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A Propulsion System for a Vehicle

Field of the invention

This invention relates to a propulsion system for a vehicle.

Background of the Invention

To propel a conventional bicycle, a user is required to move his or her legs in a circular motion so as to rotate each pedal of the conventional bicycle through an angle of 360° (i.e. a full circle) about a pivoting point. The motion of a pedal 102 of a conventional bicycle is shown in Fig. 1(a) whereby the downward movement of the pedal 102 through the first 180° is referred to as the working stroke whereas the upward motion of the pedal 102 through the next 180° is referred to as the return stroke.

Fig. 1(b) illustrates an efficiency plot for a propulsion system used for a conventional bicycle during the working stroke. As shown in Figure 1(b), the efficiency of the propulsion system is low throughout a significant portion of the working stroke and is above a level 104 only when the angle of the pedal 102 with respect to the vertical axis is in the range of approximately 90°-22.5° to 90°+22.5°. Therefore, the overall efficiency of the propulsion system in a conventional bicycle is low.

Summary of the invention

According to a first aspect of the present invention, there is provided a propulsion system for a vehicle, the propulsion system comprising: a transmission system arranged to propel at least one wheel of the vehicle; a pedal assembly having a first and second elongate members pivotably connected to a fulcrum, each of the first and second elongate members being configured to alternate between a first position and a second position to drive the transmission system to propel the at least one wheel; wherein a relative angle between the first and second elongate members, with respect to the fulcrum, forms an angle of less than 180 degrees. This can increase the efficiency of the propulsion system.

Preferably, the relative angle between the first and second elongate members, with respect to the fulcrum, forms an angle of less than or equal to 45 degrees. This can further increase the efficiency of the propulsion system.

The propulsion system may further comprise an alternating device arranged to urge the first and second elongate members to alternate between the first and second positions. The alternating device allows for the reciprocating and alternating movement of the first and second elongate members.

The alternating device may comprise a first interconnecting system having: a sprocket; an idler sprocket; and a chain arranged to cooperate with the sprocket and the idler sprocket; wherein the chain is configured to urge the first and

second elongate members to move in opposite directions to each other about the fulcrum. The first interconnecting system allows for the reciprocating and alternating movement of the first and second elongate members.

The alternating device may comprise a second interconnecting system having: a pivoting lever; wherein the first and second elongate members are connected to respective ends of the pivoting lever, the pivoting lever configured to urge the second elongate member to the second position when the first elongate member is being urged to the first position. The second interconnecting system allows for the reciprocating and alternating movement of the first and second elongate members as well. Furthermore, the second interconnecting system comprises only a single component, that is, the pivoting lever and therefore allows for easy manufacturing and maintenance.

The propulsion system may further comprise a resilient member arranged between each of the first and second elongate members and a respective end of the pivoting lever. This helps to accommodate any migration of the elongate members due to the movement of the elongate members and the pivoting lever. It should be appreciated that the pivoting lever should be placed very close to the fulcrum of the elongated members to minimize the migration.

Alternatively, the propulsion system may further comprise a rotatable member arranged between each of the first and second elongate members and a respective end of the pivoting lever, the rotatable member being rotatable about

the respective end of the pivoting lever, each of the elongate members having a longitudinal axis which remains substantially perpendicular to a direction of a force exerted on each of the elongate members. This is advantageous as it is easier for the user to pedal in this way. Furthermore, the amount of force translated to the wheel of the vehicle may be larger when the direction of the force exerted on the elongate members is substantially perpendicular to the longitudinal axes of the elongate members.

The propulsion system may further comprise a resilient element arranged between each of the first and second elongate members and the respective end of the pivoting lever, to allow the first and second elongate members to be movable along a length of the respective rotatable member. This helps to reduce the amount of stress on the elongate members during the movement of the pivoting lever.

The pivoting lever may be arranged to be movable along a length of a pivot. This allows the position of the pivoting lever to be adjusted according to the position of the elongate members.

The alternating device may comprise a baffle gear arrangement having: a first baffle gear driven by the first elongate member; a second baffle gear driven by the second elongate member; and a centre baffle gear meshed with the first and second baffle gears and arranged to urge the second elongate member to the second position when the first elongate member is being urged to the first

position. The baffle gear arrangement allows the movement of the elongate members to be smoother.

The propulsion system may further comprise a first pedal, a second pedal and a connecting member arranged between the first and second pedals and the first and second elongate members respectively to allow the first and second pedals to be adjustable along a length of the first and second elongate members respectively. Alternatively, the propulsion system may further comprise a first plurality of pedals arranged to drive the first elongate member and a second plurality of pedals arranged to drive the second elongate member. The propulsion system may further comprise a connecting member arranged between the first and second plurality of pedals and the first and second elongate members respectively to allow the first and second plurality of pedals to be adjustable along a length of the first and second elongate members respectively. The connecting member may be a lever, a piston or a screw thread.

This is advantageous as the user can adjust the position of the pedals according to his or her preferences. In addition, changing the positions of the pedals along the length of the elongate members changes the amount of force exerted on the wheel of the vehicle even though the user may be exerting the same amount of force as before. Therefore, it is possible for the user to adjust the positions of the pedals according to the terrain the vehicle is required to be propelled on.

Alternatively, the propulsion system may further comprise a first adjustable member and a second adjustable member arranged to be movable along the first and second elongate members respectively; a first pedal and a second pedal respectively arranged at a fixed position on the first elongate member and the second elongate member, wherein the relative position between the first or second adjustable member and a corresponding first or second pedal is adjustable. This is advantageous as it allows a user to adjust the force exerted on the elongate members according to the terrain the vehicle is required to be propelled on.

The transmission system may comprise: a first sprocket arrangement arranged to propel the at least one wheel of the vehicle; and a first chain arranged to cooperate with the first sprocket arrangement; wherein the first elongate member is arranged to move the first chain which in turn is arranged to drive the first sprocket arrangement to propel the at least one wheel of the vehicle.

The transmission system may further comprise: a second sprocket arrangement; an axle arranged to connect the second sprocket arrangement and the first sprocket arrangement; a second chain arranged to cooperate with the second sprocket arrangement, wherein the second elongate member is arranged to move the second chain which in turn is arranged to drive the second sprocket arrangement, the second sprocket arrangement being arranged to drive the axle and the first sprocket arrangement. This allows for easier manufacturing and maintenance.

Alternatively, the transmission system may further comprise: a second sprocket arrangement arranged to propel the at least one wheel; and a second chain arranged to cooperate with the second sprocket arrangement; wherein the second elongate member is arranged to move the second chain which in turn is arranged to drive the second sprocket arrangement to propel the at least one wheel of the vehicle. In such a transmission system, the wheel of the vehicle is connected to two sprockets of the transmission system whereby the wheel is alternately driven by the two sprockets. This can give rise to a higher efficiency. Furthermore, since the first sprocket arrangement and the second sprocket arrangement are not connected to each other, the positions of the first and second sprocket arrangements can be adjusted independently.

The transmission system may further comprise spring loaded idler sprockets arranged to maintain tension of the first and second chains.

The propulsion system may further comprise an assembly arranged to engage the chain to move in response to the movement of the first or second elongate member from the first position to the second position and further arranged to disengage with the chain in response to the movement of the first or second elongate member from the second position to the first position. The assembly may be arranged between each of the first and second chains and each of the first and second elongate members respectively. The assembly may comprise a gear unit comprising a wheel; a sprocket arranged to rotate with the wheel of the gear unit and further arranged to engage the chain; at least one lock

arranged to allow the wheel of the gear unit to rotate in only one direction; the sprocket, the gear unit and the at least one lock arranged such that (i) when the elongate member moves from the first position to the second position, the wheel of the gear unit is prevented from rotating, in turn preventing the sprocket from rotating and in turn allowing the assembly to engage with the chain to move; and (ii) when the elongate member moves from the second position to the first position, the wheel of the gear unit is arranged to rotate, in turn rotating the sprocket about the chain and in turn allowing the assembly to disengage with the chain. This arrangement allows one of the elongate members in the pedal assembly to move upwards while both chains in the transmission system are being driven downwards.

The transmission system may be disposed partially within the circumference of the at least one wheel of the vehicle. Preferably, the transmission system is disposed fully within the circumference of the at least one wheel of the vehicle. In this case, the elongate members may be longer and the angle through which the elongate members have to move to propel the at least one wheel can be smaller.

According to a second aspect of the present invention, there is provided a propulsion system comprising a pedal assembly comprising a first pedalling member; and a transmission system connected to the pedal assembly; wherein the transmission system comprises: a first sprocket arrangement arranged to propel at least one wheel of the vehicle; and a first chain arranged to cooperate

with the first pedalling member; wherein the first pedalling member is arranged to move the first chain which in turn is arranged to drive the first sprocket arrangement to propel the at least one wheel of the vehicle.

Brief Description of the Figures

Embodiments of the invention will now be illustrated for the sake of example only with reference to the following drawings, in which:

Fig. 1(a) illustrates the operation of a propulsion system in a bicycle in the prior art and Fig. 1(b) illustrates its efficiency plot;

Fig. 2 illustrates a bicycle comprising a propulsion system according to a preferred embodiment of the present invention;

Fig. 3(a) illustrates a magnified view of the propulsion system of Fig. 2 comprising a pedal assembly and a transmission system and Fig. 3(b) illustrates a further magnified view of a part of the propulsion system of Fig. 3(a);

Fig. 4 illustrates the components used in the connection of the pedal assembly to the transmission system of Figs. 3(a) and 3(b);

Figs. 5(a) and 5(b) illustrate the assembly of the components of Fig. 4;

Figs. 6(a) to 6(d) illustrate the operation of the assembly of Figs. 5(a) and 5(b).

Fig. 7(a) illustrates the operation of a propulsion system according to a preferred embodiment of the present invention and Fig. 7(b) illustrates its efficiency plot;

Fig. 8(a) illustrates a magnified view of a transmission system that is a variation of the transmission system of the propulsion system of Fig. 2 and Fig. 8(b) illustrates a further magnified view of a part of the transmission system of Fig. 8(a);

Fig. 9 illustrates a bicycle comprising a pedal assembly that is a variation of the pedal assembly in the propulsion system of Fig. 2;

Figs. 10(a), 10(b) and 10(c) respectively illustrate a cross-sectional side view, a cross-sectional top view and a 3D view of the pedal assembly of Fig. 9;

Fig. 11 illustrates a bicycle comprising a pedal assembly that is another variation of the pedal assembly of the propulsion system of Fig. 2;

Figs. 12(a) and 12(b) respectively illustrate a 3D view and a cross-sectional top view of the pedal assembly of Fig. 11 whereas Fig. 12(c) illustrates components used in the pedal assembly of Fig. 11;

Fig. 13 illustrates a scooter including the propulsion system of Fig. 2;

Fig. 14 illustrates an arrangement whereby the transmission system of the propulsion system of Fig. 8(a) fully overlaps with the wheel of the bicycle of Fig. 8(a);

Fig. 15 illustrates an assembly which adjusts the amount of force exerted on a pedalling bar of the pedal assembly of Fig. 2;

Figs. 16(a) and 16(b) illustrate an assembly that is a variation of the assembly of Fig. 15.

Fig. 17 illustrates a direct connection between pedalling bars of the pedal assembly of Fig. 8(a) and chains of the transmission system of Fig. 8(a).

Detailed Description of the Embodiments

Referring to Fig. 2, a vehicle in the form of a bicycle 200 is shown comprising a propulsion system 202 according to a preferred embodiment of the present invention. Fig. 3(a) shows a magnified version of the propulsion system 202 whereas Fig. 3(b) shows a further magnified version of a part of the propulsion system 202.

The propulsion system 202 in the preferred embodiment comprises two main parts: 1. a pedal assembly 300 and 2. a transmission system 302.

1. Pedal assembly 300

The pedal assembly 300 comprises two elongate members in the form of a first pedalling bar 304 and a second pedalling bar 306 with first and second pedals 308 and 310 attached respectively. The pedal assembly 300 further comprises an alternating device comprising an interconnecting system for operably connecting the first pedalling bar 304 and the second pedalling bar 306. The interconnecting system in turn comprises a sprocket 312, an idler sprocket 314 and a chain 316 with the chain 316 forming an endless loop around the sprocket 312 and the idler sprocket 314. The pedalling bars 304 and 306 are in turn connected to the chain 316 on opposite sides of the sprocket 312 such that a downward movement of the first pedalling bar 304 rotates the chain 316 in a direction X, resulting in an upward movement of the second pedalling bar 306.

The opposite takes place during the downward movement of the second pedalling bar 306.

The pedal assembly 300 further comprises a stopper 309 connected to the bicycle frame and arranged to prevent the pedalling bars 304 and 306 from moving beyond a particular position during their downward movement.

The pedal assembly 300 is connected to the bicycle frame of the bicycle 200 (shown in Fig. 2) by connecting one end of each of the pedalling bars 304 and 306 to a rod 318. The rod 318 in turn passes through the intersection between a head tube 204 and a down tube 206 of the bicycle frame as shown in Fig. 2. Alternatively, the rod 318 may pass through any part of the head tube 204 of the bicycle frame. The sprocket 312 and the idler sprocket 314 of the interconnecting system of the pedal assembly 300 are also connected to the bicycle frame via a spring so as to maintain the tension in the chain 316 throughout the motion of the pedalling bars 304 and 306. Alternatively, the spring may be replaced by any resilient member.

2. Transmission system 302

The transmission system 302 serves to transmit a force generated by motion of the first pedalling bar 304 and the second pedalling bar 306 of the pedal assembly 300 to a wheel 320 of the bicycle 200 of Fig. 2 to propel the wheel 320.

The transmission system 302 includes two sets of sprocket arrangements 322 and 324 interconnected by an axle in the form of an interconnecting shaft 326. The transmission system 302 is connected to the bicycle frame of the bicycle 200 (shown in Fig. 2) using suitable connecting means.

The first set of sprocket arrangement 322 is arranged to be driven by the first pedalling bar 304 and this will be elaborated later. The first set of sprocket arrangement 322 includes an upper sprocket 328, a wheel sprocket 330 and an idler sprocket 332 being arranged in a substantially star arrangement. Teeth of the sprockets 328, 330, 332 are arranged to mesh with parts of a chain 334 which forms an endless loop around each of these sprockets 328, 330, 332 such that when the chain 334 is driven to move in the direction Y, the movement of the chain 334 thus rotates the upper sprocket 328, idler sprocket 332 and also the wheel sprocket 330. The wheel sprocket 330 is connected to a wheel hub (not shown in Fig. 3(a) or 3(b)) which is in turn connected to the wheel 320. The wheel hub further comprises one unidirectional clutch arranged to operate with the wheel sprocket 330.

Furthermore, the portion of the chain 334 between the idler sprocket 332 and the wheel sprocket 330 passes over a spring loaded idler sprocket 336 which maintains the tension in the chain 334.

As shown in Fig. 3(a), the first pedalling bar 304 is connected to the portion of the chain 334 between the upper sprocket 328 and the idler sprocket

332. Applying a downward force on the first pedal 308 results in a downward movement of the first pedalling bar 304. This drives the chain 334 in the first set of sprocket arrangement 322 to move in the direction Y, hence rotating the wheel sprocket 330, in turn propelling the wheel 320 into motion or increasing the motion of the wheel 320.

The second set of sprocket arrangement 324 is driven by the second pedalling bar 306 and includes an upper sprocket 338 and a lower sprocket 340 arranged approximately below the upper sprocket 338. Teeth of the upper and lower sprockets 338, 340 are arranged to mesh with certain parts of a chain 342 which forms an endless loop around these sprockets 338,340 such that when the chain 342 is driven to move in the direction Z, the movement of the chain 342 rotates the upper and lower sprockets 338, 340.

Furthermore, a first portion of the chain 342 between the upper sprocket 338 and the lower sprocket 340 passes over a spring loaded idler sprocket 344 which maintains the tension in the chain 342.

As shown in Fig. 3(a) and 3(b), the second pedalling bar 306 is connected to a second portion of the chain 342 opposite the first portion of the chain 342 between the sprockets 338 and 340 of the second set of sprocket arrangement 324. Applying a downward force on the second pedal 310 results in a downward movement of the second pedalling bar 306. This in turn drives the chain 342 of the second set of sprocket arrangement 324 in the direction Z, hence rotating

the upper sprocket 338 of the second set of sprocket arrangement 324. Since the upper sprocket 328 of the first set of sprocket arrangement 322 and the upper sprocket 338 of the second set of sprocket arrangement 324 are connected via the interconnecting shaft 326, the rotation of the upper sprocket 338 of the second set of sprocket arrangement 324 is transmitted to the upper sprocket 328 of the first set of sprocket arrangement 322 and thus the upper sprocket 328 of the first set of sprocket arrangement 322 is rotated as well. This in turn drives the chain 334 of the first set of sprocket arrangement 322 to move in the direction Y, hence rotating the wheel sprocket 330, in turn propelling the wheel 320 into motion or increasing the motion of the wheel 320.

3. Connection of pedalling bars in pedal assembly 300 to transmission system 302

The upward movement of the pedalling bars 304, 306 in the pedal assembly 300 is independent of the movement of the chains 334 and 342 connected to them respectively. In other words, the first pedalling bar 304 can move upward to return to the top position even when both the chains 334, 342 in the transmission system 302 are being driven downward by the second pedalling bar 306, and vice versa. The arrangement of the pedalling bars 304, 306 and the chains 334, 342 to achieve this will now be described, with reference to the first pedalling bar 304 and the chain 334 in the first set of sprocket arrangement 322. It should be appreciated that the same arrangement applies to the second

pedalling bar 306 and the chain 342 in the second set of sprocket arrangement 324.

In the preferred embodiment, the pedalling bar 304 and the chain 334 are connected to each other in a manner as shown in Figs. 5(a) and 5(b) using the components shown in Fig. 4. These components comprise a nut 402, a chain guard 404, a sprocket 406, a spacer 408, bearings 410, a key 412, pins 414, locks 416, stops 418, springs 420, a gear unit 422, bolts 424 and a cover 426. The chain guard 404 is configured to prevent derailing of the chain 334.

Figs. 5(a) and 5(b) illustrate a 3D view and a cross-sectional top view showing the connection between the first pedalling bar 304 and the chain 334 of the first set of sprocket arrangement 322 as seen from the top of the bicycle 200. As shown in Figs. 5(a) and 5(b), a shaft of the gear unit 422 is connected to the sprocket 406 through the first pedalling bar 304 to allow the sprocket 406 to rotate together with a wheel of the gear unit 422. The sprocket 406 is, in turn, meshed with the chain 334 to allow the chain 334 to move together with the sprocket 406 when the sprocket 406 is not rotating. Bearings 410 is located within the first pedalling bar 304 around the shaft of the gear unit 422 to facilitate the rotation of the shaft within the first pedalling bar 304 as the wheel of the gear unit 422 rotates. Locks 416 lock the teeth of the wheel of the gear unit 422 to cause the wheel of the gear unit 422 to rotate in only one direction.

Figs. 6(a) to 6(d) illustrate the operation of the assembly of Figs. 5(a) and 5(b).

As shown in Figs. 6(a) to 6(d), as the first pedalling bar 304 is depressed in the direction A, the locks 416 lock the teeth of the wheel of the gear unit 422 and prevent the wheel of the gear unit 422 from rotating. Therefore, the sprocket 406 connected to the gear unit 422 is prevented from rotating as well. Since the sprocket 406 is connected to the first pedalling bar 304 via the gear unit 422, it moves downward together with the first pedalling bar 304. The downward movement of the sprocket 406 in turn drives the chain 334 of the first set of sprocket arrangement 322 downward.

On the other hand, during the upward movement of the first pedalling bar 304 in the direction B as shown in Fig. 6(d), the wheel of the gear unit 422 is free to rotate. The sprocket 406 is hence free to rotate along the chain 334 of the first set of sprocket arrangement 322. As a result, the movement of the sprocket 406 is independent of the movement of the chain 334 of the first set of sprocket arrangement 322 as the first pedalling bar 304 moves upward.

Fig. 7(a) shows a simplified view of the movement of the first pedalling bar 304 of the propulsion system 202 according to the preferred embodiment of the present invention. As shown in Fig. 7(a), the first pedalling bar 304 moves from a first position to a second position through an angle of 45 degrees. Fig 7(b) shows an efficiency plot of the propulsion system 202. As shown in Fig. 7(b), the overall efficiency of the propulsion system 202 is higher than that of the propulsion system in a conventional bicycle (as shown in Figs. 1(a) and 1(b)).

Furthermore, the propulsion system 202 employs the lever principle such that a small force applied on the pedalling bars 304, 306 in the pedal assembly 300 can be translated into a large force at the wheel 320 of the bicycle 200.

Although the propulsion system 202 has been described using a preferred embodiment, many variations are possible within the scope of the claims, as will be clear to a skilled reader, without departing from the scope of the invention as claimed. For example, the transmission system 302 may be replaced by a variation as shown in Figs. 8(a) and 8(b) whereas the pedal assembly 300 may be replaced by the pedal assembly 902 as shown in Figs. 9 and 10 or the pedal assembly 1102 as shown in Figs. 11 and 12. The variation will now be described.

Transmission system 802

Referring to Fig. 8(a), a propulsion system 800 is shown comprising a pedal assembly 300' and a transmission system 802. The transmission system 802 of Fig. 8(a) is a variation of the transmission system 302 of the preferred embodiment. The pedal assembly 300' is similar to the pedal assembly 300 of Fig. 3(a) and thus, the same parts will have the same reference numerals, with addition of prime.

The transmission system 802 includes two sets of sprocket arrangements 804, 806 which are not interconnected unlike those shown in Fig. 3(a). The

transmission system 802 is also connected to the bicycle frame (not shown in Figs. 8(a) or 8(b)) using suitable connecting means.

The first set of sprocket arrangement 804 of the transmission system 802 is arranged to be driven by a first pedalling bar 304' and this will be elaborated later. The first set of sprocket arrangement 804 includes an upper sprocket 808, a wheel sprocket 810 and an idler sprocket 812 which are arranged with a chain 814 in the same manner as the first set of sprocket arrangement 322 in the transmission system 302 of the preferred embodiment. The wheel sprocket 810 is in turn connected to a wheel hub 816 which is in turn connected to the wheel 818 and the bicycle frame (not shown in Fig. 8(a) or 8(b)).

Furthermore, similar to the transmission system 302 of the preferred embodiment, the portion of the chain 814 between the idler sprocket 812 and the wheel sprocket 810 passes over a spring loaded idler sprocket 820 which maintains the tension in the chain 814 of the first set of sprocket arrangement 804.

As shown in Fig. 8(a), the first pedalling bar 304' is connected to the portion of the chain 814 between the upper sprocket 808 and the idler sprocket812. Applying a downward force on the first pedal 308' results in a downward movement of the first pedalling bar 304'. This drives the chain 814 to move in the direction Y', hence rotating the wheel sprocket810 of the first set of sprocket

arrangement 804, in turn propelling the wheel 818 into motion or increasing the motion of the wheel 818.

The second set of sprocket arrangement 806 of the transmission system 802 is driven by a second pedalling bar 306' and also includes an upper sprocket 822, a wheel sprocket 824 and an idler sprocket 826 arranged with a chain 828 in a manner which is a mirror image of the first set of sprocket arrangement 804 of the transmission system 802. The wheel sprocket 824 of the second set of sprocket arrangement 806 is also connected to the wheel hub 816. The wheel hub 816 further comprises two unidirectional clutches with each unidirectional clutch arranged to operate with each of the wheel sprockets 810 and 824.

Furthermore, the portion of the chain 828 between the idler sprocket 826 and the wheel sprocket 824 of the second set of sprocket arrangement 806 also passes over a spring loaded idler sprocket 830 which serves to maintain the tension in the chain 828 of the second set of sprocket arrangement 806.

As shown in Fig. 8(a) and 8(b), the second pedalling bar 306' is connected to the portion of the chain 828 between the upper sprocket 822 and the idler sprocket 826 of the second set of sprocket arrangement 806. Applying a downward force on the second pedal 310' results in a downward movement of the second pedalling bar 306'. This drives the chain 828 of the second set of sprocket arrangement 806 to move in the direction Z', hence rotating the wheel

sprocket 824 of the second set of sprocket arrangement 806, in turn propelling the wheel 818 into motion or increasing the motion of the wheel 818.

As it can be appreciated, with the above arrangement, the wheel 818 is driven separately by each of the pedalling bars 304', 306' and its corresponding sprocket arrangements 804 and 806. Since the upper sprockets 808 and 822 of the first and second sets of sprocket arrangements 804 and 806 are not interconnected, an advantage of the transmission system 802 is that the positions of the first and second sets of sprocket arrangements 804 and 806 can be adjusted independently.

Pedal assembly 902

Referring to Fig. 9, a bicycle 900 is shown comprising a pedal assembly 902 which is a variation of the pedal assembly 300 of the preferred embodiment. A magnified view of the pedal assembly 902 is shown in Figs. 10(a) to 10(c) in which Figs. 10(a) and 10(b) illustrate cross-sectional views of one half of the pedal assembly 902 as respectively seen from the rear and from the top of the bicycle 900 whereas Fig. 10(c) illustrates a 3D view of the pedal assembly 902 as seen from the left side of the bicycle 900.

The pedal assembly 902 includes a first pedalling bar 1004 and a second pedalling bar 1006 with first and second pedals 1008 and 1010 attached respectively. The pedal assembly 902 includes an alternating device comprising

an interconnecting system having a pivoting lever1012 for operably connecting the first and second pedalling bars 1004 and 1006.

The centre of the pivoting lever 1012 is attached to a pivot in the form of a fulcrum 1014 and each end of the pivoting lever 1012 is in turn attached to one of the pedalling bars 1004, 1006 such that a downward movement of the first pedalling bar 1004 would result in the upward movement of the second pedalling bar 1006, and vice versa.

As shown in Fig. 10(b), the pivoting lever 1012 is attached to the fulcrum 1014 in a way that allows the pivoting lever 1012 to move along the length of the fulcrum 1014. Fig. 10(a) and 10(b) further show the first pedalling bar 1004 to be attached to the pivoting lever 1012 via an eye bolt 1016. Alternatively, the eye bolt 1016 can be replaced by any member that is rotatable about the end of the pivoting lever 1012. As the pivoting lever 1012 pivots about the fulcrum 1014, the eye bolt 1016 twists such that the first pedalling bar 1004 remains horizontal regardless of the position of the pivoting lever 1012. The first pedalling bar 1004 remains horizontal because of the application of a vertical force on the first pedalling bar 1004, the direction of the vertical force being substantially perpendicular to the longitudinal axis of the first pedalling bar 1004. The same occurs for the second pedalling bar 1006 connected on the other end of the pivoting lever 1012.

As shown in Figs. 10(a) and 10(b), the first pedalling bar 1004 is held in place against the pivoting lever 1012 by a nut 1018 and a spring 1020 is placed between the nut 1018 and the first pedalling bar 1004 to allow the first pedalling bar 1004 to move along the length of the eye bolt 1016 as the pivoting lever 1012 pivots about the fulcrum 1014. Alternatively, the nut 1018 can be replaced by any fastening member and the spring 1020 can be replaced by any resilient element. Alternatively, the eye bolt 1016, the nut 1018 and the spring 1020 can be removed and the first pedalling bar 1004 can be directly connected to the pivoting lever 1012 via a spring or any other resilient member to accommodate any migration of the first pedalling bar 1004 due to the movement of the first pedalling bar 1004 and the pivoting lever 1012. The second pedalling bar 1006 is connected to the other end of the pivoting lever 1012 in the same manner.

The pedal assembly 902 further comprises a stopper 1026 connected to the bicycle frame of the bicycle 900 of Fig. 9 and arranged to prevent the pedalling bars 1004 and 1006 from moving beyond a particular position during their downward movement.

The pedal assembly 902 is connected to the bicycle frame by connecting one end of each of the first and second pedalling bars 1004 and 1006 to a rod 1024 which in turn passes through the bicycle frame. The fulcrum 1014 of the pedal assembly 902 is mounted on a portion 1022 of the bicycle frame by suitable connecting means. Preferably, the fulcrum 1014 is placed as near as possible to the point of connection between the first and second pedalling bars 1004,

1006 and the bicycle frame so as to minimize the amount of horizontal movement of the first and second pedalling bars 1004, 1006.

As it can be appreciated, the above arrangement requires the use of only a single component as the interconnecting system, that is, the pivoting lever 1012. Therefore, this arrangement can be easily manufactured and maintained.

Pedal assembly 1102

Referring to Fig. 11, a bicycle 1100 is shown comprising a pedal assembly 1102 which is another variation of the pedal assembly 300 of the preferred embodiment. A magnified view of the pedal assembly 1102 is shown in Figs. 12(a) – 12(c) whereby Fig. 12(a) shows a 3D view of the pedal assembly 1102 as seen from the left of the bicycle 1100, Fig. 12(b) shows a cross-sectional top view of the pedal assembly 1102 as seen from the top of the bicycle 1100 and Fig. 12(c) shows the components of the pedal assembly 1102.

The pedal assembly 1102 includes first and second pedalling bars 1202 and 1204 with first and second pedals 1206 and 1208 attached respectively. The pedal assembly 1102 also includes an alternating device comprising a baffle gear arrangement for operably connecting the first and second pedalling bars 1202 and 1204. In pedal assembly 1102, the interconnecting system comprises a set of baffle gears including a first baffle gear 1210, a second baffle gear 1212 and a centre baffle gear 1214.

As shown in Figs. 12(a) to 12(b), the pedalling bars 1202 and 1204 in pedal assembly 1102 are connected to the first and second baffle gears 1210 and 1212 respectively and the first and second baffle gears 1210 and 1212 are in turn connected to the centre baffle gear 1214. Hence, a downward movement of the first pedalling bar 1202 results in an anti-clockwise rotation of the first baffle gear 1210 (as seen from the inner surface 1210a), which leads to a clockwise rotation of the centre baffle gear 1214 (as seen from the inner surface 1214a) which in turn leads to an anti-clockwise rotation of the second baffle gear 1212 (as seen from the inner surface 1212a). Since the second pedalling bar 1204 is connected to the second baffle gear 1212, the anti-clockwise rotation of the second baffle gear 1212 results in the upward movement of the second pedalling bar 1204. The reverse occurs when the second pedalling bar 1204 is depressed. The above arrangement allows the first and second pedalling bars 1202, 1204 to alternate between the top and bottom positions.

The pedal assembly 1102 further comprises a stopper 1216 connected to the bicycle frame of the bicycle 1100 of Fig. 11 and arranged to prevent the pedalling bars 1202 and 1204 from moving beyond a particular position during their downward movement.

The pedal assembly 1102 is connected to the bicycle frame by connecting the inwardly facing surfaces 1210a, 1212a and 1214a of gears 1210, 1212 and 1214 respectively to the bicycle frame of the bicycle 1100 of Fig. 11.

Further variations are possible within the scope of the invention as will be clear to a skilled reader.

For example, the propulsion system 202 may be used not only in bicycles but also in other vehicles such as a scooter 1300 as shown in Fig. 13. The propulsion system 202 may also be used in other vehicles such as a trishaw or a pedicab. The propulsion system 202 may also be used in a wheel chair and a user may propel the wheel chair by moving the pedalling bars 304 and 306 with his or her hands.

Although Figs. 8(a) to 8(b) show the transmission system 802 to be partially overlapping with the wheel 818, the transmission system 802 may be positioned such that it is fully overlapping with the wheel 818, the transmission system 802 being disposed fully within the circumference of the wheel 818. An example of this is illustrated in Fig. 14 whereby the transmission system 802' is fully overlapping with the wheel818'. In fact, it is preferable to position the transmission system 802 as far away as possible from the handles of the bicycle frame so as to maximize the length of the pedalling bars. With a longer pedalling bar, the angle through which the pedals (and hence the pedalling bars) have to move to propel the wheel forward by a particular distance decreases and this creates a greater mechanical advantage.

Furthermore, although the positions of the pedals on the pedalling bars are shown to be fixed in Figs. 2 to 12, the positions of the pedals may be adjustable along the pedalling bars by the use of levers, pistons, screw threads or any other suitable adjustment means. In addition, although only one pedal is shown on each pedalling bar in Figs. 2 to 12, there may be more than one pedal on each pedalling bar. Alternatively, the pedals may be totally removed and the pedalling bars may be depressed by exerting a downward force on the pedalling bars directly, although this may not be preferred.

Alternatively, the pedalling bar 304 may be arranged with an assembly 1500 as shown in Fig. 15. In Fig. 15, the pedal 308' is fixed in position on the pedalling bar 304'. Preferably, the distance between the pedal 308' and a saddle of the bicycle is in the range of 0.15 to 0.3 metres. A piston 1502 comprising a piston actuator 1504, a piston rod 1506, a first tube 1510 and a second tube 1508 is arranged to move a first portion 1514 of an adjustable member 1512 along the pedalling bar 304'. A second portion 1516 of the adjustable member 1512 is arranged to move through the pedal 308' when the first portion 1514 of the adjustable member 1512 moves along the pedalling bar 304'.

When a user exerts a downward force N on the pedal 308', the adjustable member 1512 moves downward as well resulting in the first portion 1514 of the adjustable member 1512 exerting a downward force on the pedalling bar 304'. When air is pumped into the first tube 1510 of the piston 1502, the first portion 1514 of the adjustable member 1512 is moved in a direction C away from the

pedal 308' and the distance between the pedal 308' and the first portion 1514 of the adjustable member 1512 increases. Hence, when the user exerts the same amount of downward force N on the pedal 308', a larger momentum is generated and therefore a larger force is exerted on the pedalling bar 304' by the first portion 1514 of the adjustable member 1512. This is usually done when the bicycle is required to move across a difficult terrain or up a slope. The reverse occurs when air is pumped into the second tube 1508.

In a further alternative, the piston 1502 of Figure 15 may be replaced by a spring mechanism 1602 (as shown in Figure 16(a) and (b)) arranged to adjust the position of the adjustable member 1512. The spring mechanism 1602 is arranged to bias the adjustable member 1512 to a first end of the pedalling bar 304' (i.e. away from the pedal 308', such as that shown in Figure 16(a)). The spring mechanism 1602 may be actuated by a cable 1604 connecting the adjustable member 1512 to a drum 1606. The drum 1606 includes a handle 1608 and when rotated in a first rotational direction, is arranged to coil up the cable 1604 which pulls the adjustable member 1512 thereby compressing the spring mechanism 1602 (as shown in Fig. 16(b)) to any desired position along the pedalling bar 304', and a lock of the drum 1606 is configured to lock the handle 1608 to the desired position. For example, by following this method, the position of the adjustable member 1512 may be moved towards the position of the pedal 308' on the pedalling bar 304'. The handle 1608, when released causes the spring mechanism 1602 to decompress and to bias the adjustable member 1512 towards the first end of the pedalling bar 304' and likewise, the

lock may be used to lock the adjustable member 1512 at any desired position along the pedalling bar 304'. In this way, it should be appreciated that the adjustable member 1512 may be moved to any position along the pedalling bar 304' to suit to the user's preference.

Although the pedalling bars are shown to be substantially rectangular in shape in Figs. 2 to 12, they may be replaced with any suitable elongate member that is sufficiently long to extend from a position below the handles of the bicycle frame to the chains in the transmission system.

In addition, each of the interconnecting systems of the pedal assemblies 300, 902 and 1102 can be used alone or in combination with one or more of the other interconnecting systems.

Also, for low performance (low speed) bicycles, instead of connecting the pedal assembly 300 to the transmission system 802 using the assembly in Figs. 4 – 6, the pedalling bars 304' and 306' can be directly connected to the chains 814 and 828 respectively because the inertia of the chains 814 and 828 will be low in low performance (low speed) bicycles. The same can be done for connecting any of the pedal assemblies 902 or 1102 to the transmission system 802. An example of this is illustrated in Fig. 17 which shows the direct connection of pedalling bars 304' and 306' to the chains 814 and 828 respectively. Alternatively, the assembly in Figs. 4 – 6 can be replaced by a unidirectional clutch attached to a sprocket.

Claims:

1. A propulsion system for a vehicle, the propulsion system comprising:

a transmission system arranged to propel at least one wheel of the vehicle;

a pedal assembly having a first and second elongate members pivotably connected to a fulcrum, each of the first and second elongate members being configured to alternate between a first position and a second position to drive the transmission system to propel the at least one wheel;

wherein a relative angle between the first and second elongate members, with respect to the fulcrum, forms an angle of less than 180 degrees.

2. A propulsion system according to claim 1, wherein the relative angle between the first and second elongate members, with respect to the fulcrum, forms an angle of less than or equal to 45 degrees.

3. A propulsion system according to claim 1 or 2, further comprising an alternating device arranged to urge the first and second elongate members to alternate between the first and second positions.

4. A propulsion system according to claim 3, wherein the alternating device comprises a first interconnecting system having:

a sprocket;

an idler sprocket; and

a chain arranged to cooperate with the sprocket and the idler sprocket;

wherein the chain is configured to urge the first and second elongate members to move in opposite directions to each other about the fulcrum.

5. A propulsion system according to claim 3 or 4, wherein the alternating device comprises a second interconnecting system having:

a pivoting lever; and

wherein the first and second elongate members are connected to respective ends of the pivoting lever, the pivoting lever configured to urge the second elongate member to the second position when the first elongate member is being urged to the first position.

6. A propulsion system according to claim 5, further comprising a resilient member arranged between each of the first and second elongate members and a respective end of the pivoting lever.

7. A propulsion system according to claim 5, further comprising a rotatable member arranged between each of the first and second elongate members and a respective end of the pivoting lever, the rotatable member being rotatable about the respective end of the pivoting lever, each of the elongate members having a longitudinal axis which remains substantially perpendicular to a direction of a force exerted on each of the elongate members.

8. A propulsion system according to claim 7, further comprising a resilient element arranged between each of the first and second elongate members and the respective end of the pivoting lever ,to allow the first and second elongate members to be movable along a length of the respective rotatable member.

9. A propulsion system according to any of claims 5 to 8, wherein the pivoting lever is arranged to be movable along a length of a pivot.

10. A propulsion system according to any of claims 3 to 9, wherein the alternating device further comprises a baffle gear arrangement having:

a first baffle gear driven by the first elongate member;

a second baffle gear driven by the second elongate member; and

a centre baffle gear meshed with the first and second baffle gears and arranged to urge the second elongate member to the second position when the first elongate member is being urged to the first position.

11. A propulsion system according to any preceding claim, further comprising a first pedal, a second pedal and a connecting member arranged between the first and second pedals and the first and second elongate members respectively to allow the first and second pedals to be adjustable along a length of the first and second elongate members respectively.

12. A propulsion system according to any of claims 1 to 10, further comprising a first plurality of pedals arranged to drive the first elongate member and a second plurality of pedals arranged to drive the second elongate member.

13. A propulsion system according to claim 12, further comprising a connecting member arranged between the first and second plurality of pedals and the first and second elongate members respectively to allow the first and second plurality of pedals to be adjustable along a length of the first and second elongate members respectively.

14. A propulsion system according to claim 11 or claim 13, wherein the connecting member is a lever, a piston or a screw thread.

15. A propulsion system according to any of claims 1 to 10, further comprising:

a first adjustable member and a second adjustable member arranged to be movable along the first and second elongate members respectively;

a first pedal and a second pedal respectively arranged at a fixed position on the first elongate member and the second elongate member, wherein the relative position between the first or second adjustable member and a corresponding first or second pedal is adjustable.

16. A propulsion system according to any preceding claim, wherein the transmission system comprises:

a first sprocket arrangement arranged to propel the at least one wheel of the vehicle; and

a first chain arranged to cooperate with the first sprocket arrangement;

wherein the first elongate member is arranged to move the first chain which in turn is arranged to drive the first sprocket arrangement to propel the at least one wheel of the vehicle.

17. A propulsion system according to claim 16, wherein the transmission system further comprises:

a second sprocket arrangement;

an axle arranged to connect the second sprocket arrangement and the first sprocket arrangement;

a second chain arranged to cooperate with the second sprocket arrangement, wherein the second elongate member is arranged to move the second chain which in turn is arranged to drive the second sprocket arrangement, the second sprocket arrangement being arranged to drive the axle and the first sprocket arrangement.

18. A propulsion system according to claim 16, wherein the transmission system further comprises:

a second sprocket arrangement arranged to propel the at least one wheel; and

a second chain arranged to cooperate with the second sprocket arrangement;

wherein the second elongate member is arranged to move the second chain which in turn is arranged to drive the second sprocket arrangement to propel the at least one wheel of the vehicle.

19. A propulsion system according to any of claims 16 to 18, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the first chain.

20. A propulsion system according to any of claims 16 to 19, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the second chain.

21. A propulsion system according to any of claims 16 to 20, further comprising an assembly arranged to engage the chain to move in response to the movement of the first or second elongate member from the first position to the second position and further arranged to disengage with the chain in response to the movement of the first or second elongate member from the second position to the first position.

22. A propulsion system according to claim 21, wherein the assembly is arranged between each of the first and second chains and each of the first and second elongate members respectively.

23. A propulsion system according to claim 21 or 22, wherein the assembly comprises:

a gear unit comprising a wheel;

a sprocket arranged to rotate with the wheel of the gear unit and further arranged to engage the chain;

at least one lock arranged to allow the wheel of the gear unit to rotate in only one direction;

the sprocket, the gear unit and the at least one lock arranged such that

(i) when the elongate member moves from the first position to the second position, the wheel of the gear unit is prevented from rotating, in turn preventing the sprocket from rotating and in turn allowing the assembly to engage with the chain to move; and

(ii) when the elongate member moves from the second position to the first position, the wheel of the gear unit is arranged to rotate, in turn rotating the sprocket about the chain and in turn allowing the assembly to disengage with the chain.

24. A propulsion system according to any preceding claim, wherein the transmission system is disposed partially within the circumference of the at least one wheel of the vehicle.

25. A propulsion system according to claim 18, wherein the transmission system is disposed fully within the circumference of the at least one wheel of the vehicle.

26. A propulsion system for a vehicle, the propulsion system comprising:

a pedal assembly comprising a first pedalling member; and

a transmission system connected to the pedal assembly;

wherein the transmission system comprises:

a first sprocket arrangement arranged to propel at least one wheel of the vehicle; and

a first chain arranged to cooperate with the first pedalling member;

wherein the first pedalling member is arranged to move the first chain which in turn is arranged to drive the first sprocket arrangement to propel the at least one wheel of the vehicle.

27. A propulsion system according to claim 26, wherein the transmission system further comprises:

a second sprocket arrangement;

an axle arranged to connect the second sprocket arrangement to the first sprocket arrangement; and

a second chain arranged to cooperate with the second sprocket arrangement wherein the second pedalling member is arranged to move the second chain which is in turn arranged to drive the second sprocket

arrangement, the second sprocket arrangement being arranged to drive the axle and the first sprocket arrangement.

28. A propulsion system according to claim 26, wherein the transmission system further comprises:

a second sprocket arrangement arranged to propel the at least one wheel of the vehicle; and

a second chain arranged to cooperate with the second sprocket arrangement;

wherein the second pedalling member is arranged to move the second chain which in turn is arranged to drive the second sprocket arrangement to propel the at least one wheel of the vehicle.

29. A propulsion system according to any of claims 26 to 28, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the first chain.

30. A propulsion system according to any of claims 26 to 29, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the second chain.

31. A vehicle comprising a propulsion system according to any preceding claim.

32. A vehicle according to claim 31 wherein the vehicle is a bicycle, a trishaw or a pedicab.

33. A vehicle according to claim 31 wherein the vehicle is a wheelchair.