pulleys of the rocker arm 1020 of the rear derailleur 1016. In this way, the chain 100 is left free to vibrate and/or to change the shape of the closed loop path 130.

[0109] Because as the gear ratio, namely the chainring 1002 - sprocket 1004 pair, changes, the chain 100 takes up a different closed loop configuration and thus has a different intended path, it is possible to size the magnet 12 and the sensor 14 in such a way that at least one second length 140A of a second closed loop path 130A followed by the chain 100, at a second predetermined gear ratio, is also immersed in the magnetic field generated by the magnet 12. In this way, a same magnet/sensor pair can detect the presence and/or the movement of the chain 100 at the various gear ratios.

[0110] Alternatively, different magnet/sensor combinations can be provided for the various gear ratios.

[0111] Thus, the detector 10 can possibly comprise a second magnet 12A, as shown, which generates a second generated magnetic field and a second magnetic field sensor 14A, wherein the mutual position of the second magnet 12A and of the second sensor 14A is fixed, and the second sensor 14A is immersed in the second generated magnetic field, wherein a second length 140A of a second closed loop path 130A followed by the chain 100, at a second predetermined gear ratio, is immersed in the second generated magnetic field so that, if and when a second chain portion is actually in said second path length 140A, the second sensor 14A detects the second magnetic field perturbed by the second chain portion.

[0112] In this way, the detector 10 can be advantageously used to check not only whether the chain 100 is broken or dropped and/or is moving, but also which the actual gear ratio is or, respectively, which toothed wheel 1002, 1004 is currently engaged by the chain 100. Indeed, depending on the actual gear ratio, the chain 100 will extend along one of the closed loop path 130 and the second closed loop path 130A, and thus will be detected by one of the two sensors 14 or 14A.

[0113] As an alternative or in addition, for the same purpose the detector 10 can possibly comprise the second magnet 12A that generates the second generated magnetic field, but associated with the same sensor 14 as the magnet 12, namely wherein the mutual position of the second magnet 12A and of said sensor 14 is fixed and the sensor 14 is also immersed in the second generated magnetic field. Also in this case, the second length 140A of the second closed loop path 130A followed by the chain 100, at the second predetermined gear ratio, is immersed in the second generated magnetic field, so that the sensor 14 also detects the second magnetic field perturbed by a possible chain portion 100 that is actually in said second path length 140A.

[0114] As an alternative or in addition, the detector 10 can possibly comprise the magnet 12 that generates the generated magnetic field, the sensor 14 and the second magnetic field sensor 14A, wherein the mutual position of the magnet 12 and of the sensor 14 is fixed, and the mutual position of the magnet 12 and of the second sensor 14A is fixed, the sensor 14 is immersed in the generated magnetic field, and the second sensor 14A is immersed in the generated magnetic field, wherein the second length 140A of the second closed loop path 130A followed by the chain 100, at a second predetermined gear ratio, is immersed in the generated magnetic field so that, if and when a second chain portion is actually in said second path length 140A, the second sensor 14A detects the second magnetic field perturbed by the second chain portion.

[0115] The configurations outlined above can be repeated, in any combination, for all of the gear ratios. Hereinafter, for the sake of brevity, reference will be made to the detector 10 in its basic configuration comprising a magnet 12 and a sensor 14.

[0116] The detector 10 can be mounted at a suitable length of the closed loop path 130, 130A of the chain 100, for example by providing a suitable support fixed to the frame of the bicycle 1000.

[0117] In FIGs. 3-8 the magnet 12 and the sensor 14 are schematically illustrated, mounted on two carriers 16, 18, respectively.

[0118] The aforementioned carriers 16, 18 are in the form of two parallel and suitably spaced apart flat walls so as to allow the passage, between the magnet 12 and the sensor 14, of the chain 100 in the preferred geometric relationship described above, of alignment along the direction *n*.

[0119] The magnet 12 is supported by the carrier 16. In particular, in the case shown the magnet 12 is glued in a through hole 20, formed in the carrier 18 and better visible in FIGs. 4, 6, and 8. The hole 20 can be replaced by a recessed seat or a blind hole.

[0120] As an alternative to gluing, the magnet 12 could just be forcedly fit into the hole 20 or fixed to the carrier 16 in a different manner, for example welded, co-molded, or in other ways.

[0121] The sensor 14 is, in the case shown, mounted onto the carrier 18 through a casing 22 configured for being fixed to the carrier 18, and in which a housing seat 24 is defined. It is understood that the casing 22 is made of a suitable material so as not to interfere with the detection by the sensor 14 of the magnetic field generated by the magnet 12, possibly perturbed by the chain portion 150, 152, 154.

[0122] The magnetic field sensor 14 is in particular embodied on a Printed Circuit Board (PCB) 26, which can i.a. carry the electronics described above.

[0123] A cable (cf. the description of the following FIGs. 10-18) that carries signals and/or power to/from the sensor extends from the board 26, a suitable passage hole being provided in the casing 22. Alternatively, outside of the scope of the claimed invention, the sensor 14 can be provided with its own battery power supply unit and with a wireless communication circuit, the cable being absent.

[0124] More specifically, the casing 22 has a T-shaped cross-section, and the seat 24 is made in a portion 28 thereof corresponding to the leg of the T. The portion 28 of the casing 22 containing the housing seat 24 is inserted in a notch 30 of a corresponding shape, formed on the top of the carrier 18. In particular, the wall of the carrier 18 and the portion 28 of the casing 22 have the same thickness, so that the casing 22 is flush with the face of the carrier 18 facing towards the magnet 12, so that the sensor 14 is in proximity of the magnet 12 - and in proximity of the chain portion 150, 152, 154 when present along the path length 140 that extends between the magnet 12 and the sensor 14. However, the notch 30 can be replaced by a recessed seat on the opposite face of the carrier, namely by a groove.

[0125] The casing 22 of the sensor 14 is fixed in a suitable manner to the carrier 18. In the embodiment shown, the fixing takes place through suitable screws 32 extending through the portion 34 of the casing 22 corresponding to the head of the T. Alternatively, the casing 22 could be fixed to the carrier 18 in a different manner, for example through gluing, riveting, welding, etc.

[0126] The carriers 16, 18 could, for example, comprise two legs of a small fork suspended in a suitable position with respect to the closed loop path 130 followed by the chain 100.

[0127] Advantageously, according to some embodiments of the invention, the detector 10 is mounted in a derailleur 1014, 1016 of the motion transmission system of the bicycle 100.

[0128] More specifically, the detector 10 is mounted in, or in any case is associated with, a wireless electronic derailleur 200, of which FIG. 9 illustrates the main components.

[0129] The wireless electronic derailleur 200 comprises i.a. a support body 202, configured to be mounted on the frame of the bicycle 1000 at an assembly of coaxial toothed wheels 1002, 1004 of the gearshift 1012, namely at the chainrings 1002 or the sprockets 1004; a movable body 204, comprising a chain guide 206; and an electromechanical actuator 208 or actuation means 208 configured to move the movable body 204 with respect to the support body 202. The actuation means 208 comprise an electric motor 210, typically part of a geared motor, and can comprise a linkage, such as for example an articulated parallelogram.

[0130] The wireless electronic derailleur 200 further comprises a controller 240 of the electric motor 210, as well as a wireless communication device 242. The wireless communication device 242 is configured to receive gearshifting request signals 250 from a wireless transmitter 252.

[0131] The gearshifting request signals 250 can be emitted by the manual control devices 1022 fixed to the handgrips of the handlebars 1024 and/or by a control unit of the gearshift 1012 that receives them from such manual control devices 1022 or that processes them automatically. The wireless transmitter 252 can be part of the manual control devices 1022 or of another component of the gearshift 1012 of which the derailleur 200 is part.

[0132] The detector 10, when it detects the movement status of the bicycle 1000 - in particular in the case described above inferring it from the movement status of the chain 100 -, is configured to emit a wake signal 244 for the wireless communication device 242, so as to lead it into an operating mode from a standby mode, and possibly keep it in operating mode.

[0133] When the bicycle is in use, therefore, the wireless communication device 242 of the wireless electronic derailleur 200 is constantly kept in operating mode so as to be ready to receive the gearshifting request signals 250 at any moment. Only when the bicycle is stopped for a prolonged period, the wireless communication device 242 can enter standby mode. In order to distinguish a prolonged stop, for example in a parking slot or garage, from a temporary stop, for example at a traffic light, it is possible to use the same signal emitted by the movement detector 10 to prevent the standby mode to be entered, namely as an anti-sleep signal; alternatively it is possible to use a specific timer (not shown).

[0134] The other devices of the wireless electronic derailleur 200, in particular the controller 240 and/or the actuator 208, can instead enter standby mode also during the use of the bicycle, and be woken by a second wake signal, generated by the wireless communication device 242 when it receives the gearshifting request signals 250 from the wireless transmitter 252.

[0135] In a *per se* known manner, the wireless communication device 242, the controller 240 and the motor 210 can be housed at various mechanical parts of the derailleur 200. In particular, the wireless communication device 242 is housed in a first casing that is fixed to or is part of the support body 202 or is fixed to or is part of a connecting rod of the articulated parallelogram linkage of the electromechanical actuator 208, although these are shown as distinct components in the block diagram of FIG. 9.

[0136] Some exemplary embodiments of wireless electronic derailleur 200 with an associated detector 10 will now be described.

[0137] FIG. 10 shows, as an example, a front derailleur, indicated with reference numeral 300, in which the detector 10 is mounted.

[0138] The front derailleur 300 comprises a support body 302, configured to be mounted on a bicycle frame at an assembly of chainrings 1002, a movable body 304 comprising a chain guide 306 (in the case shown, movable body and chain guide coincide), and actuation means 308 configured to move the movable body 304 with respect to the support body 302.

[0139] In the case shown, the front derailleur 300 is electronic and the actuation means 308 comprise a geared motor 310 and an articulated parallelogram linkage 312, but the front derailleur could be made differently, in a *per se* well known manner.

[0140] The magnet 12 and the sensor 14 of the detector

10 are fixed at the chain guide 306.

[0141] The magnet 12 and the sensor 14 are, in particular, fixed at corresponding positions of opposite plates 314, 316 of the chain guide 306, so that the closed loop path 130 followed by the chain 100 passes in between them. When magnet 12 and sensor 14 are at corresponding positions as shown, they turn out to be aligned along a direction perpendicular to the tangent to the path length that the chain 100 follows between the plates of the chain guide 314 themselves.

[0142] More specifically, the magnet 12 is fixed to the outer plate 314 of the chain guide 306 and the sensor 14 is fixed to the inner plate 316 of the chain guide 306, at a projection 318 projecting upwards from the inner plate 316, so that the sensor 14 is at the same height as the magnet 12. When magnet 12 and sensor 14 are at the same height, they are aligned along the direction parallel to the rotation axes of the chainrings 1002.

[0143] The magnet 12 and the sensor 14 in the mounted positions illustrated turn out to be in an optimal mutual position and at an optimal distance for the described operation of the detector 10.

[0144] A cable 320 connecting the casing 22 containing the sensor 14 to the support body 302 is also shown, in which support body 302, in the embodiment shown, the electronics of the derailleur 300 and in particular the wireless communication device 242, as well as a possible battery power source unit, are housed. The cable 320 is advantageously provided with a removable connector 322 configured for removable connection with a matching connector (not visible) of the support body 302, so as to facilitate a possible replacement of the sensor 14.

[0145] The detector 10 further comprises, in the embodiment shown, the second magnet 12A and the second sensor 14A coupled to each other, so as to detect the presence/movement of the chain 100 when it follows one of two closed loop paths, depending on the chainring 1002 with which it engages, in the case of a front gearshift assembly having two chainrings. The second sensor 14A is shown housed in a second casing 22A, from which a cable 320A extends that is provided with a connector 322A, similarly to the sensor 14. However, a single casing housing the two sensors could be provided for.

[0146] Also the cabled connection could follow a different scheme, for example in which the second sensor 14A is connected to the first sensor 14 and only the first sensor 14 is connected to the support body 302.

[0147] In the case of a front gearshift assembly having three or more chainrings, there will be a third magnet and a third sensor, or more.

[0148] All of the other magnet/sensor combinations described above are also possible.

[0149] FIGs. 11-14 show, as an example, a rear derailleur, indicated with reference numeral 400, in which the detector 10 is mounted.

[0150] The rear derailleur 400 comprises a support body 402, configured to be mounted on a bicycle frame at an assembly of sprockets 1004, a movable body 404, comprising a chain guide 406, and actuation means 408 configured to move the movable body 404 with respect to the support body 402.

[0151] In the case shown, the rear derailleur 400 is electronic and the actuation means 408 comprise a geared motor 410 and an articulated parallelogram linkage 412, the geared motor 410 being arranged along the diagonal of the articulated parallelogram 412, but the rear derailleur could be implemented differently, in a *per se* well known way.

[0152] The magnet 12 and the sensor 14 of the detector 10 are fixed at the chain guide 406.

[0153] The magnet 12 and the sensor 14 are, in particular, fixed at corresponding positions of opposite plates 414, 416 of the chain guide 406, so that the closed loop path 130 followed by the chain 100 passes in between them. When magnet 12 and sensor 14 are at corresponding positions, they are aligned along a direction perpendicular to the tangent to the path length that the chain 100 follows between the plates of the chain guide 406 themselves.

[0154] More specifically, the sensor 14 is fixed to the outer plate 414 or pulley-carrying plate of the rocker arm or chain tensioner or chain guide 406, and the magnet 12 is fixed to the inner plate 416 or pulley-carrying plate of the rocker arm 306.

[0155] Even more specifically, magnet 12 and sensor 14 are fixed to the pulley-carrying plates 414, 416 at the toothing 426 of a pulley 428, more preferably of the upper pulley 428 of the chain tensioner 406.

[0156] In the present description and in the attached claims, the terms "upper" and "lower" are used with reference to the normal condition of use of the bicycle.

[0157] In this manner, magnet 12 and sensor 14 are aligned along the direction parallel to the rotation axes of the pulleys 428, 430.

[0158] Since irrespective of the sprocket 1004 engaged by the chain 100, the latter always follows a same length of a closed loop path that winds around the pulleys 428, 430, the single pair formed by magnet 12 and sensor 14 turns out to be sufficient.

[0159] FIGs. 13-14 show a section through the chain guide 406 at the detector 10. In FIG. 13, in the path length immersed in the magnetic field generated by the magnet 12 there is a chain portion corresponding to a joint element 170, 172 of the chain 100. In FIG. 14, in the path length immersed in the magnetic field generated by the magnet 12 there is a chain portion corresponding to a pair of small plates 162-168 (the outer ones 162, 164 in the case shown).

[0160] It can be seen that in the condition of FIG. 14, between magnet 12 and sensor 14 a tooth 432 of the toothing 426 of the pulley 428 is also partially arranged, which tooth however does not perturb the magnetic field because the pulleys 428, 430 are typically made of plastic material. In any case, its contribution to the perturbation could be duly taken into account.

[0161] Also in this case a cable 420 is shown that connects the casing 22 containing the sensor 14 to the outer connecting rod 413 of the linkage 412, inside which in the embodiment shown the electronics of the derailleur 400 and in particular the wireless communication device 242 are housed. The cable 420 is advantageously provided with a connector 422 of the removable type configured for the removable connection with a matching connector (not visible) of the outer connecting rod 413, so as to facilitate a possible replacement of the sensor 14.

[0162] FIGs. 15-16 show, as an example, another rear derailleur, indicated with reference numeral 500, wherein the movement detector 10 is differently mounted.

[0163] The rear derailleur 500 comprises a support body 502, configured to be mounted on a bicycle frame at an assembly of sprockets 1004, a movable body 504, comprising a chain guide 506, and actuation means 508 configured to move the movable body 504 with respect to the support body 502.

[0164] In the case shown, the rear derailleur 500 is electronic and the actuation means 508 comprise a geared motor 510 and an articulated parallelogram linkage 512, the geared motor 510 being arranged along the diagonal of the articulated parallelogram 512, but the rear derailleur could be differently implemented, in a *per se* well known way.

[0165] The magnet 12 and the sensor 14 of the detector 10 are fixed at the chain guide 506.

[0166] In particular, the magnet 12 is fixed to one of the pulleys 528, 530 of the chain guide or chain tensioner or rocker arm 506, in the case shown to the upper pulley 528 of the rocker arm 506.

[0167] The sensor 14 is fixed to one of the pulley-carrying plates 514, 516, in the case shown to the outer plate 514 of the chain tensioner 506, in such a position as to be periodically immersed in the magnetic field generated by the magnet 12 during the rotation of the pulley 528 to which it is fixed.

[0168] In this manner, the sensor 14 detects the magnet 12 when the latter enters its detection field, and thus the movement of the motion transmission chain 100 - in turn indicative of the movement of the bicycle 1000 - is monitored through the movement of the pulley 528.

[0169] During the rotation of the pulley 528, the magnet 12 and the sensor 14 periodically come to be at corresponding positions.

[0170] Even more specifically, the magnet 12 is fixed to the upper pulley 528 along a radial and at a certain distance from the rotation axis, in a radially inner position with respect to the toothing 526. The sensor 14 is fixed to the outer plate 514 along a radial and substantially at the same distance with respect to the rotation axis of the upper pulley 528. In the angular position of the upper pulley 528 wherein magnet 12 and sensor 14 are in corresponding positions, they are aligned along a direction parallel to the rotation axes of the pulleys 528, 530.

[0171] Also in this case, because irrespective of the sprocket 1004 engaged by the chain 100, the latter always follows a same length of the closed loop path that winds around the pulleys 528, 530, the single pair formed by magnet 12 and sensor 14 turns out to be sufficient.

[0172] FIGs. 17-18 show sections through the chain guide 506 at the detector 10, in different rotation conditions of the upper pulley 528.

[0173] In particular, in FIG. 17 the upper pulley 528 is rotated into an angular position wherein the magnet 12 and the sensor 14 are at corresponding positions.

[0174] In FIG. 18, on the other hand, the upper pulley 528 is rotated into an angular position wherein the magnet 12 and the sensor 14 are not at corresponding positions; the magnet 12, as a consequence, is not visible.

[0175] It should be noted that in this case the portion 28 of the casing 22 housing the sensor 24 is housed in a groove of the pulley-carrying plate 514, so that a thin wall 534 extends in front of the sensor 14, in a direction towards the magnet 12. If such a wall 534 is made of paramagnetic or ferromagnetic material, its contribution to the perturbation of the magnetic field generated by the magnet 12 is in any case constant, and therefore can be duly taken into account.

[0176] Also in this case a cable 520 is shown connecting the casing 22 containing the sensor 14 to the outer connecting rod 513 of the linkage 512, inside which in the embodiment shown the electronics of the derailleur 500 and in particular the wireless communication device 242 are housed. The cable 520 is advantageously provided with a connector 522 of the removable type configured for removable connection with a matching connector (not visible) of the outer connecting rod 513, so as to facilitate a possible replacement of the sensor 14.

[0177] As stated in the introductory part, the movement detector 10 could comprise a non-magnetic sensor for detecting the movement of the chain 100 of the bicycle.

[0178] For example, it could be an optical sensor arranged in a similar manner to the embodiments of FIGs. 2-14, such as a photoelectric cell the light beam of which is blocked by the passage of the joints 170, 172 of the chain 100, but not by the passage of the inner small plates 162, 164 and outer small plates 166, 168 of the links 160 of the chain 100 - the light source and the photoelectric cell being aligned along a direction perpendicular with respect to that of the elements 12, 14 shown, namely along a direction perpendicular both to the direction t and to the direction n defined above.

[0179] Alternatively it could be an optical sensor arranged in a similar manner to the embodiment of FIGs. 15-18, wherein a light beam generated by a source adjacent to the optical sensor is reflected by a small mirror fixed to a pulley 528, 530 of the rear derailleur only when the small mirror passes in front of it.

[0180] More in general, it could be a movement detector not based on the detection of the movement of the chain, for example a clinometer, a gyroscope, a vibration sensor, etc.

[0181] The movement detector 10 need not necessarily be fixed - as a whole or in part - to the movable body 204, 304, 404, 504 of the derailleur 200, 300, 400, 500 as in the embodiments shown, rather it can be fixed to other parts of the derailleur, or it can be fixed to the bicycle frame.

[0182] The communication cable 302, 302A, 402, 502 between the detector 10 and the wireless communication device 242 can be an electric cable or it can be a fiber optic cable.

[0183] The wireless communication device 242 can be housed in a different casing than the one indicated above in the various embodiments, and in general it can be part of or fixed to the support body, part of or fixed to any component of the linkage, or even part of or fixed to the movable body of the derailleur.

Claims

1. Bicycle wireless electronic derailleur (200, 300, 400, 500), comprising:

    - a support body (202, 302, 402, 502), configured to be mounted on a frame of a bicycle (1000) at an assembly of coaxial toothed wheels (1002, 1004) of the bicycle (1000),
    - a movable body (204, 304, 404, 504), comprising a chain guide (204, 306, 406, 506),
    - actuation means (208, 308, 408, 508) configured to move the movable body (204, 304, 404, 504) with respect to the support body (202, 302, 402, 502), comprising an electric motor (210, 310, 410, 510),
    - a controller (240) of the electric motor (210, 310, 410, 510),
    - a wireless communication device (242), part of or in communication with the controller (240), configured to receive gearshifting request signals from a wireless transmitter (252), the wireless communication device (242) being housed in a first casing (202, 208, 302, 413, 513),
    - a bicycle movement detector (10) configured to emit a wake signal (244) for the wireless communication device (242),

    characterized in that the movement detector (10) is at least partially housed in at least one second casing (22, 22A) different from the first casing (202, 208, 302, 413, 513), and is in communication through at least one cable (320, 320A, 420, 520) with the wireless communication device (242).

2. Derailleur (200, 300, 400, 500) according to claim 1, wherein the communication through at least one cable (320, 320A, 420, 520) between the wireless communication device (242) and the movement detector (10) is provided with at least one pair of matching removable connectors (322, 322A, 422).

3. Derailleur (200, 300, 400, 500) according to claim 1 or 2, wherein the movement detector (10) comprises at least one magnet (12, 12A) that generates a magnetic field and at least one magnetic field sensor (14, 14A), the magnetic field detected by the sensor (14, 14A) being different depending on whether the bicycle is moving or stationary.

4. Derailleur (200, 300, 400, 500) according to claim 3, wherein both the magnet (12, 12A) and the sensor (14, 14A) are attached to the chain guide (204, 306, 406, 506), at least the sensor (14, 14A) being housed in the at least one second casing (22) and being in communication through the at least one cable (320, 320A, 420, 520) with the wireless communication device (242).

5. Derailleur (200, 300, 400, 500) according to claim 3 or 4, wherein the sensor (14, 14A) is fixed to a first plate (314, 316, 414, 416, 514, 516) of the chain guide (204, 306, 406, 506).

6. Derailleur (200, 300, 400, 500) according to claim 5, wherein the derailleur is a front derailleur (300) and the sensor (14, 14A) is fixed to an inner plate (316) of the chain guide (206, 306).

7. Derailleur (200, 300, 400, 500) according to claim 5, wherein the derailleur is a rear derailleur (400, 500) and the sensor (14) is fixed to an outer plate (414, 514) of the chain guide (206, 406, 506).

8. Derailleur (200, 300, 400, 500) according to any of claims 5-7, wherein the sensor (14, 14A) is fixed at a respective recessed seat or at a notch (30) in the first plate (314, 316, 414, 416, 514, 516) of the chain guide (206, 306, 406, 506).

9. Derailleur (200, 300, 400, 500) according to any of claims 5-8, wherein the magnet (12) is fixed to a second plate (314, 316, 414, 416) of the chain guide (206, 306, 406), wherein the mutual position of the magnet (12) and of the sensor (14) is fixed, and the sensor (14) is immersed in the magnetic field generated by the magnet (12), and wherein a length (140) of a closed loop path (130) followed by a motion transmission chain (100) of the bicycle (1000), at least at a predetermined gear ratio, is immersed in the magnetic field generated by the magnet (12), so that, if in said path length (140) there is at least one actual chain portion (150, 152, 154), the sensor (14) detects the magnetic field perturbed by said actual chain portion (150, 152, 154).

10. Derailleur (200, 300, 400, 500) according to claim 9, wherein the path length (140) passes through a space between the magnet (12) and the sensor (14).

11. Derailleur (200, 300, 400, 500) according to any of

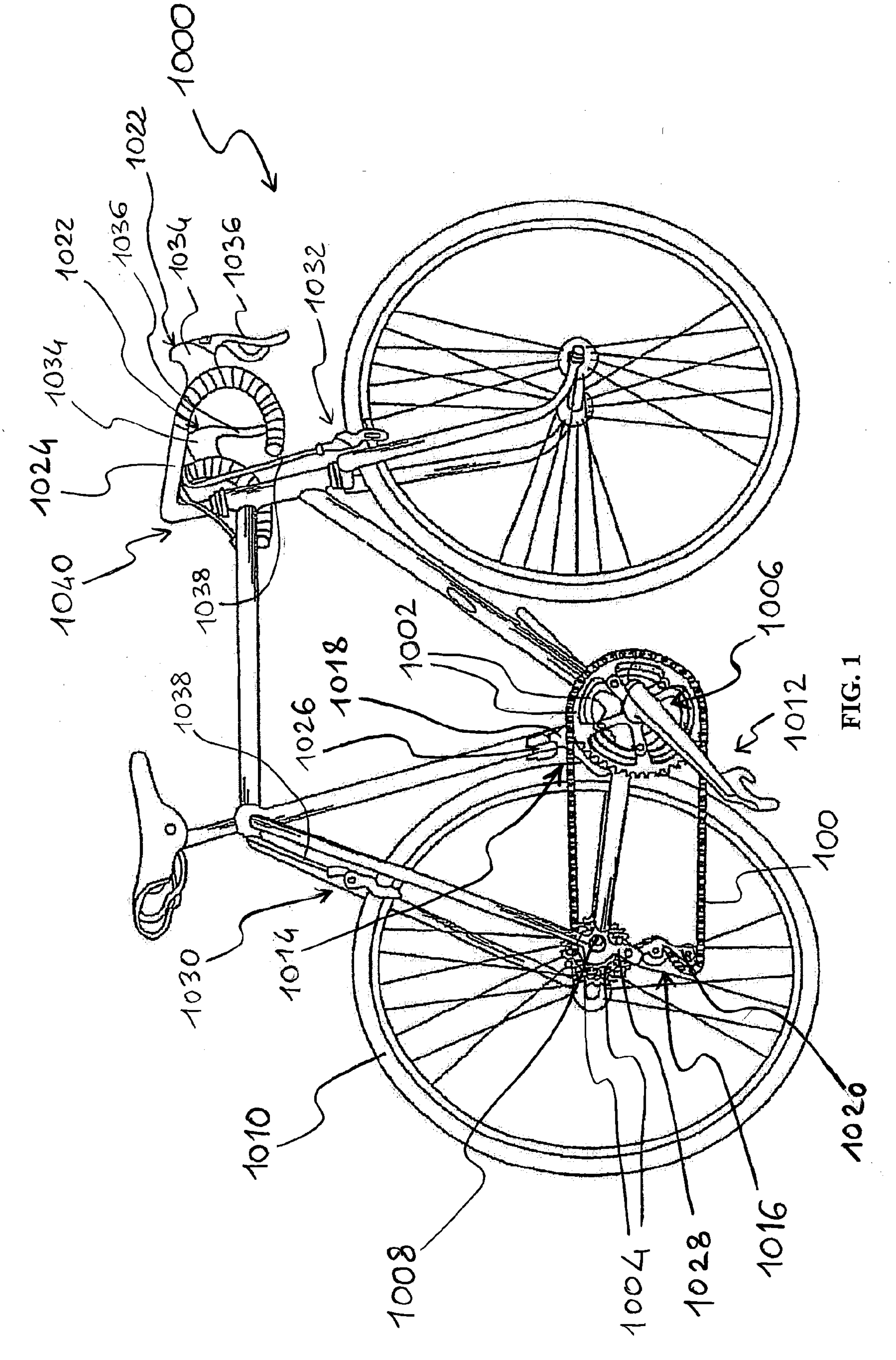
claims 4-10, wherein the magnet (12) and the sensor (14) are fixed at corresponding positions of opposite plates (314, 316, 414, 416) of the chain guide (206, 306, 406).

12. Derailleur (200, 300, 400, 500) according to any of claims 9-11, wherein the derailleur is a rear derailleur (400, 500) and the chain guide (406, 506) comprises two pulley-carrying plates (414, 416), wherein the magnet (12) and the sensor (14) are fixed to said pulley-carrying plates (414, 416) at corresponding positions at the toothing (426) of a pulley (428, 430), preferably of the upper pulley (428) of the chain tensioner (206, 406).

13. Derailleur (200, 300, 400, 500) according to any of claims 9-11, wherein the derailleur (200, 300) is a front derailleur (300).

14. Derailleur (200, 300, 400, 500) according to any of claims 1-5, 7-8, wherein the derailleur (200, 400) is a rear derailleur (400) and the chain guide (206, 506) comprises two pulley-carrying plates (414, 416) and two pulleys (428, 430) pivotally supported between the pulley-carrying plates (414, 416), the magnet (12) is fixed to a first pulley (428, 430) of the chain guide (206, 506), and the sensor (14) is fixed to a pulley-carrying plate (414, 416) in such a position as to be periodically immersed in the magnetic field generated by the magnet (12) during the rotation of the first pulley (428, 430).

15. Derailleur (200, 300, 400, 500) according to any of claims 1-14, wherein the first casing (202, 208, 302, 413, 513) is part of or fixed to the support body (202, 302, 402, 502).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1038
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100
1030
1014
1010
1020
1016
1028
1004
1008

FIG. 1

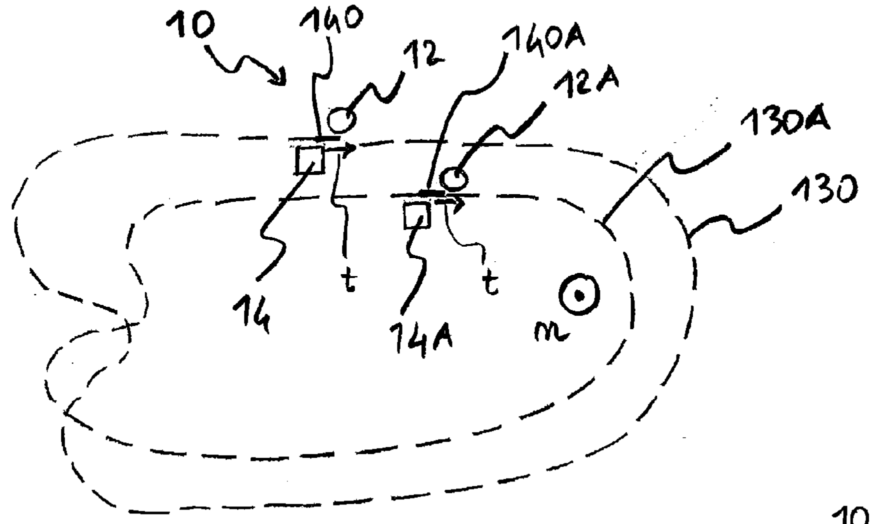


FIG. 2

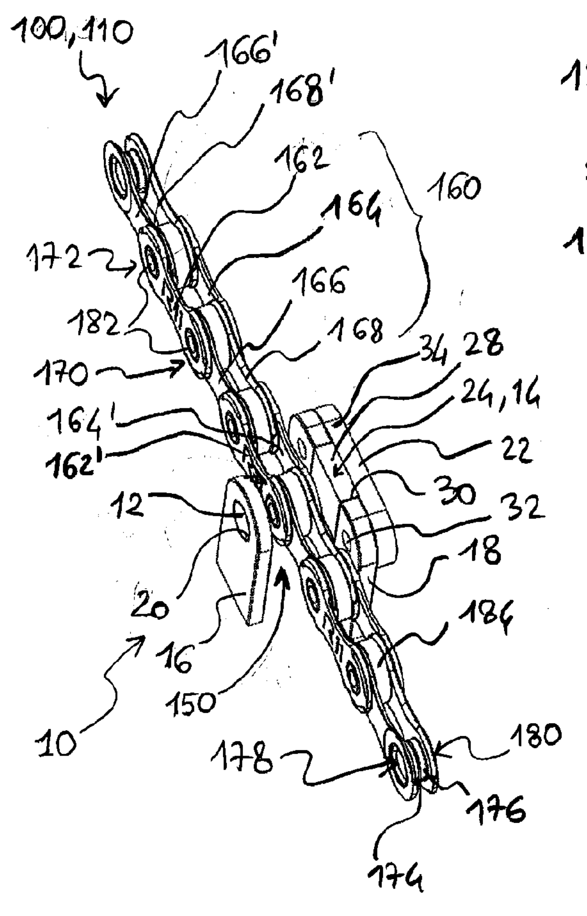


FIG. 3

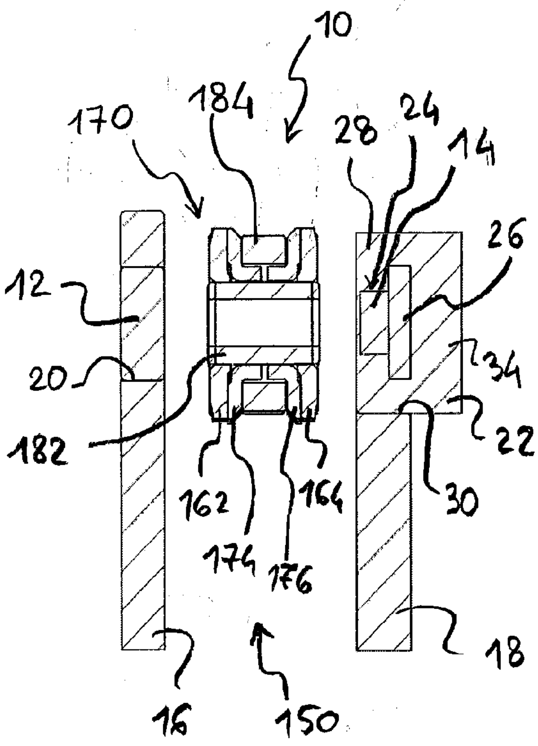


FIG. 4

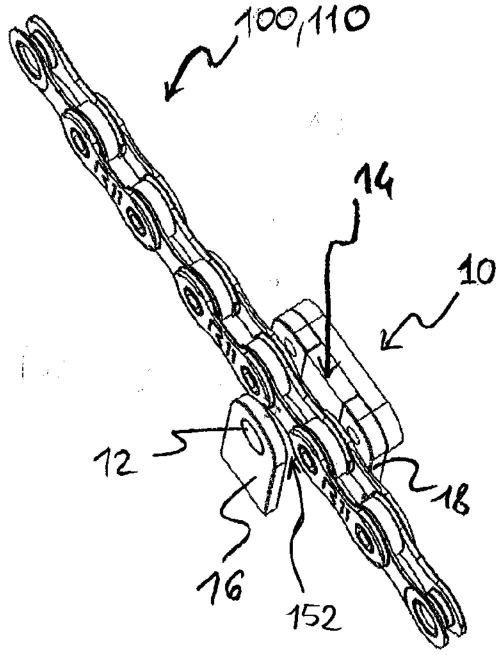


FIG. 5

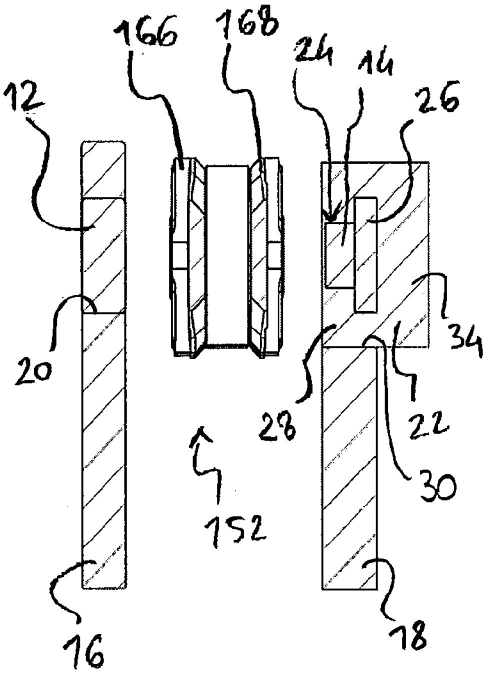


FIG. 6

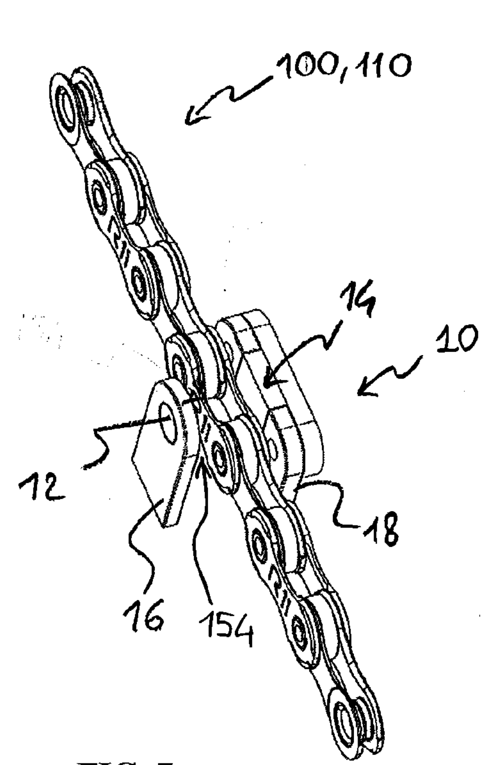


FIG. 7

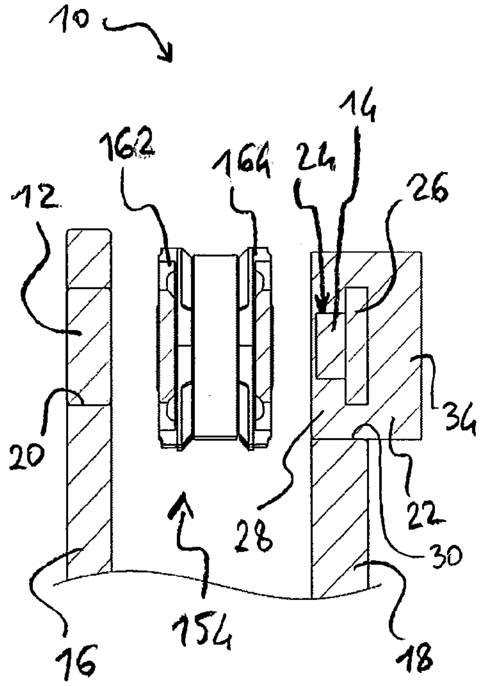


FIG. 8

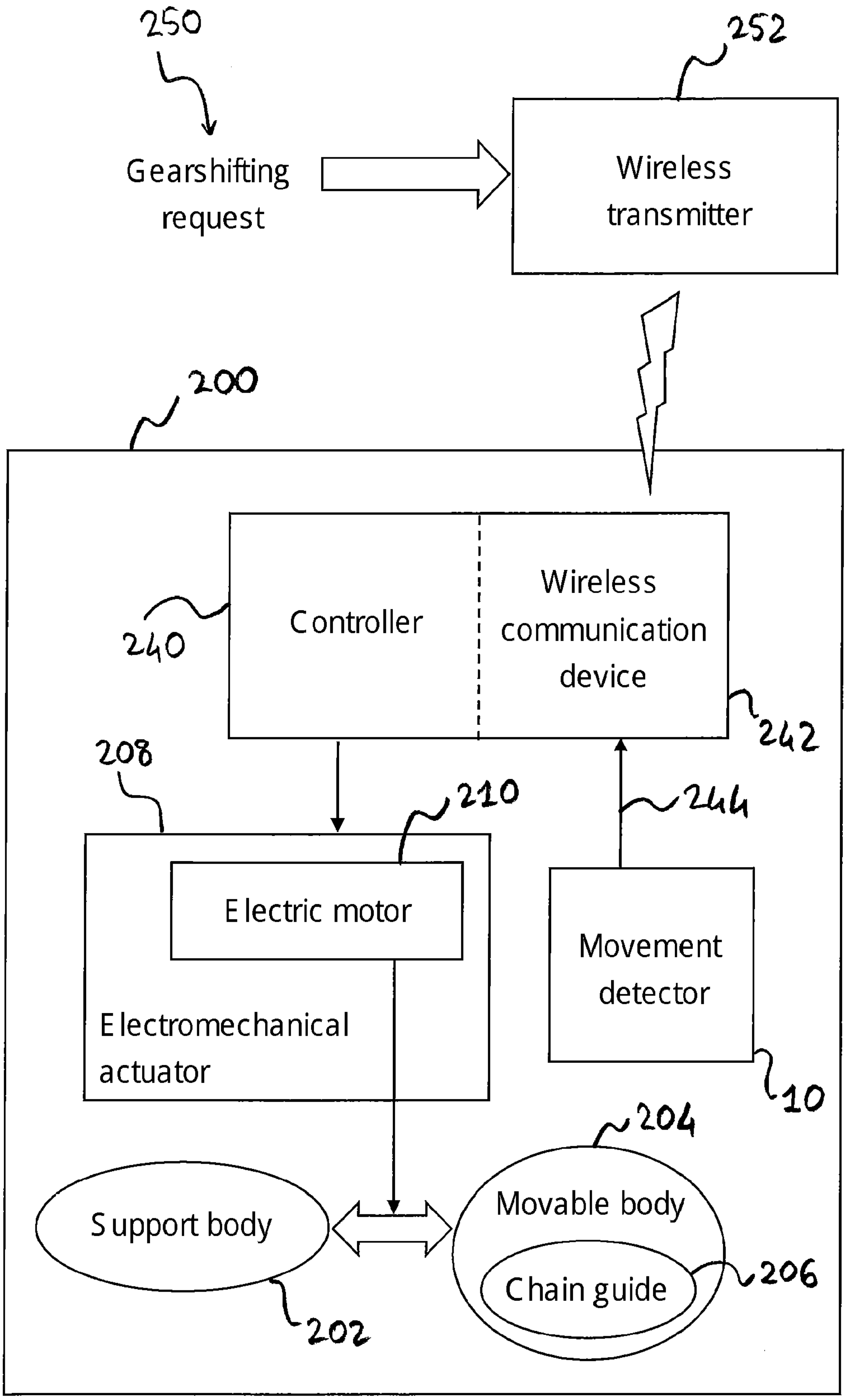
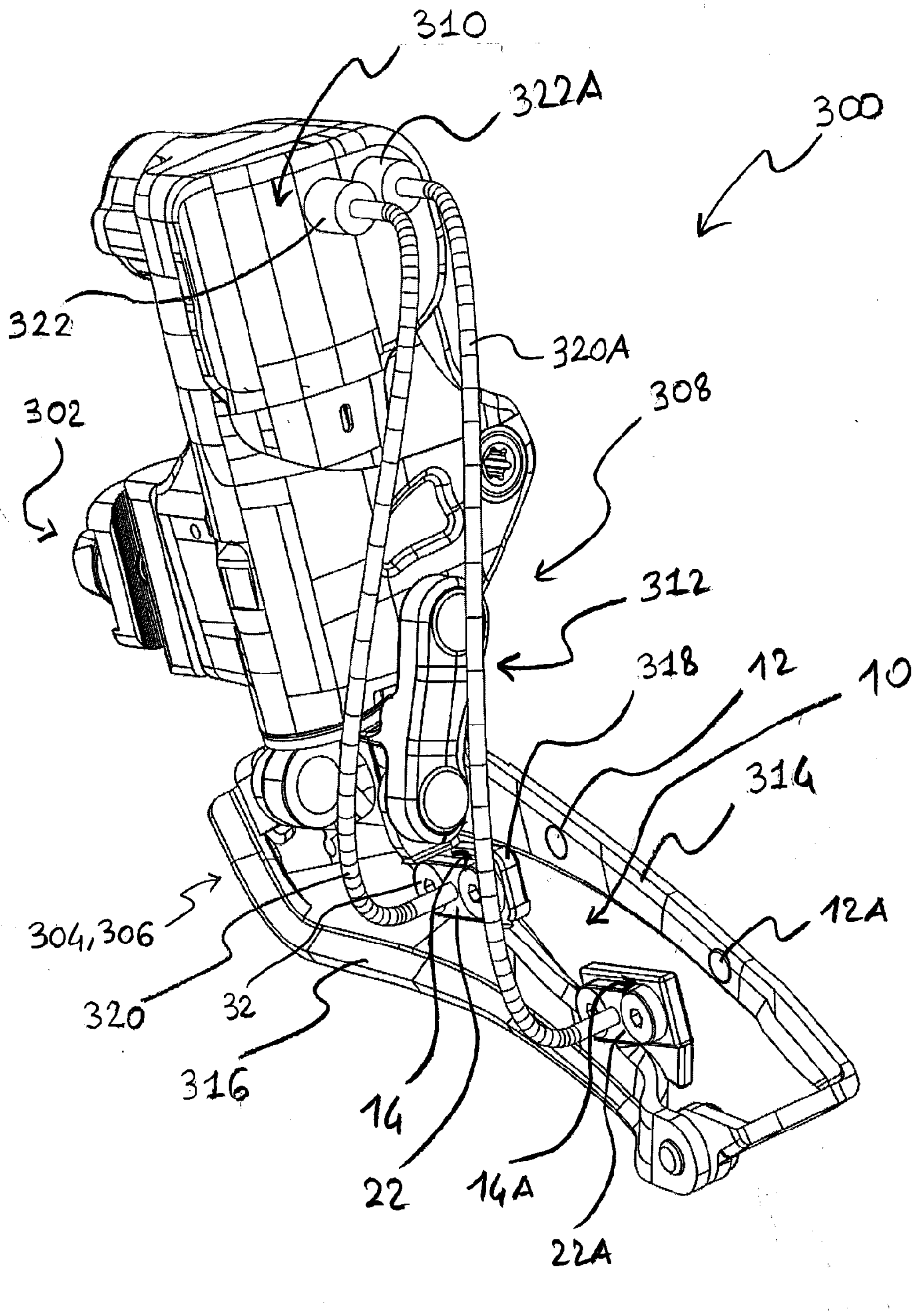

250
Gearshifting request
252
Wireless transmitter
200
240
Controller
Wireless communication device
242
208
210
244
Electric motor
Movement detector
Electromechanical actuator
10
204
Support body
Movable body
Chain guide
206
202

FIG. 9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322A
300
322
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302
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318
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12A
304,306
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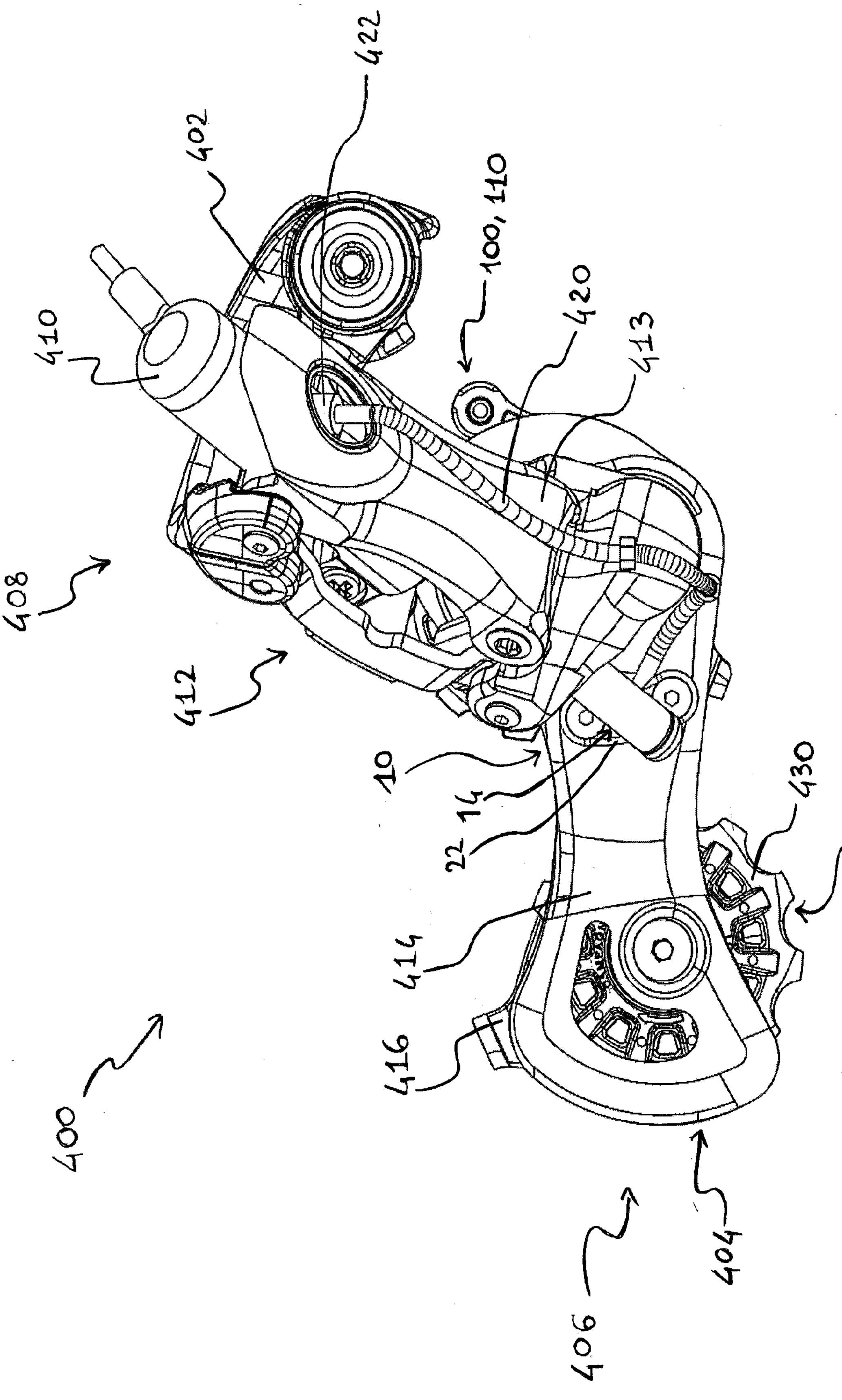
316
14
22
14A
22A

FIG. 10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100, 110
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413
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412
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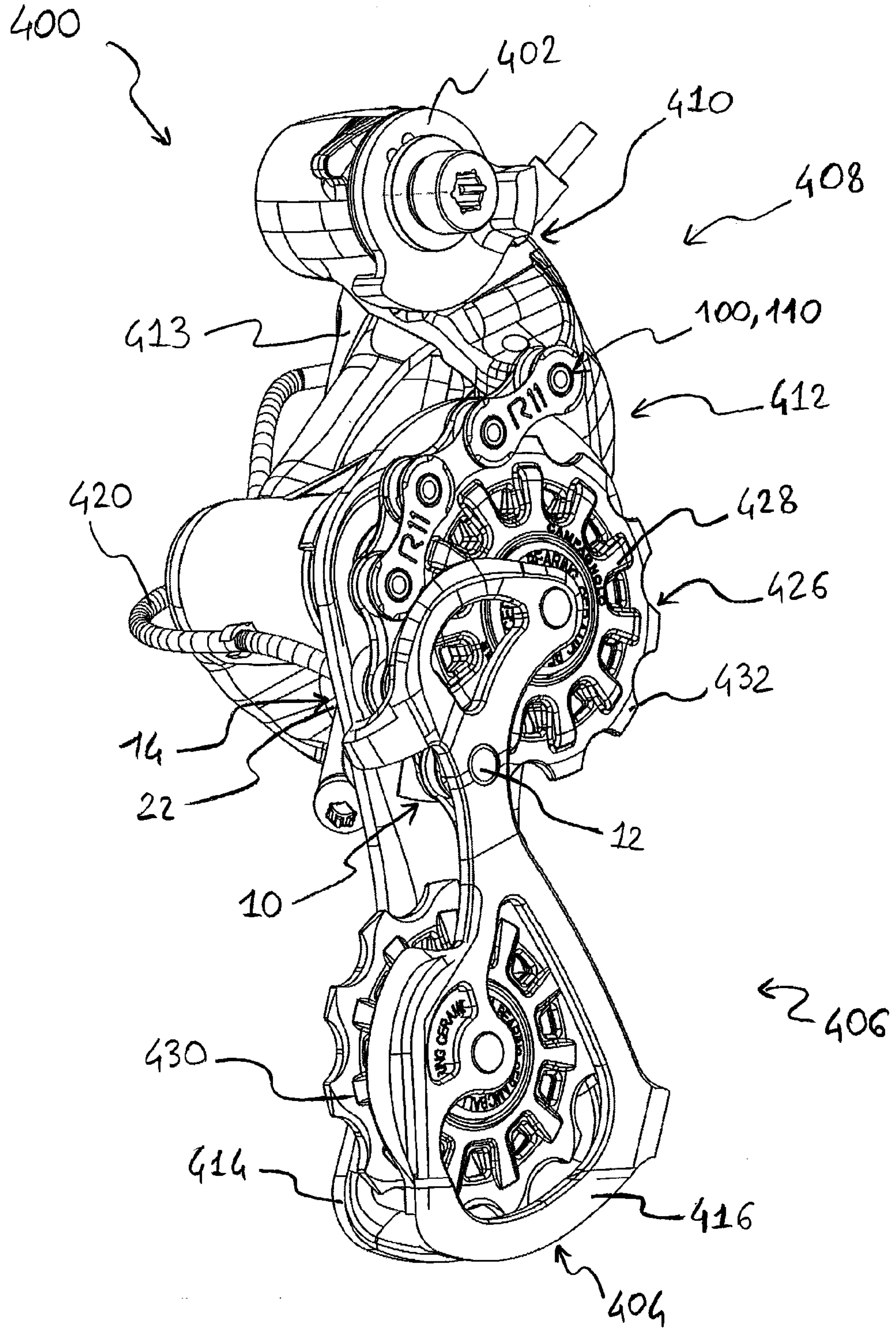
14
22
430
426
414
416
400
406
404

FIG. 11


400
402
410
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100,110
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420
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432
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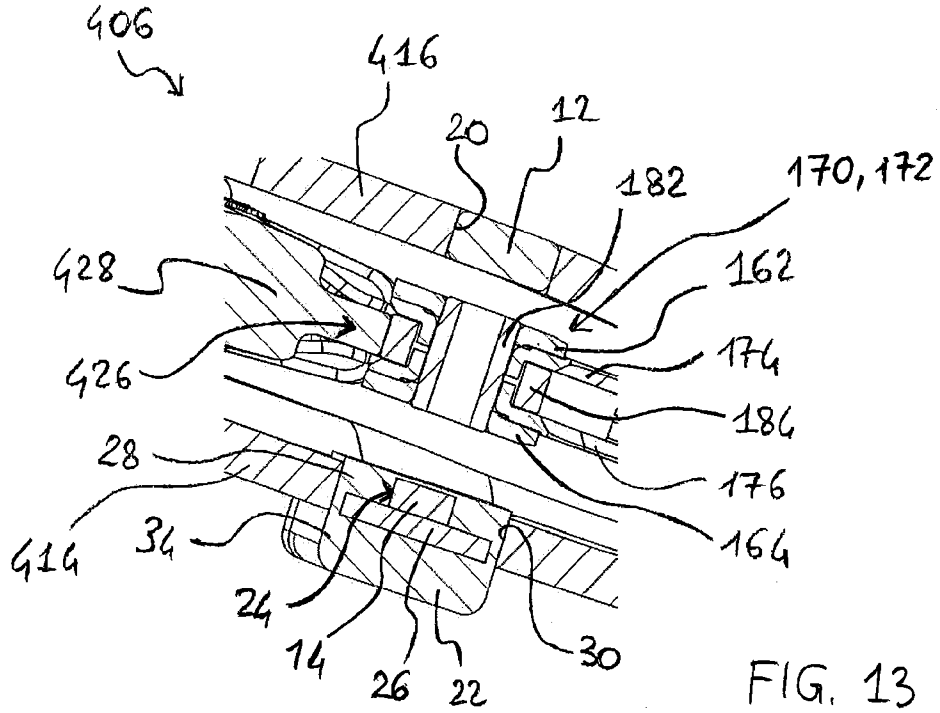
406
430
414
416
404

FIG. 12


406
416
20
12
182
170, 172
428
162
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174
186
28
176
414
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164
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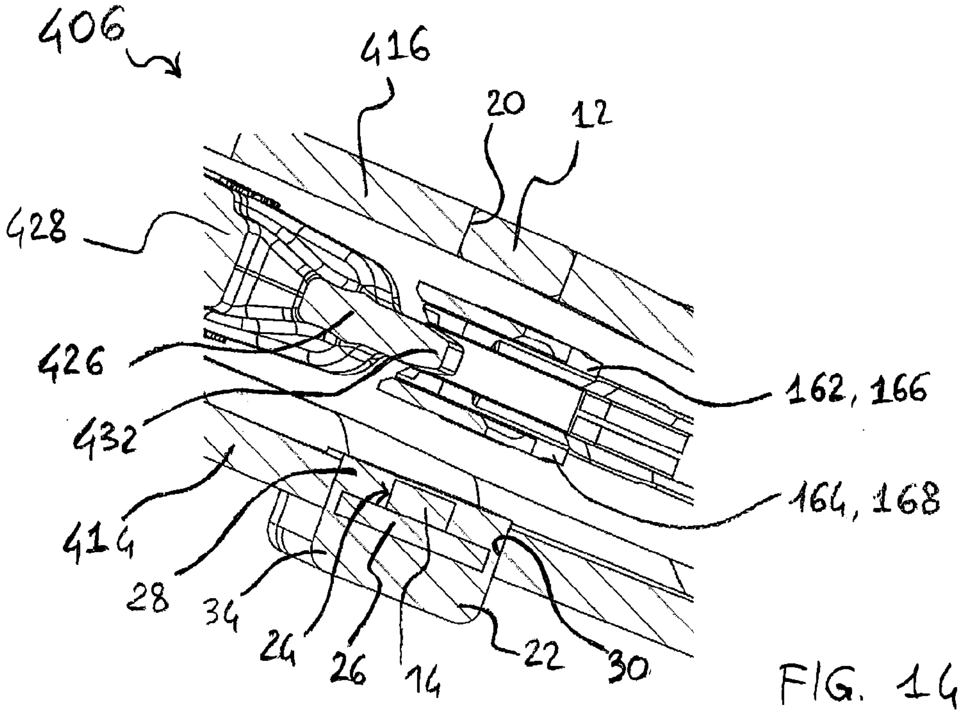
FIG. 13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432
164, 168
414
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22
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FIG. 14

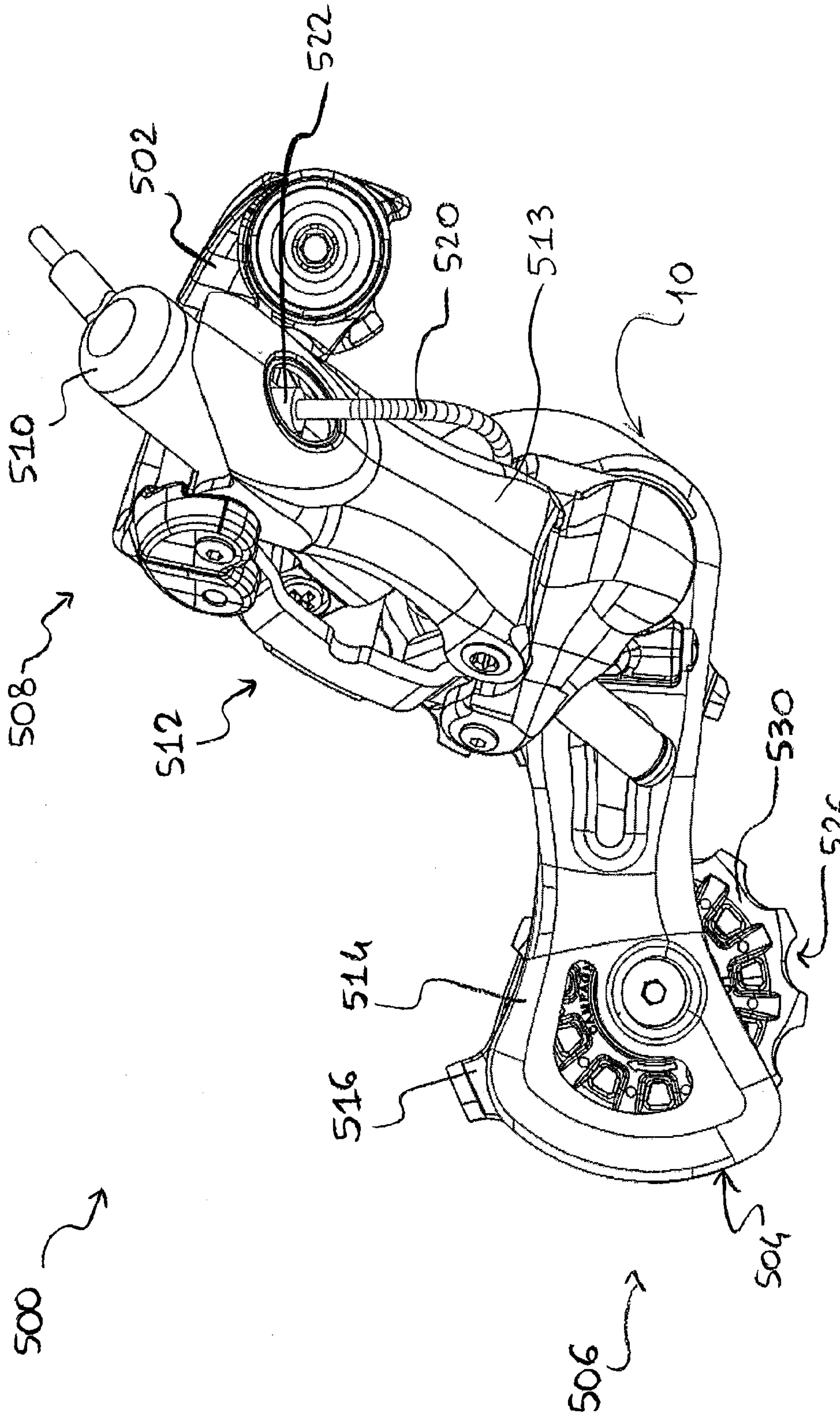
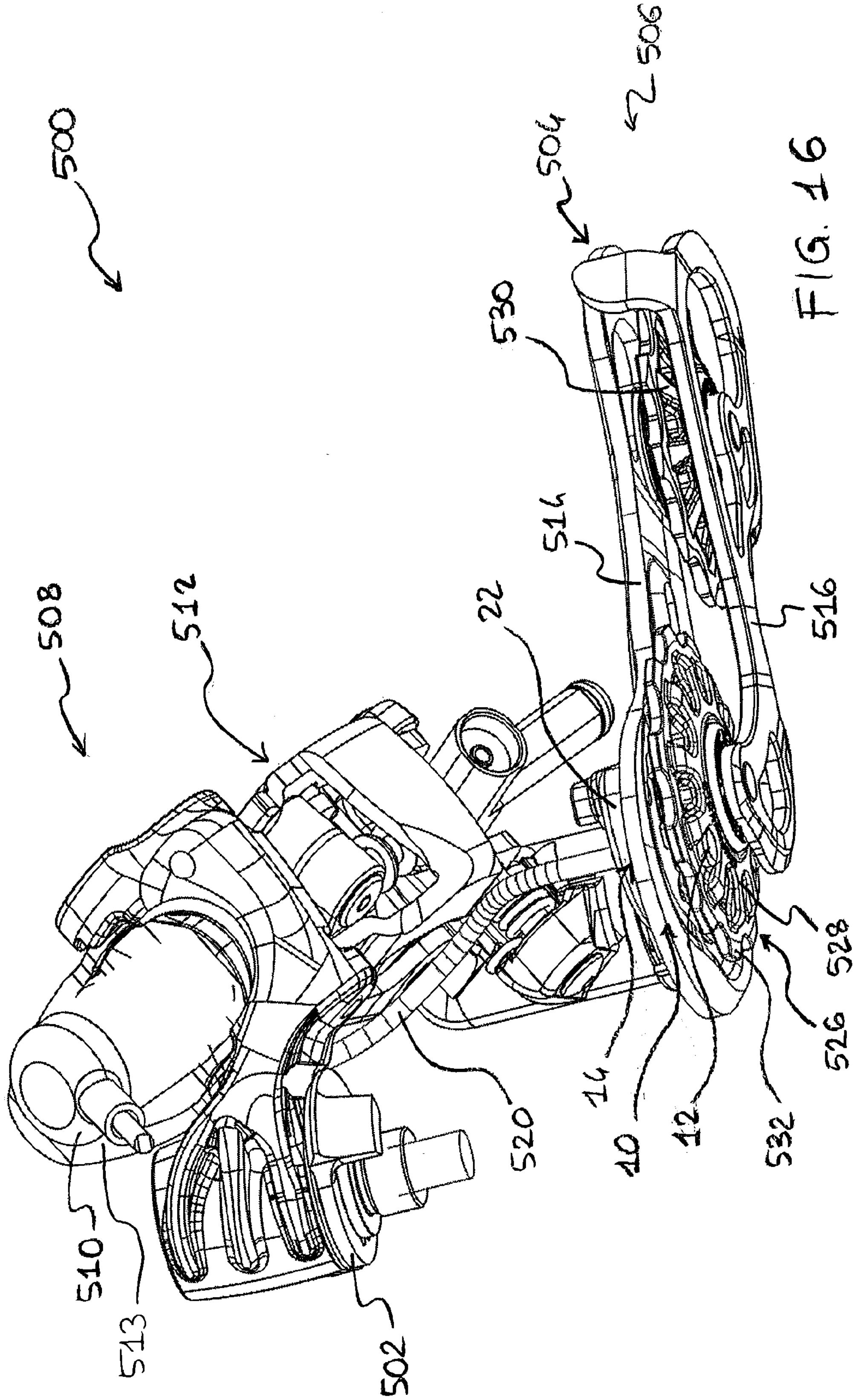


FIG. 15


500
508
512
22
514
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526
532
12
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14
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502
513
510

FIG. 16

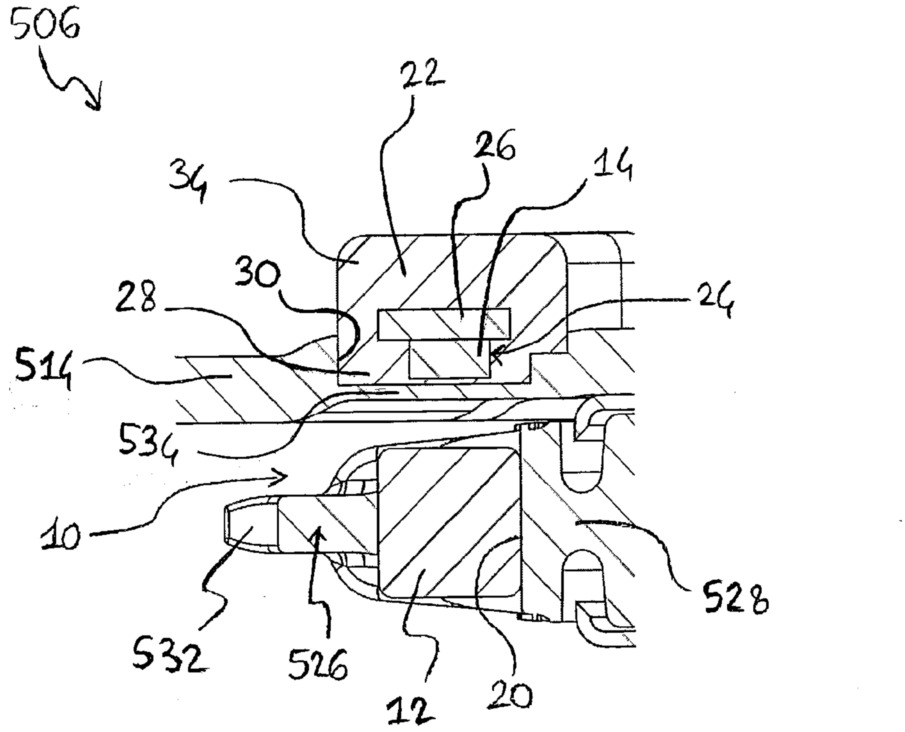
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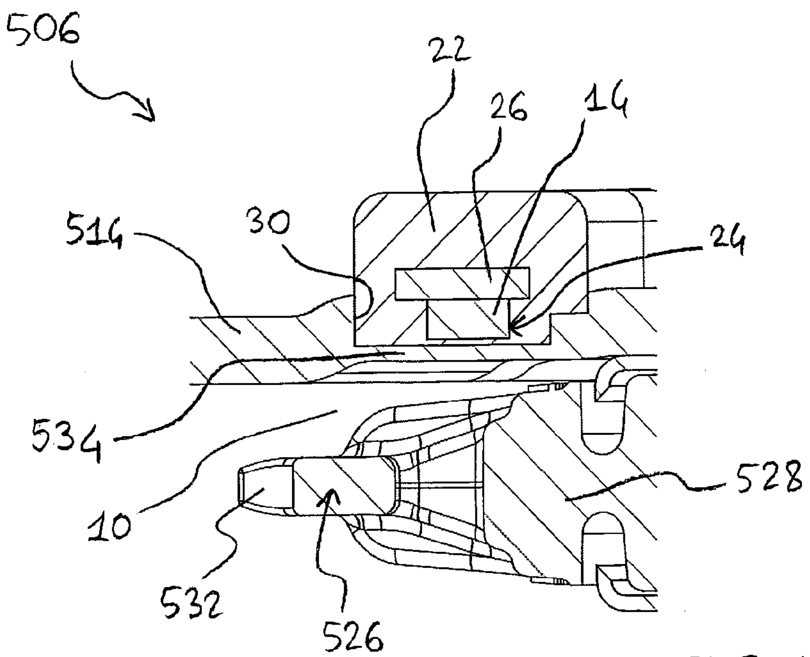
FIG. 17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526

FIG. 18

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 8633

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y A	US 2016/257269 A1 (WATARAI ETSUYOSHI [JP] ET AL) 8 September 2016 (2016-09-08) * paragraph [0088] - paragraph [0135]; figures 1-7 *	1-8,11, 14,15 9,10,12, 13	INV. G01P13/00 B62M9/122 B62M9/127 B62M9/132 B62M9/137
Y	EP 2 719 616 A2 (SRAM LLC [US]) 16 April 2014 (2014-04-16) * paragraph [0062] - paragraph [0066]; figure 9 *	1-8,11, 14,15	
Y	US 2004/138017 A1 (KITAMURA SATOSHI [JP]) 15 July 2004 (2004-07-15) * paragraph [0051] - paragraph [0066]; figures 1-6 *	3,4,8, 11,14	
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	18 May 2018	Verdelho, Luís

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