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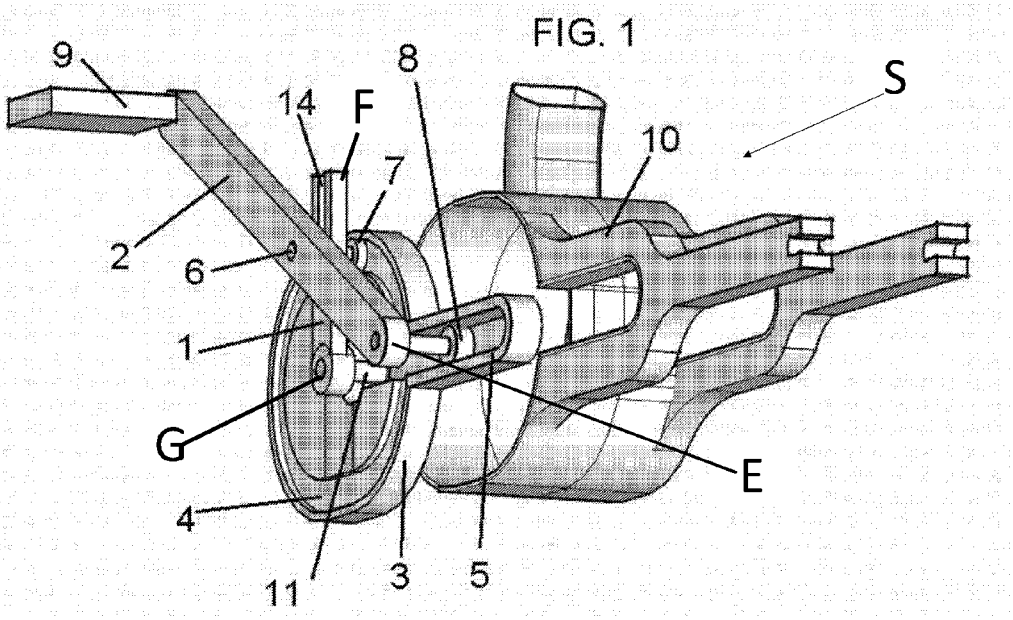
(54) Title: PEDAL PROPULSION SYSTEM

FIG. 1



(57) Abstract: Pedal propulsion system (S) comprising a shaft (11) rotatably associated with a support and integral with a ring gear (12), the shaft having two opposite ends, and in which for each of the opposite ends a first lever (1) having a first end (G) fixed on the corresponding end of the shaft and a second end (F) opposite to the first, a second lever having a first end (E) and a second end (L) opposite to the first to which a pedal (9), in which the first end is slidingly associated with a first guide (5) of longitudinal shape and operationally arranged approximately horizontally, a second guide (4) of oval or circular or quasi-elliptical or elliptical shape, or of any shape closed, also composed of portions of regular shapes, whose horizontal axis is greater than the vertical one, arranged in a plane parallel to the plane of the ring gear (12) so that an axis defined by the first guide (5) is at least secant for the second second guide a view coaxial with the shaft or hub (11), and in which a first intermediate point (6) of the second lever is constrained to follow said

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second guide, in which a second intermediate point of the second lever, arranged between the first intermediate point (6) and the first end (E) of the second lever, is slidingly associated with the second end (F) of the first lever, the first and second guides being mutually fixed forming a left unit (3) and a right unit (3 bis) arranged in a mutually specular way at the opposite ends of the shaft (11).

TITLE: PEDAL PROPULSION SYSTEM

Description

Field of the Invention

The present invention refers to a pedal propulsion system, in particular to the bicycle sector, but also applicable to quadricycles, tricycles etc.

Background

The pedal propulsion system, widely used in bicycles, includes a pair of drive arms, each generally 170/175 mm long.

The drive arms essentially consists of a crank rod which is provided with its own end fixed to a hub or central rotation shaft supported rotating inside a hollow seat of the bicycle frame. The hub or shaft is horizontal when in operating conditions, so as to operate the pair of drive arms essentially by means of the weight force of the user.

A ring gear is associated with the hub or shaft to typically rotate a chain, which meshes simultaneously with a gear wheel associated with the hub of a driving wheel.

A pedal is fixed, by means of a pivot revolving around its own axis, to the opposite end of the drive arm, so as to define an L-shaped structure with the same drive arm.

The fixed length of the drive arm arm represents the radius of a circumference drawn by the pedal when operated by a user.

The propulsion system includes a pair of drive arms arranged opposite each other, so that the user can unload his weight alternately on one or the other. The length of the drive arm arm, or the distance between the axis of rotation of the central shaft and the axis of rotation of the pedal, is determined according to the user's height. This also involves dimensional constraints on the frame of the means of transport, be it a bicycle or other.

At the state of the art in the bicycle sector and more specifically in drive arm systems, double lever systems are already known, alternative to the traditional one, which can be identified in patent applications FR842114A, US2424639A, WO9626103 A1 and EP963905 A2.

These are characterized by showing variable length drive arms. In all cases the idea is to use a first lever, comparable with the aforementioned drive arm as it has a first end hinged on the hub or shaft and a second lever having an intermediate point hinged on the second end of the first lever. Furthermore, a first end of the second lever supports a pedal in a known way, while the second end is constrained to perform an approximately horizontal translation on a guide which often coincides with the rear arm of the bicycle.

The first lever may not be present on the side where the ring gear is present so that the intermediate point of the second lever is hinged directly on the ring gear. Consequently, the central hinge point of the second lever describes a concentric circumference with the ring when in operating conditions.

Pedals according to the patent EP1132285 are also known which allow to automatically obtain an elongation of the drive arms, which are telescopic and vary their length continuously during the pedal stroke, without the possibility for the user to maintain a constant length of the drive arms

themselves. In relation to the modest advantages that can be obtained, the pedal boards according to this solution are complicated to manufacture and expensive.

According to GB2362861, the length of the drive arm can instead be set between two lengths and kept constant during the use of the bicycle. The user has the possibility to choose the greater or lesser length for each drive arm according to the needs of use. The setting of the length must generally be carried out by the user by exerting a lateral push on the pedal with the foot and then on the drive arm, and subsequently a push forward or backward on the pedal in order to translate the mobile part of the drive that is it will fit on the chosen length. With this type of solution, the user is forced to make a non-ergonomic movement with the foot during use of the bicycle, i.e. a double movement on the pedal.

It is worth highlighting that according to this last solution, the length of the drive arm remains constant as long as the user does not intervene again to change it according to the procedure described above. This implies that according to this solution, unlike those described in FR842114A, US2424639A, WO9626103 A1 and EP963905 A2, the pedals describe circumferences rather than approximately elliptical paths.

Summary of the Invention

The object of the present invention is to provide a pedal crank propulsion system whose use allows to obtain a reduction in the muscular and / or articular effort of the cyclist with respect to the known systems.

Another object is to present a pedal crank propulsion system at least alternative to those of the known art.

Another object of the present invention is to evolve the solutions shown in FR842114A, US2424639A, WO9626103 A1 and EP963905 A2 allowing the pedals to describe trajectories different from those described in these documents.

The basic idea of the present invention is to release the intermediate point of the second lever from the ring gear and / or from the first lever forcing it to follow a path other than a circular or circular and concentric path with the shaft or hub. For this reason, the intermediate point of the second lever is slidingly constrained on the first lever while following the aforementioned path.

This path is achieved by means of a special guide separate and distinct from the gear ring.

Preferably, the guide has an approximately elliptical shape and the shaft or hub is located in a point between the two foci defining the approximately elliptical shape, however the shaft or hub could also be external to the space between the two foci and the system would work anyway.

The dependent claims describe preferred variants of the present invention, forming an integral part of the present description.

Brief description of the figures

Further objects and advantages of the present invention will become clear from the following detailed description of an example of embodiment of the

same (and its variants) and from the attached drawings given purely for explanatory and non-limiting purposes, in which:

Figure 1 shows an exploded perspective view of the pedal propulsion system according to a preferred example of the present invention,

Figure 2 shows separately some components of the system of Figure 1,

Figure 3 shows additional components of the example of Figure 1 that are not visible in Figure 1,

Figure 4 shows the same assembly as Figure 3 according to a different perspective with a partial integration of a component of the system in a vehicle frame,

Figure 5 shows a further example of a component of the previous figures.

The same reference numbers and letters in the figures identify the same elements or components or functions.

In the context of this description, the term "second" component does not imply the presence of a "first" component. These terms are in fact used as labels to improve clarity and should not be understood in a limiting way.

The elements and features illustrated in the various preferred embodiments, including the drawings, can be combined with each other without however departing from the scope of the present application as described below.

Detailed description of preferred examples of the invention

With reference to Figure 1, a shaft or hub 11 is stably connected to the ring 12 visible in Figures 3 and 4 intended to drive a chain 13 or belt in a known

way. Therefore, the shaft or hub is rotatably associated with a support, for example obtained in a part of a vehicle frame directly or indirectly.

A first lever 1 has a first end G stably connected on one end of the shaft or hub and a second end F, opposite to the first, hereinafter referred to as "free". Therefore, the first lever 1 finds the fulcrum of rotation in the shaft or hub.

A second lever 2 has a first end E slidingly associated with a first guide 5 having a longitudinal shape and arranged in operating conditions approximately horizontally, for example according to any of the examples shown in the known art, and a second end L, opposite to the first, to which a pedal 9 is associated that can rotate according to an axis parallel to the axis of the shaft or hub 11. It is worth highlighting that the pedals can also have an oscillation of 90 ° or less, or a little more, with respect to the end of the lever 2 to which they are conected. According to a preferred dimensioning, the oscillation of the pedals is between 70 and 75 °.

The horizontal direction is parallel to any surface on which the vehicle is intended to move in operating conditions. Generally, the vehicle comprises at least two wheels, one front and one rear. If the wheels have the same diameter, the axis passing through the centers of rotation of the two wheels is assumed to be horizontal when the vehicle is in operating conditions.

The intermediate point 6 of the second lever is slidingly constrained in a second guide 4 which can have a simple oval, elliptical, quasi-elliptical shape, or of any closed shape, also composed of portions of regular shapes, whose horizontal axis is greater than that vertical, etc ... arranged in a plane parallel to the plane in which the ring lies and therefore in a plane perpendicular to the axis of the shaft or hub 11.

Preferably, according to a view coaxial with the shaft or hub 11, the identified axis of the longitudinal shape of the first guide 5 is secant due to the circular or oval shape defined by the second guide 4. Furthermore, again according to this view, the first guide is incident compared to the second guide.

Since the guide 5, according to this view, is secant for the shape defined by the guide 4, the latter, in the portion incident with the other guide, shows a discontinuity necessary for the pin 15 to follow the wheel 8, when this reaches its position more advanced according to the direction of the pedal stroke.

The casing 3 actually encloses the two guides 4 and 5, but this is only for convenience, because these could also be made separately. Preferably, the guide 4 lies on a more external plane than that in which the guide 5 lies, but according to a view coaxial with the hub the guide 5 extends inside the area described by the guide 4. The guide 4 has an interruption (clearly visible in fig.2), necessary for the pin 15 to cross the perimeter described by the guide 4. Otherwise the wheel 8 could not cover the guide 5 for its entire length.

It must be considered that the shorter the lever 1 is, the more the lever 2 must be able to apply the force on it with a greater multiplier effect. In the preferred embodiment, the lever 2 acts with a multiplier effect 2.5, i.e. the force arm, represented by the center distance of the ends E and L, is 2.5 times longer than the resistant arm, represented by the distance between the end E and point 6. If the guide 5 could not encroach the inner area defined by the guide 4, the resistant arm would be by far greater and consequently, also the

lever as a whole. In essence, this measure allows to contain the overall dimensions, improving the technical effect.

The whole of the first guide and the second guide are reminiscent of the lowercase "φ" according to the Greek language, where, however, the rectilinear portion is almost only external to the circular portion.

In reality, the first guide 5 is located in an innermost plane, of the plane in which the second guide 4 lies, therefore, from the outside towards the inside of each side of the propulsion system there are: the second lever, the first lever , the second guide, the first guide, the ring.

Preferably, this axis is parallel or coincident with an axis passing through the focus F1, F2 of the shape of the second guide 4.

The second lever has another intermediate point, which can be between the intermediate point 6, (included) and approximately the first end E (excluded). This other intermediate point is slidably associated with the free end of the first lever 1.

Preferably, the other intermediate point coincides with the intermediate point 6.

With reference to Figures 1 and 2, the free end of the first lever 1 has a slot that acts as a guide passing through a pin fixed on the second lever in the other intermediate point. The slot has a longitudinal shape coaxial with the development axis of the first lever itself. It can be open in the shape of a tuning fork or it can be closed at the free end.

According to the present invention, a quasi-elliptical shape is derived from a quasi-ellipse, that is, two semicircles, even of different radius, connected by two rectilinear or almost rectilinear sections.

According to Figure 1, since the intermediate point 6 coincides with the other intermediate point, then a pin 6 fixed to the second lever and operationally parallel with the shaft or hub, crosses the guide 14 to cooperate with the second guide 4. It is worth noting that the same reference 6 is used to indicate both the intermediate point and the pin fixed in the intermediate point, for descriptive convenience.

When the user pushes on the pedal 9, the second lever is bound to simultaneously follow the second guide 4 through the relative intermediate point 6 and the first guide 5 through the relative first end E, moving forward. Together with the second lever, the pin 6 also advances and progressively moves away from the end G of the lever 1, so that the arm of the lever 1 on which the pin 6 exerts the pressure is gradually greater and this happens without any mechanical component of the system changes its size.

The trajectory of the pedals is different and more comfortable than that described by the solutions of the known art. In particular, this is achieved thanks to the possibly irregular closed shape of the guide and the use of two pairs of pedals 1 and 2 simultaneously. It is not possible to achieve this result without the combination of these characteristics which therefore develop a synergistic effect.

Another feature that improves the technical effect is the fact that the longitudinal guide intersects the one having a closed shape.

To facilitate sliding in the guides, the first end E is associated with the first guide 5 preferably by means of a bearing 8 and a relative pin 15, while the intermediate point 6 is associated with the second guide 4 by means of the pin 6, associated with the guide 4 preferably by means of bearing 7.

The pin 6 itself could be equipped with a bearing or a bushing or with a ceramic coating designed to reduce friction during mutual sliding in slot 14.

As can be seen from the figures, the pedals 9 project outwards, as is usual in normal bicycles.

The pins 6 and 15 instead project in the opposite direction to the pedals 9, from the second lever 2, so as to cooperate with the guides and with the first lever 1.

According to a preferred variant of the invention, a casing 3 defines, that is, it brings together in a single component, the first and the second guide.

The casing intended to be fixed to the vehicle frame or part of it.

The vehicle can be a bicycle or a tricycle or a quadricycle.

With reference to Figure 1, the vehicle is equipped with a shaped support 10, fixed to the vehicle frame and shaped so as to receive the casings 3 on opposite sides.

The casing has a substantially flat shape and in operating conditions is perpendicular to the shaft or hub 11.

As can be seen from the figures, each drive arm has its own casing 3 for the left drive arm and 3bis for the right drive arm (not shown).

The figures show that, in operating conditions, the first lever is interposed between the second lever and the left casing 3 (or right 3 bis).

From figures 1, 3 and 4 it can be clearly seen that the casings 3 and 3bis are mirrored with respect to the longitudinal axis of the vehicle implementing the present propulsion system S.

This implies that even the guides 4 and 5, right and left, are mirrored with respect to the longitudinal axis of the vehicle.

Preferably, the shaft or hub is located in a point between the two foci defining the approximately elliptical shape of the second guide 4. More preferably, the shaft is located near the focus F2, but below the horizontal axis passing through for the two foci.

Preferably, the first guide 5 is approximately aligned with the focus of the approximately elliptical shape, of the second guide 4. More preferably, the guide 5 is approximately parallel with the horizontal axis passing through the two foci F1 and F2, but its axis is located above said horizontal axis passing through the two foci.

Preferably, the first guide 5 has a longitudinal shape defining an axis which intersects the guide 4.

In figure 3, the position of the focus F1 and F2 is indicated by the segments perpendicular to the major axis of the quasi-elliptical shape.

From what has been described up to now it is evident that the first lever 1 has a shorter length than the second lever 2, and in general the length of the first lever is clearly shorter than the length of a normal drive arm.

In the preferred embodiment, the first lever 1 has such a length that its free end overlaps the second guide 4 in each angular position of the first lever. If the intermediate points of the lever 2 do not coincide, the free end of the lever 1 may not be superimposed on the guide 4 in each angular position of the first lever.

For the purposes of the present description it is worth pointing out that the quasi-elliptical shape of the second guide 4 is oval and has no cusps which can prevent a smooth sliding of the bearing 7 therein.

Figure 5 shows an example of a second guide 4. Although this closed figure is less regular than the solution of Figures 1 - 4, it too can be used for the present purposes, since in relation to the selected bearing, also the presence of moderate cusps may not prevent fluid sliding of the bearing itself.

Figure 5 is particularly relevant because it makes it clear that, in compliance with the concept of oval shape (approximately rounded closed shape), the left portion of the guide 4 is more rounded than the right one, since the left one, in accordance with the representations of the previous figures, corresponds to the pedaling phase, in which the user charges his weight on the pedal. Other oval shapes can be identified as long as the horizontal axis is greater than the vertical axis of the guide. It is clear that the horizontal and vertical axes have a clear meaning when we consider driving in operating conditions, i.e. fixed to the propulsion system and connected to the vehicle chassis.

Due to the fact that the first guide 5 is aligned with the focus of the quasi-elliptical shape it is evident that the second guide has an axis, the operationally horizontal one, greater than the other.

Advantageously, when the user charges his weight on the pedal, he is with the lever 2 in the most advanced position with respect to the pedaling direction with the end E of the second lever proximal to the shaft or hub 11.

With reference to Figures 1 and 4, the ring 12 is located between the two casings 3, 3bis, to drive the chain 13 which meshes with the pinion integral with the hub of the driving wheel.

An essential aspect of the present invention is that the first lever and the second lever are mutually associated in a sliding manner.

Also in this case, a beneficial extension of the arm of the system is obtained in correspondence with the pedal stroke by the user.

Advantageously, the lengthening of the lever arm obtaining greater pedaling efficiency and comfort.

By means of this system S it is possible to make the traditional pedaling mechanism more effective, also considerably improving and simplifying known telescopic systems.

In fact, this configuration certainly creates an advantage in overcoming the top dead center, which can be tackled with a less closed knee angle, but the greatest advantage is the possibility of lengthening the levers without exceeding the biomechanical limits that the human body imposes. If the traditional drive arms have a length that can vary from 170 mm to 180 mm, this is due to the fact that beyond these measures the pedaling would lose efficiency, therefore any type of elongation, even if telescopic, would be ineffective. The system S object of the present invention despite the extension of the arm of the system during pedaling, is able to contain the distance between the pedals according to an operationally horizontal axis, allowing to obtain elongation of the lever arm, on which to apply the force, unrealizable according to known systems.

Implementation variants of the described non-limiting example are possible, without however departing from the scope of protection of the present invention, including all the equivalent embodiments for a person skilled in the art, to the content of the claims.

From the above description, the person skilled in the art is able to realize the object of the invention without introducing further construction details.

CLAIMS

1. Pedal propulsion system (S) comprising

- a shaft (11) rotatably associated to a support and fixed with a ring gear (12), the shaft having to opposite ends, ad wherein for each of the opposite ends:

- a first lever (1) having a first end (G) fixed on a corresponding end of the shaft and a second end (F) opposite to the first one,

- a second lever (2) having a first end (E) and a second end (L) opposite to the first, in which a pedal (9) is associated with the second end, and the first end is slidingly associated with a first guide (5),

- a first guide (5) having longitudinal shape,

- a second guide (4) having oval or quasi-elliptical or elliptical shape, or of any closed shape, even consisting of portions of regular shapes, whose horizontal axis is greater than the vertical one, arranged in a plane parallel to a plane of the ring gear (12), and wherein a first intermediate point (6) of the second lever is bound to follow said second guide,

wherein said first intermediate point of the second lever is slidingly associated to the second end (F) of the first lever,

the first and the second guides being reciprocally fixed forming a left set (3) and a right set (3bis) arranged at the opposite ends of the shaft (11) to support a second left lever and a second right lever.

2. System according to claim 1, wherein said sliding coupling between said intermediate point of the second lever and the second end (F) of the first lever is able to compensate for a geometric diversity between the

circumference described by the second end (F) during the relative rotation around the first end (G) and the second guide (4).

3. System according to claim 2, wherein said geometric diversity can consist in the fact that said second guide is circular and eccentric with respect to the shaft (11), or has an oval, elliptical or quasi-elliptical shape or of any closed shape, also composed of portions of regular shapes, the whose horizontal axis is greater than the vertical one, eccentric with respect to the shaft (11).

4. System according to any one of the preceding claims, wherein when said second guide is oval, elliptic or quasi-elliptic, or of any closed shape, even consisting of portions of regular shapes, whose horizontal axis is greater than the vertical one, the shaft is in an intermediate point between the two foci (F1, F2) defined by the second guide, or in one of the two foci and/or above or below a major axis defined by the second guide shape.

5. System according to claim 4, wherein said first guide is, according to a view coaxial with the shaft or hub (11), secant with respect to the second guide and/or secant and parallel or coaxial with said major axis.

6. System according to claim 5, wherein the first guide is completely separate from the second guide or is incident with the second guide by means of a relative first end.

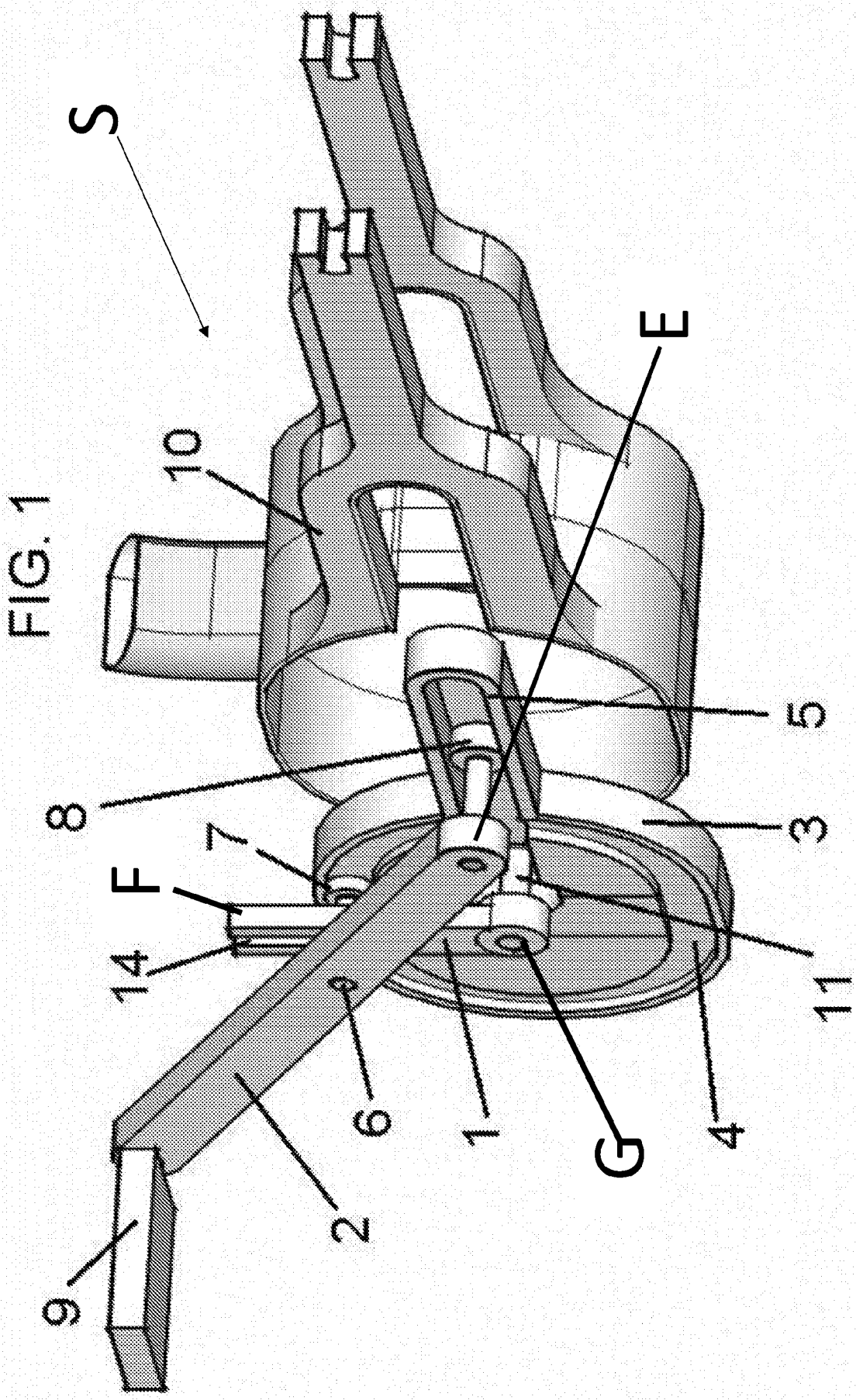
7. System according to any one of the preceding claims, wherein said second lever is associated with said first and second guide by means of friction

reduction means selected from bearings (7, 8), bushings or coatings in low friction materials.

8. System according to any one of the preceding claims, wherein each of said left and right sets define a component separate from a vehicle frame or are defined by a vehicle frame.

9. Human-powered vehicle, such as a bicycle, a tricycle or a quadricycle, comprising a propulsion system (S) according to any one of the preceding claims and a driving wheel operatively rotated directly or indirectly by said ring gear (12).

FIG. 1



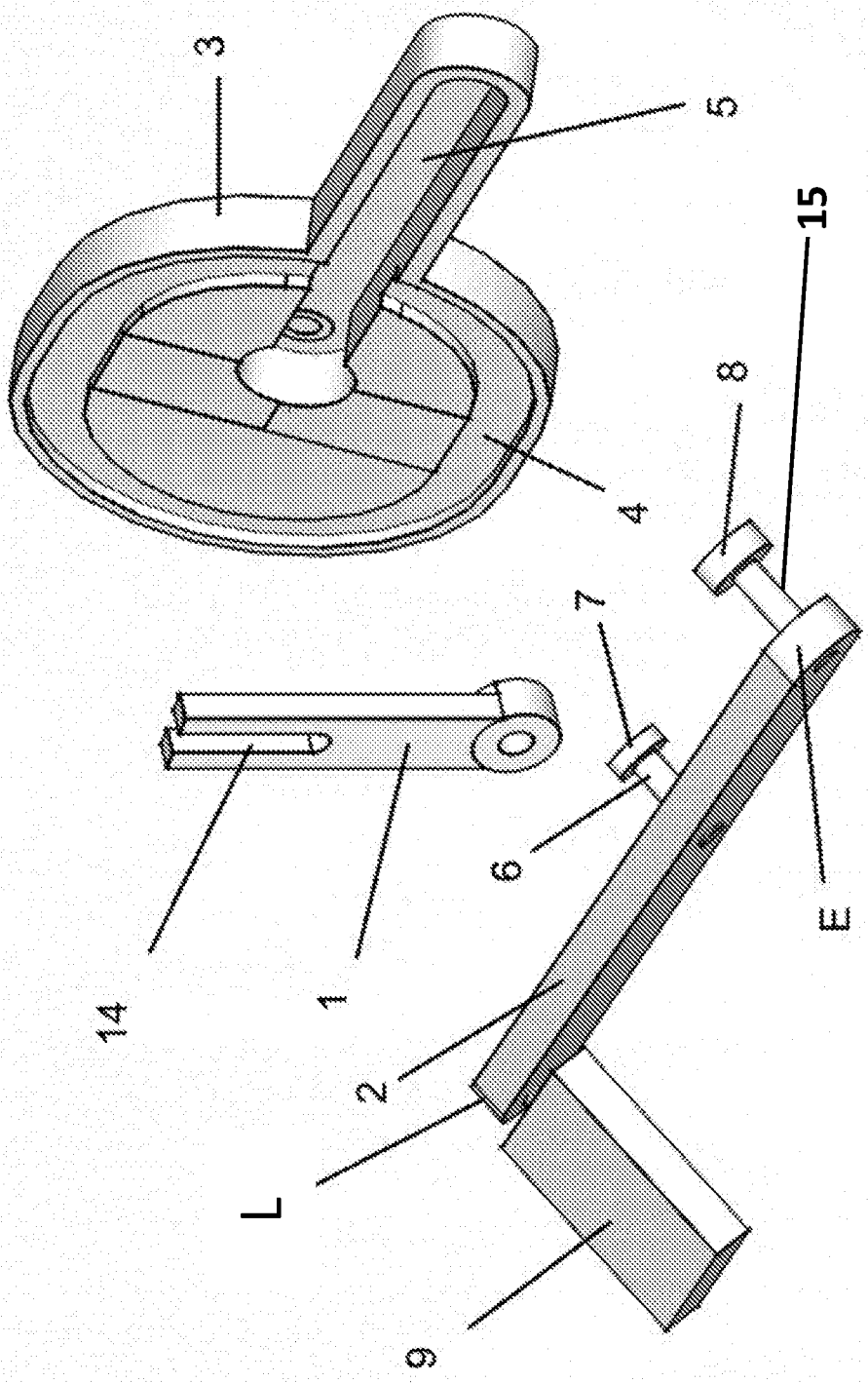


FIG. 2

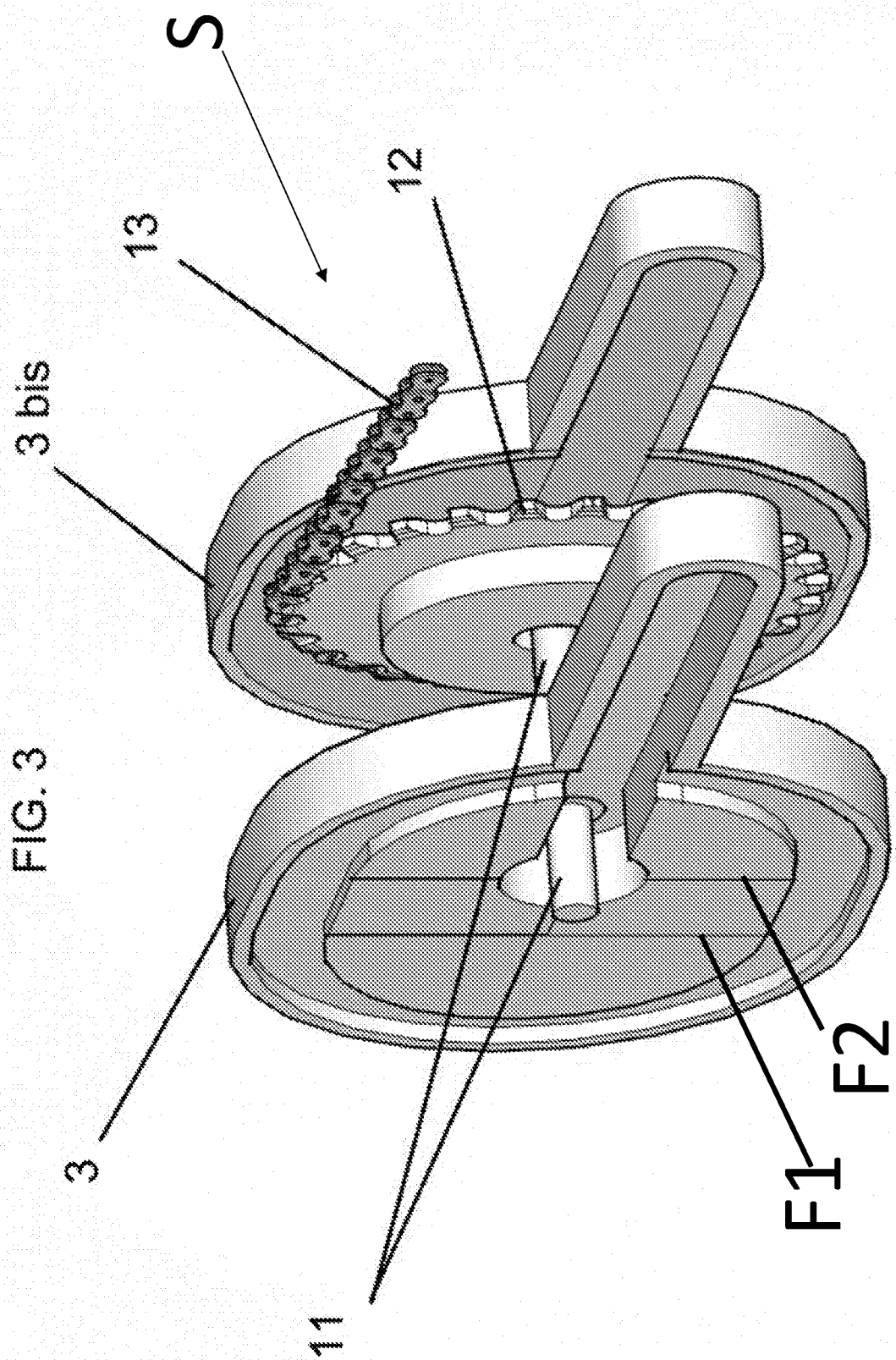


FIG. 3

FIG. 4

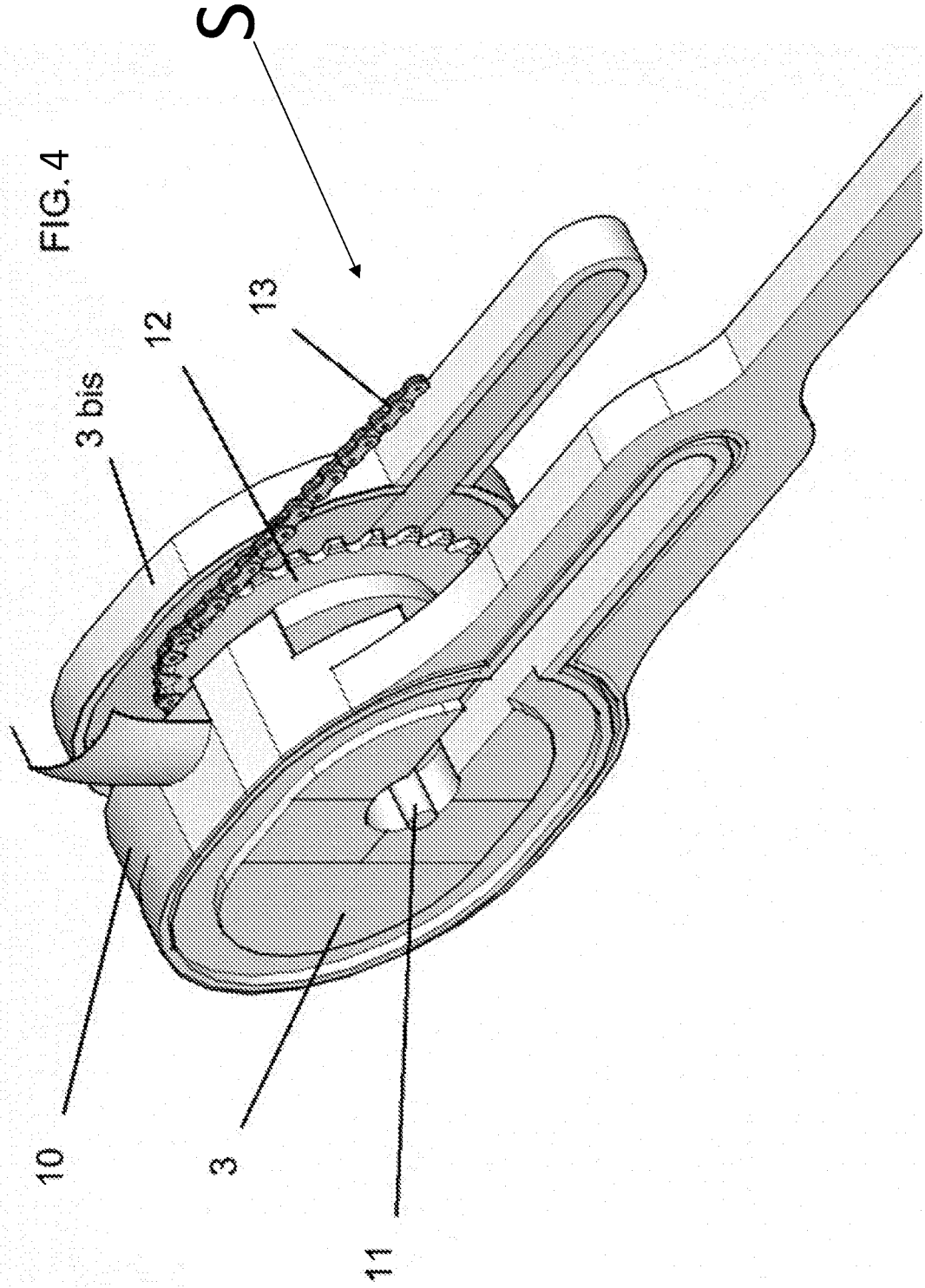
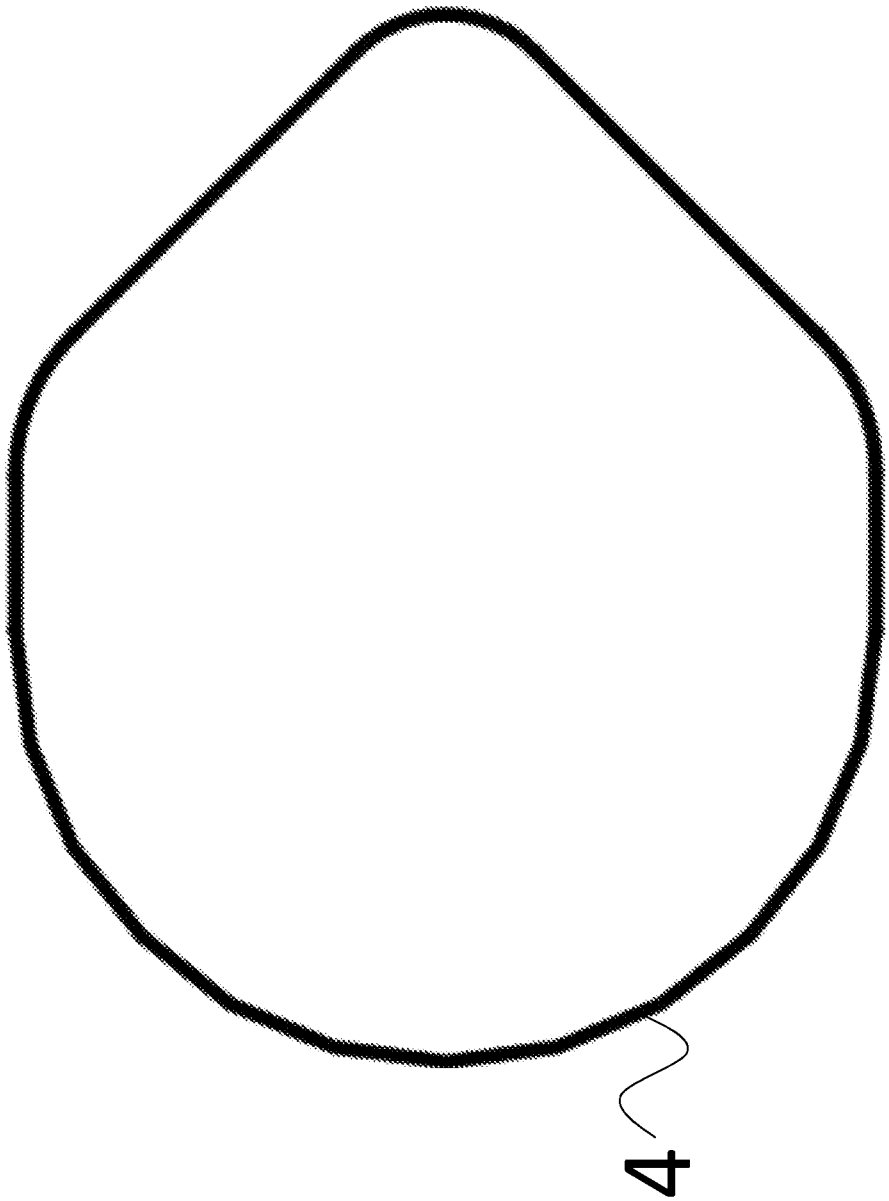


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B62M3/04 B62M3/06 B62M1/26
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B62M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 12526 A A.D. 1896 (ANDERSON JUAN [DE]) 17 April 1897 (1897-04-17) figure 1	1-9
X	EP 1 000 849 A2 (SONY CORP [JP]) 17 May 2000 (2000-05-17) figures 2,6	1-9
X	US 1 577 585 A (FRANCK MONTIGLIO) 23 March 1926 (1926-03-23) figures 2-3	1-9
A	US 653 873 A (MALONE JAMES ANDREW [US]) 17 July 1900 (1900-07-17) figures 1-5	1-9

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2021/059937

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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