

A Propulsion System for a Vehicle

Field of the invention

5 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
10 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
15 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
20 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 $90^\circ - 22.5^\circ$ to
 $90^\circ + 22.5^\circ$. 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 and achieve a smaller pedalling angle. In addition, there is no dead spot at the 12 and 6 o' clock position in this propulsion system unlike the propulsion system in a conventional bicycle.

15 Preferably, the elongate members are relatively long to overcome the limitation encountered by a conventional bicycle due to the length of the crank arm in the conventional bicycle.

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.

5 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.

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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.

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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
5 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
10 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.

15 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
20 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 bevel gear arrangement having: a first bevel gear driven by the first elongate member; a second bevel gear driven by the second elongate member; and a centre bevel gear meshed with the first and second bevel 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 bevel gear arrangement allows the movement of the elongate members to be smoother.

The propulsion system may further comprise a first plurality of pedals arranged to drive the first elongate member at respective first driving points and a second plurality of pedals arranged to drive the second elongate member at respective second driving points. This is advantageous as the user can change the amount of force transmitted to the transmission system by simply selecting the pedal on which he or she steps on.

The propulsion system may further comprise a first pedal arranged to drive the first elongate member at a first driving point and a second pedal arranged to drive the second elongate member at a second driving point, and means for adjusting the positions of the first and second driving points along a length of the first and second elongate members. This is advantageous as the user can adjust the amount of force transmitted from the pedals to the transmission system. Therefore, it is possible to increase the amount of force transmitted to the transmission system when the vehicle is required to travel across rougher terrain or up a slope.

The positions of the pedals may be adjustable relative to the fulcrum. This may be achieved using levers, pistons or screw threads. This is advantageous as the user can adjust the amount of force transmitted from the pedals to the transmission system. Therefore, it is possible to increase the amount of force transmitted to the transmission system when the vehicle is required to travel across rougher terrain or up a slope.

The adjusting means may comprise: a support frame coupled to the pedal; and an adjustable member arranged to be movable along a length of the respective elongate member, the adjustable member coupled to the support frame and the respective elongate member to restrict the movement of the support frame away from the respective elongate member. This is advantageous as not only can the user adjust the amount of force transmitted from the pedals to the transmission system, the user can also increase the pedalling speed when the vehicle is propelling on smoother terrain. This can achieve the same effect as changing gear in a conventional bicycle without the need for expensive multiple sprockets.

The adjusting means may further comprise a mechanism arranged to maintain the support frame in a substantially horizontal position. Preferably, the mechanism comprises at least two chains and at least two sprockets arranged to rotate together in synchronization and cooperate with the two chains to maintain the support frame in a horizontal position. This is advantageous as this allows the pedal stroke (distance moved by the pedal from the top to the

bottom) to increase when the adjustable member is further away from the fulcrum (corresponds to low gear in a conventional bicycle) and the pedal stroke to decrease when the adjustable member is nearer the fulcrum (corresponds to high gear in a conventional bicycle).

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The adjustable member may be coupled to the support frame using an adjustable element arranged to be movable along a length of the support frame. This is advantageous as less force is required to move the adjustable member along the length of the respective elongate member since the support frame is not required to move together with the adjustable member.

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The propulsion system may further comprise an adjusting device arranged to urge the adjustable member along the respective elongate member. The adjusting device may comprise a piston. Alternatively, the adjusting device may comprise: a spring mechanism arranged to bias the adjustable member towards a first direction; and a drum arranged to pull the adjustable member in a direction opposite the first direction. This is advantageous as the position of the adjustable member can be easily adjusted using these components.

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20 Preferably, the positions of the pedals are ergonomically selected in a manner that suits the human body the most.

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.

- 5 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
- 10 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
- 15 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
- 20 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
5 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
10 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
15 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
20 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);

5 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).

10 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.

15 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;

20 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;

5 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 a bicycle comprising pedalling bars pivotably attached to a fulcrum nearer a back wheel of the bicycle, the pedalling bars arranged with
10 adjusting means adjusted by an adjusting device; ;

Fig. 16(a) illustrates a cross-sectional side view of the assemblies of Fig. 15 and Fig. 16(b) illustrates a cross-sectional view of a portion of one of the assemblies of Fig. 16(a);

Fig. 17 illustrates a 3D view of one of the assemblies of Fig. 15;

15 Fig. 18 illustrates how one of the assemblies of Fig. 15 is assembled with the frame of the bicycle of Fig. 15;

Fig. 19 illustrates how the assemblies of Fig. 15 are arranged with the chains of the bicycle of Fig. 15;

Fig. 20(a) illustrates a cross-sectional side view of assemblies which are
20 variations of the assemblies of Fig. 15 and Fig. 20(b) illustrates a cross-sectional view of a portion of one of the assemblies of Fig. 20(a);

Fig. 21 illustrates pedalling bars pivotably attached to a fulcrum further away from a back wheel of a bicycle, the pedalling bars arranged with the adjusting means of Fig. 15;

Figs 22(a) and 22(b) illustrate cross-sectional views of the adjusting means and the pedalling bars of Fig. 21;

Fig. 23 illustrates an adjusting device that is a variation of the adjusting device of Fig. 15.

5 Fig. 24 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

10 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.

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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

20 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 pedalling bars 304 and 306 are pivotably connected to a fulcrum 208 (see Fig. 2). 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 at the fulcrum 208. 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
5 320.

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
10 200 (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
15 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
20 332 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.

- 5 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
- 10 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
- 15 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.

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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

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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.

5 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
10 406 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.

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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
20 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, 5 806 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 10 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 15 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 20 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 sprocket 812.

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 sprocket 810 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 lever 1012 for operably connecting
5 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 pivot 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
10 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 pivot 1014 in a way that allows the pivoting lever 1012 to move along the length of the pivot
15 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
20 the pivot 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
5 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 pivot 1014. Alternatively, the nut 1018 can be replaced by any fastening member and the spring 1020 can be replaced by any resilient
10 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
15 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
20 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 pivot 1014 of the pedal

assembly 902 is mounted on a portion 1022 of the bicycle frame by suitable connecting means. Preferably, the pivot 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.

10

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.

20

The pedal assembly 1102 includes first and second pedalling bars 1202 and 1204 with first and second pedals 1206 and 1203 attached respectively. The pedal assembly 1102 also includes an alternating device comprising a bevel 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 bevel gears including a first bevel gear 1210, a second bevel gear 1212 and a centre bevel gear 1214.

5 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 bevel gears 1210 and 1212 respectively and the first and second bevel gears 1210 and 1212 are in turn connected to the centre bevel gear 1214. Hence, a downward movement of the first pedalling bar 1202 results in an anti-clockwise rotation of the first bevel
10 gear 1210 (as seen from the inner surface 1210a), which leads to a clockwise rotation of the centre bevel gear 1214 (as seen from the inner surface 1214a) which in turn leads to an anti-clockwise rotation of the second bevel gear 1212 (as seen from the inner surface 1212a). Since the second pedalling bar 1204 is connected to the second bevel gear 1212, the anti-clockwise rotation of the
15 second bevel 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.

20 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. Preferably, a spring is incorporated in the stopper 1216. This can not only cushion the impact of the force exerted on the stopper

1216 by the pedalling bars 1202 and 1204, the recoil of the spring can also help to recover some of the energy lost when the pedalling bars 1202 and 1204 are pushed against the stopper 1216, hence preventing a total loss of energy.

- 5 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
10 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
15 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
20 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 wheel 818'. 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.

Fig. 15 illustrates an alternative to the arrangement of the pedalling bars. Although the pedalling bars are shown to pivot about a fulcrum nearer the front wheel of the bicycle in Figs 2 to 14, they may also be arranged to pivot about a fulcrum nearer the back wheel of the bicycle. As shown in Fig. 15, first and second pedalling bars 1502 and 1504 are arranged to pivot about a fulcrum 1506 nearer a back wheel 1508 of a bicycle 1500. The advantage of this is that the length of the pedalling bars 1502 and 1504 can extend to the maximum limit of the frame of the bicycle 1500. This can achieve a stronger mechanical advantage suitable for propelling the bicycle 1500 with a heavier load.

Furthermore, the pedalling bars 1502 and 1504 may be arranged with an adjusting means comprising a first assembly 1514 (between a first pedal 1510 and a first pedalling bar 1502) and a second assembly 1516 (between a second

pedal 1512 and a second pedalling bar 1504) shown in Fig. 15. The assemblies 1514 and 1516 are attached to the top tube 1518 and the down tube 1520 of the bicycle 1500 via chains 1522.

- 5 Preferably, the assemblies 1514 and 1516 are positioned 0.2 metres from the seat 1524 of the bicycle 1500 whereas the distance between the pedals 1510, 1512 and the seat 1524 of the bicycle 1500 is chosen to be approximately 0.15 to 0.3 metres (depending on the body height of the user). Also preferably, the maximum downward distance moved by each of the pedals 1510, 1512 is about
10 0.32 metres and the lowest point which each of the pedals 1510, 1512 reaches is about 0.10 metres above the ground. These distances are ergonomically chosen to fit a human body although these distances can vary and be adapted to suit the built of the user.
- 15 Figs. 16(a) and 16(b) respectively show a magnified cross-sectional side view of the first and second assemblies 1514 and 1516 and a cross-sectional view of a portion of the first assembly 1514 as seen from direction D whereas Fig. 17 shows a 3D view of the first assembly 1514.
- 20 The first assembly 1514 comprises a connecting element 1602, a horizontal bar 1604 and an adjustable member in the form of a carriage 1608. Alternatively, it would be apparent that the horizontal bar 1604 can be replaced by any other suitable support frame. The first pedal 1510 is arranged with the horizontal bar 1604 and the connecting element 1602 to urge the horizontal bar 1604 to follow

any upward or downward movement of the first pedal 1510. The horizontal bar 1604 is in turn arranged with the first pedalling bar 1502 to urge the first pedalling bar 1502 to follow any upward or downward movement of the horizontal bar 1604.

5

The carriage 1608 is arranged to be movable along the pedalling bar 1502 through the use of an adjusting device comprising the assembly 1612. The assembly 1612 comprises a drum 1614 and a spring mechanism 1616 arranged to adjust the position of the carriage 1608. The spring mechanism 1616 is
10 arranged to bias the carriage 1608 to a first end of the pedalling bar 1502 (as shown in Fig. 16(a) and 17). The spring mechanism 1616 may be actuated by a cable 1618 connecting the carriage 1608 to the drum 1614. The drum 1614 includes a handle 1620 and when rotated in a first rotational direction, is arranged to coil up the cable 1618 which pulls the carriage 1608 thereby
15 compressing the spring mechanism 1616, hence moving the carriage 1608 in a direction C to any desired position along the pedalling bar 1502, and a lock of the drum 1614 is configured to lock the handle 1620 to the desired position. The handle 1620, when released causes the spring mechanism 1616 to decompress and to bias the carriage 1608 towards the first end of the pedalling bar 1502
20 and likewise, the lock may be used to lock the carriage 1608 at any desired position along the pedalling bar 1502. In this way, it should be appreciated that the carriage 1608 may be moved to any position along the pedalling bar 1502 to suit to the user's preference.

In addition, an adjustable element in the form of a collar 1610 (See Fig. 16(b)) is arranged to be movable along a length of the horizontal bar 1604 and is further arranged to move together with the carriage 1608. . When a user exerts a downward force on the first pedal 1510, the connecting element 1602, together with the horizontal bar 1604, moves downwards. This exerts a downward force on the first pedalling bar 1502 at the point of contact between the carriage 1608 and the first pedalling bar 1502 (driving point 1606) resulting in a downward movement of the first pedalling bar 1502. To increase the amount of force transmitted to the transmission system 302' the carriage 1608 and the collar 1610 are moved further away from the fulcrum 1506. The further the carriage 1608 and the collar 1610 are from the fulcrum 1506, the larger the moment generated by the force at the driving point 1606 about the fulcrum 1506 and in turn, the larger the amount of force transmitted to the transmission system 302'. Therefore, the carriage 1608 and the collar 1610 are usually moved further away from the fulcrum 1506 when the bicycle 1500 is required to move across a difficult terrain or up a slope.

On the other hand, when the carriage 1608 and the collar 1610 are moved nearer the fulcrum 1506, even though the first pedal 1510 alternates through a smaller distance, the distance the first pedalling bar 1502 alternates through and the amount of revolution in the back wheel 1508 of the bicycle 1500 remain the same. This allows the user to pedal faster although more force may be required to push the first pedal 1510 downwards in this case. Therefore, the

carriage 1608 and the collar 1610 are usually moved nearer the fulcrum 1506 when the bicycle 1500 is required to move across smooth terrain.

Fig. 18 illustrates how the first assembly 1514 (comprising the connecting

5 element 1602 and the horizontal bar 1604), together with the first pedal 1510, is arranged with the top tube 1518 and the down tube 1520 of the bicycle 1500.

The connecting element 1602 is engaged with the chains 1522 using locks 1802 and the chains 1522 are in turn respectively attached to the top tube 1518

and the down tube 1520 of the bicycle 1500 using nuts 1804, 1814, sprockets

10 1806, 1816, spacers 1808, 1818, bearings 1810, 1820, gear units 1812, 1822

and keys 1814, 1824. These components are arranged through the holes 1826

and 1828 in the top tube 1518 and the down tube 1520 respectively in the order

illustrated in Fig. 18. This arrangement allows the rotation of the chains 1522 in

unison in a direction E when the first pedal 1510 is urged downwards and the

15 rotation of the chains 1522 in unison in a direction F when the first pedal 1510

moves upwards as the second pedal 1512 at the opposite side of the bicycle

1500 (not shown in Fig. 18) is urged downwards. Note that it is preferable to

engage the connecting element 1602 with at least two chains 1522 and at least

two sprockets 1806, 1816 arranged to rotate together in synchronization and

20 cooperate with the at least two chains 1522 so that the horizontal bar 1604 can

remain in a horizontal position parallel to the first pedal 1510.

As shown in Fig. 19, the connecting elements 1602 and 1902 of the first and

second assemblies 1514 and 1516 respectively are engaged with opposite

sides of the chains 1522 thereby urging the connecting elements 1602 and 1902 to move in opposite directions.

Although the above only describes the arrangement between the first assembly 1514, the first pedal 1510, the first pedalling bar 1502 and the chains 1522, it should be appreciated that the same arrangement applies to the second assembly 1516, the second pedal 1512, the second pedalling bar 1504 and the chains 1522. Preferably, whenever the carriage 1608 of the first assembly 1514 is adjusted along the length of the first pedalling bar 1502, the carriage of the second assembly 1516 is also adjusted along the length of the second pedalling bar 1504 until the distance between the fulcrum 1506 and each of the carriages is approximately the same. It is also preferable to adjust the carriage 1608 together with the collar 1610 when the first pedalling bar 1502 and the horizontal bar 1604 are aligned along their lengths. The same applies when adjusting the carriage and collar of the second assembly 1516.

Figs. 20(a) and 20(b) respectively illustrates a magnified cross-sectional side view of an alternative adjusting means comprising an alternative first assembly 2002 and an alternative second assembly 2004 whereas Fig. 20(b) illustrates a cross-sectional view of a portion of the alternative first assembly 2002 as seen from direction G. The alternative assemblies 2002, 2004 are similar to the assemblies 1514, 1516 and thus the same parts of the alternative assemblies 2002, 2004 are labelled with the same reference numerals with the addition of prime. Instead of being fixed in position, the horizontal bar 1604' in the

alternative first assembly 2002 may be arranged to move together with the carriage 1608' as the latter is being adjusted along a length of the pedalling bar 1502'. As shown in Fig. 20(b), this is achieved by attaching the carriage 1608' to the horizontal bar 1604' with a connector 2006. The same applies for the

5 second alternative assembly 2004. Variation in the amount of force transmitted to the transmission system 302' and in the alternating distance moved by the first and second pedals 1510', 1512' can be achieved using the alternative assemblies 2002, 2004 in the same manner as the assemblies 1514, 1516 of Fig. 15.

10

Although Fig. 15 illustrates the first and second pedalling bars 1502 and 1504 being arranged to pivot about a fulcrum 1506 nearer a back wheel 1508 of the bicycle 1500, it should be appreciated that the assemblies 1514, 1516 of Fig. 15 and the alternative assemblies 2002 and 2004 of Fig. 20 may also be used

15 when the pedalling bars are arranged to pivot about a fulcrum further away from the back wheel of the bicycle (for example fulcrum 208 of Fig. 2). For example, as shown in Fig. 21, the pedalling bars 304'' and 306'' are arranged to pivot about a fulcrum 208'' further away from the back wheel 818' and may be arranged with the first assembly 1514' and the second assembly 1516' in the

20 same manner as the arrangement of Fig. 15.

Figs. 22(a) and 22(b) shows magnified cross-sectional views of the first assembly 1514' of Fig. 21 with Fig. 22(a) illustrating the position of the carriage

1608" when the spring 1616" is decompressed and Fig. 22(b) illustrating the position of the carriage 1608" when the spring 1616" is compressed.

Alternatively, as shown in Fig. 23, the adjusting device may instead comprise a
5 piston 2302 comprising a piston actuator 2304, a piston rod 2306, a first tube 2310 and a second tube 2308. When air is pumped into the first tube 2310 of the piston 2302, the carriage 1608"" is moved in a direction H along the length of the pedalling bar 304"" and the reverse occurs when air is pumped into the second tube 2308. It would be appreciated that the adjusting device of Fig. 15
10 may also comprise the piston 2302 instead of the assembly 1612.

Although only one pedal is shown on each pedalling bar in Figs. 2 to 14, there may be more than one pedal on each pedalling bar, the pedals arranged to drive the respective elongate members at respective driving points.

15 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.

Although the pedalling bars are shown to be substantially rectangular in shape
20 in Figs. 2 to 24, 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.

- 5 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
10 any of the pedal assemblies 902 or 1102 to the transmission system 802. An example of this is illustrated in Fig. 24 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
15 clutch attached to a sprocket.

Claims:

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

a transmission system comprising first and second sprocket

5 arrangements;

a pedal assembly having first and second elongate members pivotably connected to a fulcrum, and

an alternating device arranged to urge the first and second elongate members to alternate between a first position and a second position, the first
10 and second elongate members arranged to drive the respective sprocket arrangements, with each sprocket arrangement arranged to separately and directly propel at least one wheel of the vehicle;

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

15 and 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;

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

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.

5 3. A propulsion system according to any preceding claim, 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
10 second elongate member to the second position when the first elongate member is being urged to the first position.

4. A propulsion system according to claim 3, further comprising a resilient member arranged between each of the first and second elongate members and
15 a respective end of the pivoting lever.

5. A propulsion system according to claim 3, 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
20 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.

6. A propulsion system according to claim 5, 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.

5

7. A propulsion system according to any of claims 3 to 6, wherein the pivoting lever is arranged to be movable along a length of a pivot.

8. A propulsion system according to any preceding claim, wherein the

10 alternating device further comprises a bevel gear arrangement having:

a first bevel gear driven by the first elongate member;

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

a centre bevel gear meshed with the first and second bevel gears and

arranged to urge the second elongate member to the second position when the

15 first elongate member is being urged to the first position.

9. A propulsion system according to any preceding claim, further comprising a first plurality of pedals arranged to drive the first elongate member at respective first driving points and a second plurality of pedals arranged to drive the second
20 elongate member at respective second driving points.

10. A propulsion system according to any of claims 1 to 8, further comprising a first pedal arranged to drive the first elongate member at a first driving point and a second pedal arranged to drive the second elongate member at a second

driving point, and means for adjusting the positions of the first and second driving points along a length of the first and second elongate members.

11. A propulsion system according to claim 10 wherein the positions of the
5 pedals are adjustable relative to the fulcrum.

12. A propulsion system according to claim 11 wherein the positions of the pedals are adjustable relative to the fulcrum using levers, pistons or screw threads.

10

13. A propulsion system according to claim 10, wherein the adjusting means comprises:

a support frame coupled to the pedal; and

an adjustable member arranged to be movable along a length of the

15 respective elongate member, the adjustable member coupled to the support frame and the respective elongate member to restrict the movement of the support frame away from the respective elongate member..

14. A propulsion system according to claim 13, wherein the adjusting means
20 further comprises a mechanism arranged to maintain the support frame in a substantially horizontal position.

15. A propulsion system according to claim 14, wherein the mechanism comprises at least two chains and at least two sprockets, the at least two chains

and the at least two sprockets arranged to cooperate with each other to maintain the support frame in the horizontal position.

16. A propulsion system according to any of claims 13 to 15, further comprising
5 an adjusting device arranged to urge the adjustable member along the respective elongate member.

17. A propulsion system according to any of claims 13 to 16, wherein the adjustable member is coupled to the support frame using an adjustable element
10 arranged to be movable along a length of the support frame.

18. A propulsion system according to any of claims 13 to 17, wherein the adjusting device comprises a piston.

15 19. A propulsion system according to any of claims 13 to 17, wherein the adjusting device comprises:

a spring mechanism arranged to bias the adjustable member towards a first direction; and

a drum arranged to pull the adjustable member in a direction opposite
20 the first direction.

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

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.

- 5 21. A propulsion system according to claim 20, wherein the transmission system further comprises:

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

- 10 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.

- 15 22. A propulsion system according to claim 20, wherein the transmission system further comprises:

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

- 20 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.

23. A propulsion system according to any of claims 20 to 22, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the first chain.

- 5 24. A propulsion system according to any of claims 20 to 23, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the second chain.

25. A propulsion system according to any of preceding claims, wherein the
10 first and second elongate members are directly coupled to the respective sprocket arrangements.

26. A propulsion system according to any of claims 20 to 24, further comprising an assembly arranged to engage the chain to move in response to the
15 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.

- 20 27. A propulsion system according to claim 26, wherein the assembly is arranged between each of the first and second chains and each of the first and second elongate members respectively.

28. A propulsion system according to claim 26 or 27, wherein the assembly comprises:

a gear unit comprising a wheel;

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

5 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

10 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.

15

29. 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.

20

30. A propulsion system according to claim 23, wherein the transmission system is disposed fully within the circumference of the at least one wheel of the vehicle.

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

a pedal assembly comprising a first pedalling member and a second pedaling member; and

5 a transmission system connected to the pedal assembly;

wherein the transmission system comprises:

first and second sprocket arrangements, each sprocket arrangement arranged to separately and directly propel at least one wheel of the vehicle; and

10 first and second chains arranged to cooperate respectively with the first and second pedalling members;

wherein the first and second pedalling members are arranged to move the first and second chains respectively which in turn are arranged to drive the corresponding first and second sprocket arrangements to propel the at least one wheel of the vehicle.

15

32. A propulsion system according to claim 31, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the first chain.

20 33. A propulsion system according to claim 31 or 32, wherein the transmission system further comprises a spring loaded idler sprocket arranged to maintain tension of the second chain.

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

35. A vehicle according to claim 34 wherein the vehicle is a bicycle, a trishaw or a pedicab.

5 36. A vehicle according to claim 34 wherein the vehicle is a wheelchair.

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

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

10 a pedal assembly having first and second elongate members pivotably connected to a fulcrum, and

an alternating device arranged to urge the first and second elongate members to alternate between a first position and a second position to drive the transmission system to propel the at least one wheel;

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

the propulsion system further comprises a first plurality of pedals arranged to drive the first elongate member at respective first driving points and
20 a second plurality of pedals arranged to drive the second elongate member at respective second driving points.

38. 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 first and second elongate members pivotably connected to a fulcrum, and

5 an alternating device arranged to urge the first and second elongate members 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;

10 and wherein

the propulsion system further comprises a first pedal arranged to drive the first elongate member at a first driving point and a second pedal arranged to drive the second elongate member at a second driving point, and means for adjusting the positions of the first and second driving points along a length of

15 the first and second elongate members.