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Other: EPODOC, WPI

(54) Title of the Invention: **A folding bike**  
Abstract Title: **Leaning folding tricycle**

(57) A folding, leaning, 3-wheeled cycle comprises a central frame portion, a seat mounted on the central frame portion, a rear frame portion connected to, and foldable relative to, the central frame portion, a rear wheel 16 connected to the rear frame portion, a front frame portion 18 connected to, and foldable relative to, the central frame portion, and comprising a pair of arms 22, a pair of front wheels 20, each front wheel 20 connected to an arm 22 of the front frame portion 18, and a rocker mechanism 26 connected to each arm 22 of the front frame portion 18, the rocker mechanism 26 having an unlocked configuration allowing the arms 22 to move relative to each other and a locked configuration preventing the arms 22 from moving relative to each other. The locking mechanism may comprise a pair of pins actuated by a cam. When the rocker mechanism is locked, the tricycle must remain fully upright, and when the rocker mechanism is unlocked, the tricycle may lean, facilitating cornering.

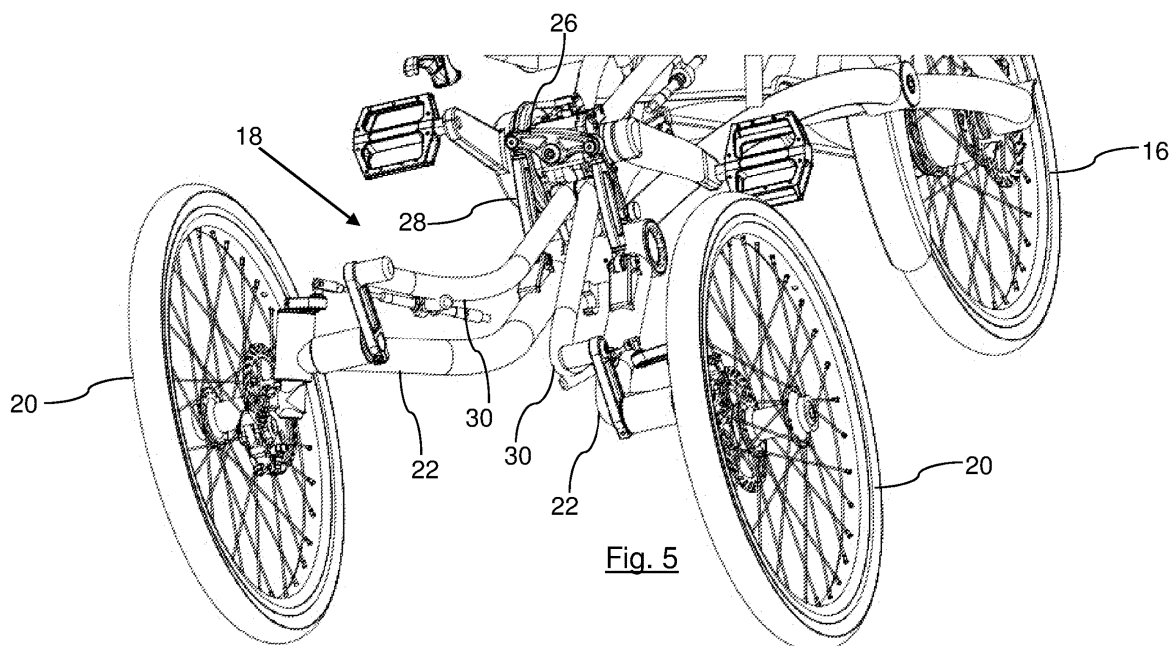


Fig. 5

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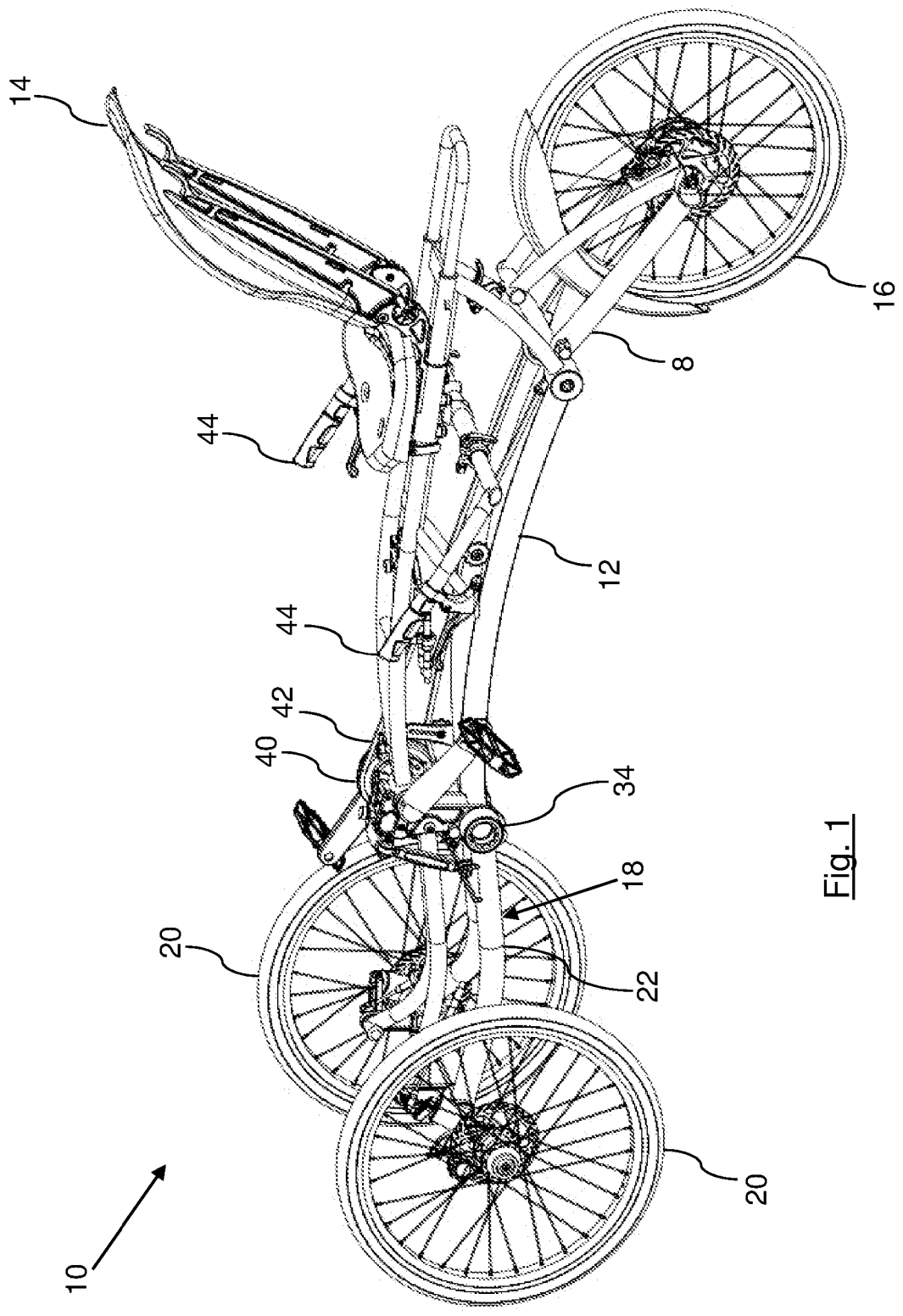


Fig. 1

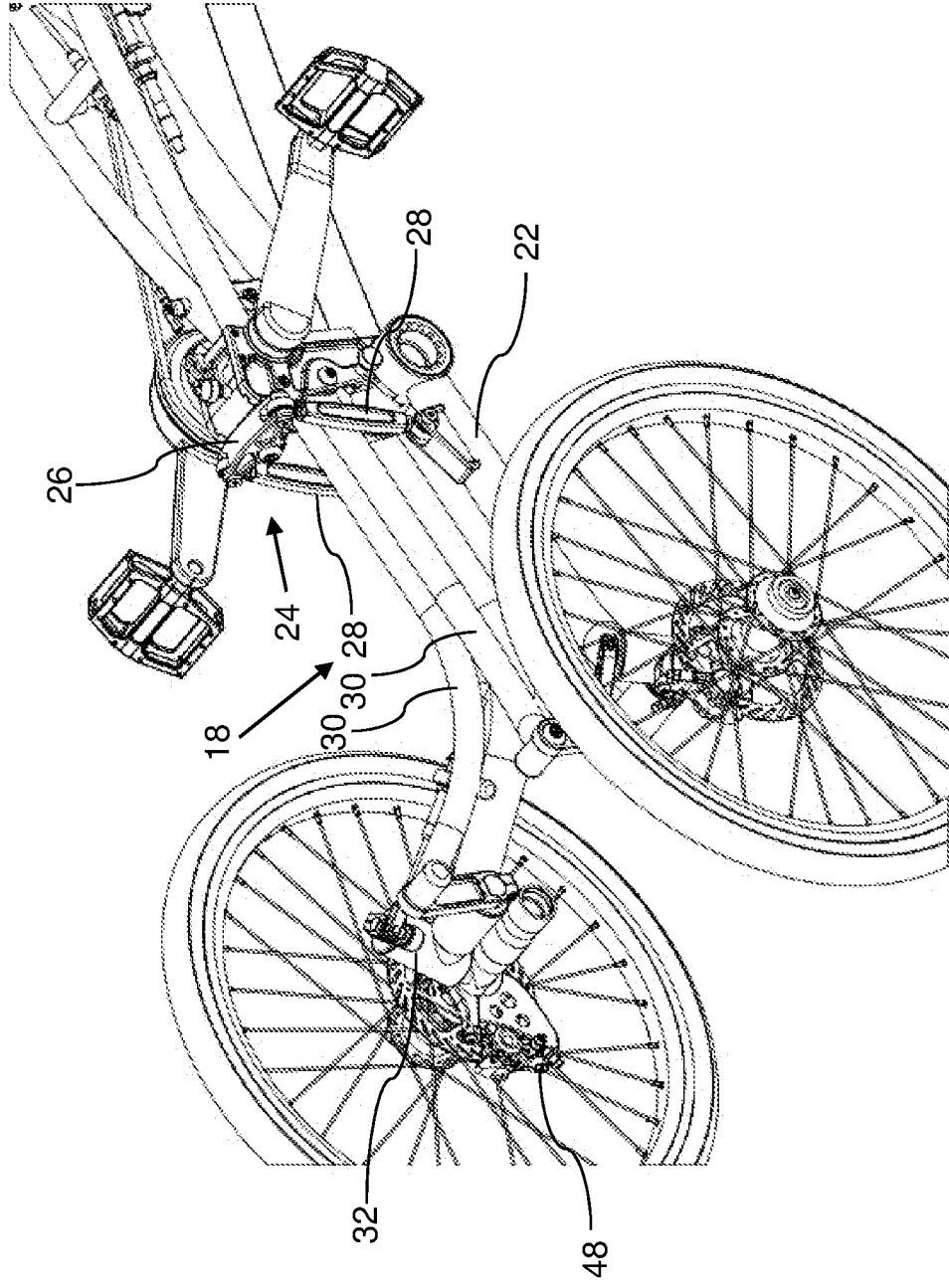


Fig. 2

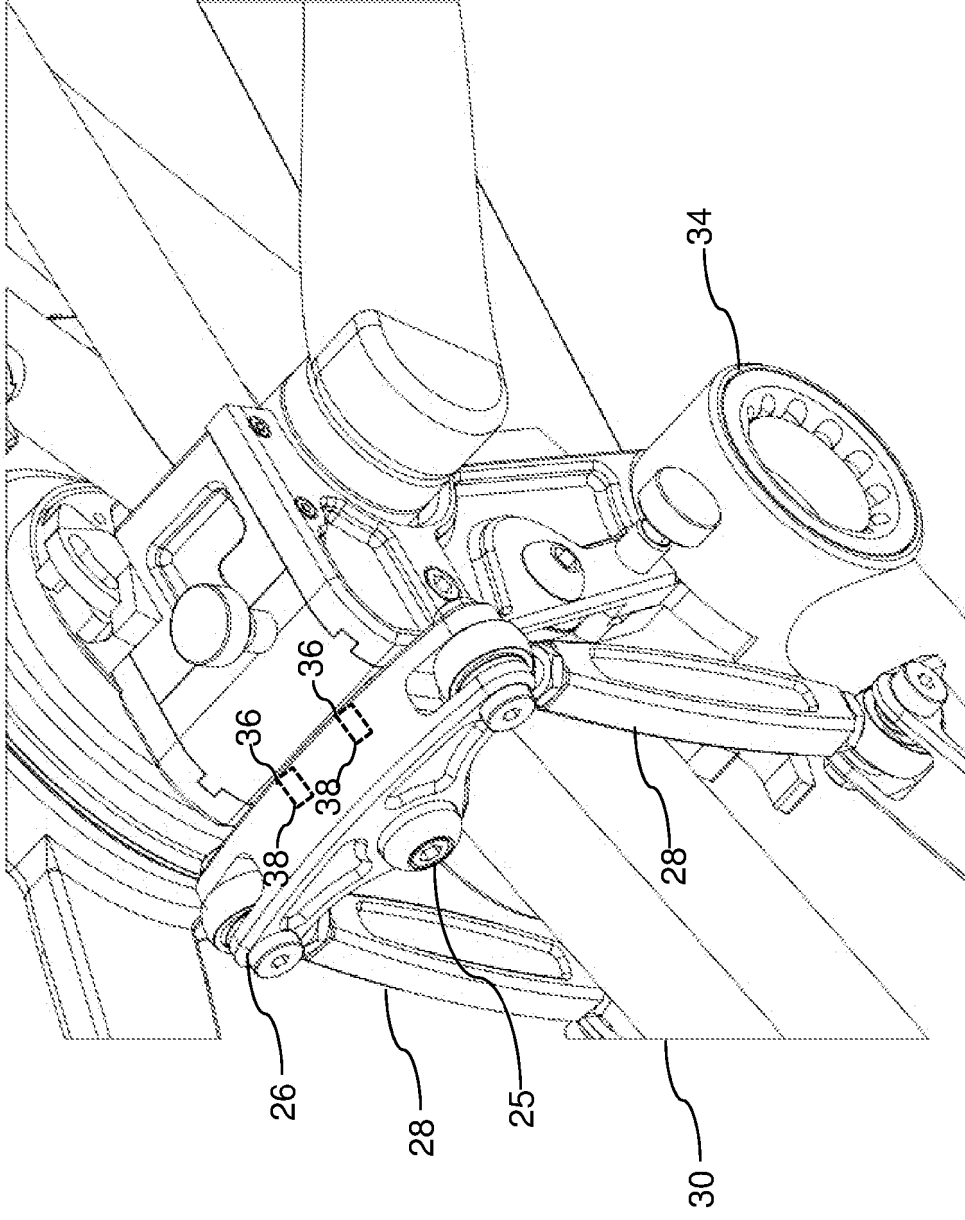


Fig. 3

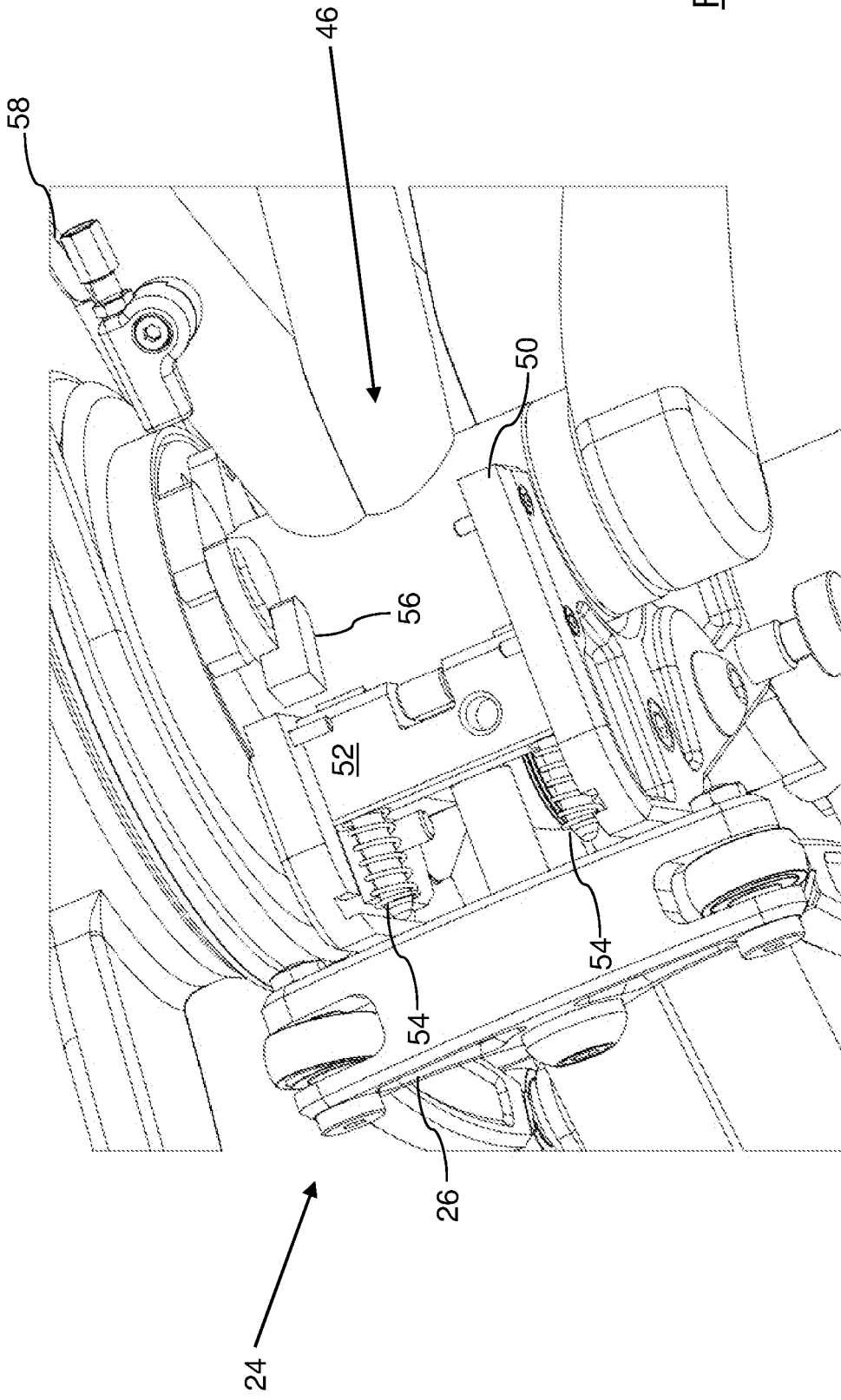


Fig. 4



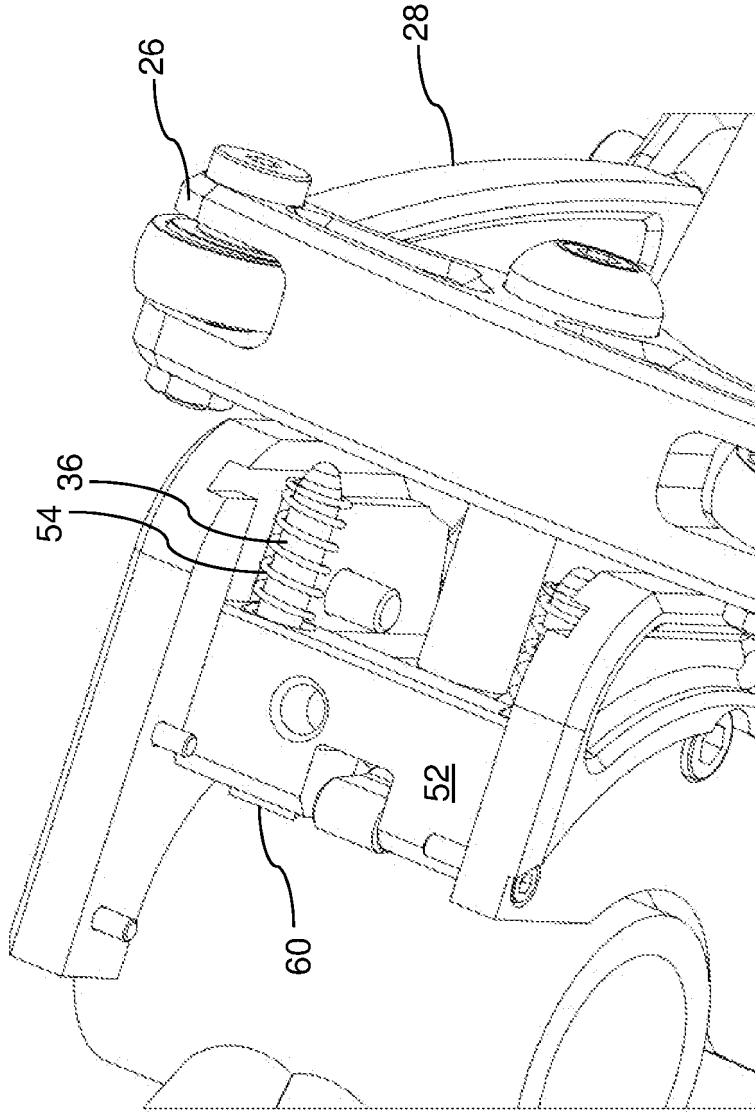


Fig. 6

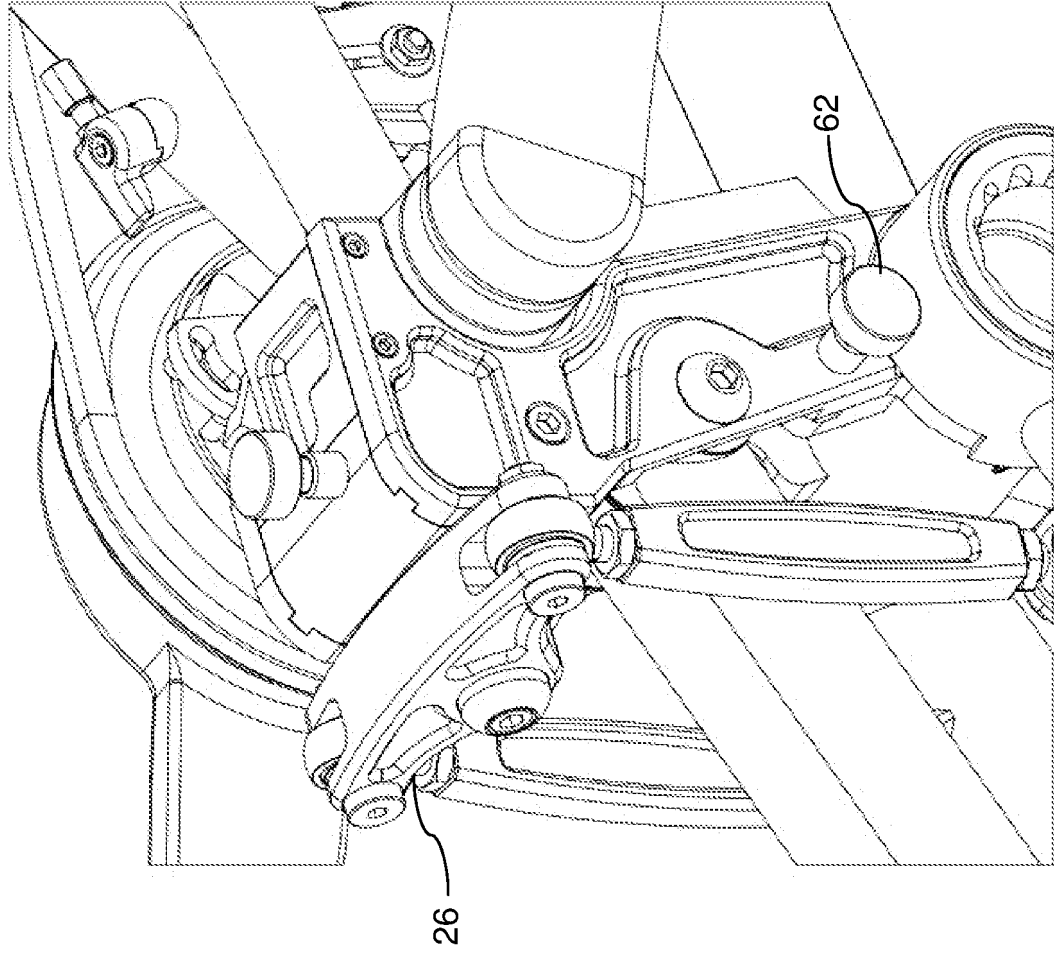


Fig. 7



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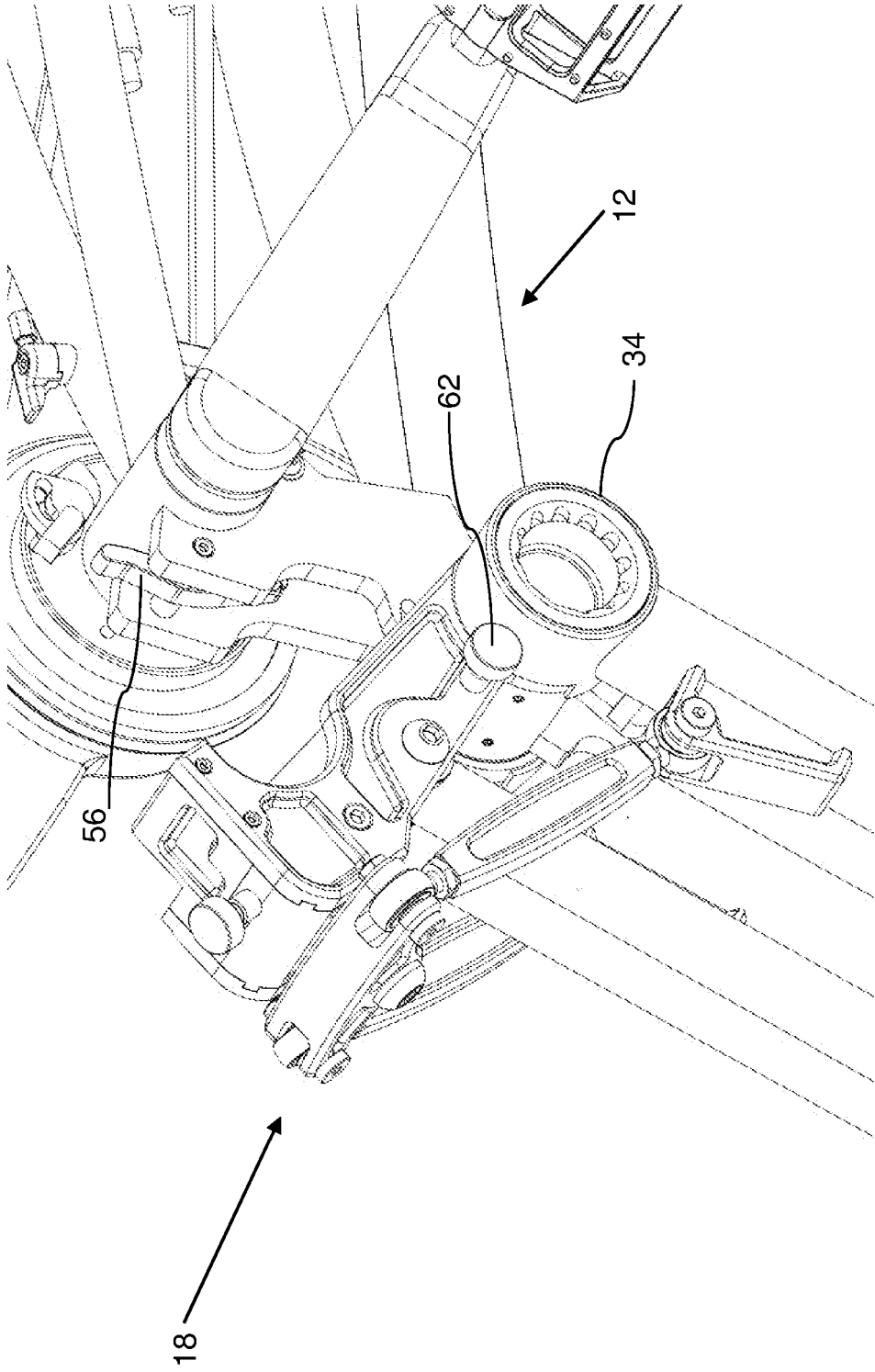


Fig. 8



## DESCRIPTION

**A FOLDING BIKE**

5 This invention relates to a folding 3-wheeled bike.

Folding bikes have been known for many years. Conventional upright two wheel bicycles that are capable of being folded have been in widespread use since at least the early 1980s. These bikes are popular with commuters, city dwellers and those escaping citified areas as they tend to be lightweight and convenient to use, since they can be folded into a relatively small space. This helps with storage and also allows them to be carried easily on both personal and public transport. Such lightweight and collapsible bikes are viewed as both better for the environment and healthier for the user by giving an alternative to using entirely auxillary-powered vehicles for journeys within urban environments. However, such folding bikes can suffer from issues of reduced comfort and performance with respect to non-folding bikes, since in order to incorporate the folding mechanism and keep the bike as light as possible, usually one or more other technical aspects of the bike design have to be compromised.

3-wheeled bicycles have also existed for almost as long as 2-wheelers. Today, there are two distinct types of pedal-powered 3-wheelers; those representing a traditional upright bicycle, with an extra wheel at the rear, and those of the recumbent style, with the third wheel either at the front or rear. These two types present their own drawbacks: The uprights feature a high centre of gravity and as a result of their design lack in handling, resulting in lower cornering speeds and poor stability on uneven ground. The recumbent style features the rider in an extremely low position which dramatically improves handling, but at the expense of making it difficult to get on/off and reduces the riders visibility of the surroundings. More importantly, this style of cycle and low position makes it extremely difficult to be seen by other

motorists, putting the rider in excessive danger which is only slightly overcome by the use of a flag on a pole.

5 It is therefore an object of the invention to improve upon these known arts.

According to the present invention, there is provided folding bike comprising a central frame portion, a seat mounted on the central frame portion, a rear frame portion connected to, and foldable relative to, the central frame portion, a rear wheel connected to the rear frame portion, a front frame portion connected to, and foldable relative to, the central frame portion, and comprising a pair of arms, a pair of front wheels, each front wheel connected to an arm of the front frame portion, and a rocker mechanism connected to each arm of the front frame portion, the rocker mechanism having an unlocked configuration allowing the arms to move relative to each other and a locked configuration preventing the arms from moving relative to each other.

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Owing to the invention, it is possible to provide a folding bike that is not of the conventional upright two-wheel bicycle design, but is of a three-wheel, more comfortable and elevated sitting position design, but nevertheless provides an excellent riding experience. The provision of the rocker mechanism that can lock and unlock the two arms that are connected to the front wheels means that the bike can be used with the arms unlocked to provide proper steering and riding dynamics through leaning of the bike during cornering and uneven terrain and can also be used with the arms locked to provide rigidity, for example when the bike is being used on a long straight stretch, an uphill section or in slow or stationary traffic. A comfortable, yet flexible, cycle riding experience is provided in a three-wheel bike that can be folded up for storage and carriage purposes.

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Preferably, the rocker mechanism comprises a pivoted crossbar that is perpendicular to the arms of the front frame portion and is connected at each end to a respective arm via a respective tilt link, and where, when the rocker mechanism is in its locked configuration, the crossbar is prevented from pivoting. The rocker mechanism can be embodied using a crossbar that is

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pivoted in its centre, the crossbar being provided in an orientation that is at right angles to the longitudinal arms that connect to the front wheels. At each end of the crossbar a tilt link is connected, which joins the crossbar to the respective arm that is connected to a front wheel. If the crossbar is locked from tilting, then the arms are prevented from moving from their locked position of being parallel to each other. If the crossbar can tilt then the two arms can move relative to each other. As the crossbar rises on one side it will lower on the opposite side, providing the movement that the arms need to allow the bike to tilt to aid steering.

Advantageously, the rocker mechanism further comprises a pair of movable pins arranged to engage with corresponding holes present in the crossbar and wherein when the rocker mechanism is in its locked configuration, the crossbar is prevented from pivoting by the movable pins being located in the corresponding holes in the crossbar. The locking of the crossbar can be provided by spring-loaded pins that can move into position engaging with holes in the crossbar. This will lock the crossbar from moving and will keep the arms of the front frame portion locked in their parallel configuration, unable to move relative to each other. The movable pins that are locking the crossbar in position provide a simple method of implementing the mechanism for being able to lock the arms of the front frame portion in position.

Ideally the rocker mechanism further comprises a frame, the frame mounting a movable slider, wherein the movable slider mounts the pins arranged to engage with corresponding holes present in the crossbar. The rocker mechanism can be configured to include a frame that mounts the various components, including a movable slider that mounts the pins that can be used to lock and unlock the crossbar. The slider can be spring loaded, with the position of the slider being controlled using a cam that the rider of the bike can control using a lever and cable system mounted on the handlebars. This allows the rider to adjust the position of the slider without having to interrupt their ride and is designed in such a way that the crossbar can only be locked when the bike is upright. The spring-loaded mechanism allows the rider to

engage the lock at any point but locking will only occur when the bike reaches an upright position. The change in position of the slider either introduces the pins into the crossbar locking the crossbar and hence the arms connected to the front wheels, or withdraws the pins from the crossbar allowing the crossbar to tilt, thereby allowing the arms to move independently of each other. In this configuration, the bike can lean when cornering, allowing for tighter and faster corners to be undertaken without toppling.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a perspective view from behind of a folding bike,

Figure 2 is a perspective view from above of a front frame portion of the bike,

Figures 3 and 4 are perspective views of a rocker mechanism of the bike,

Figure 5 is a further perspective view of the front frame portion of the bike, and

Figures 6 and 7 are further perspective views of the rocker mechanism of the bike,

Figure 8 is a perspective view of a part of the bike as it is being folded, and

Figure 9 is a perspective view of a part of the bike in a fully folded configuration.

Figure 1 shows the folding bike 10. The main components of the bike 10 are a central frame portion 12, a seat 14 mounted on the central frame portion 12, a rear frame portion 8 connected to, and foldable relative to the central frame portion 12, a rear wheel 16 connected to the rear frame portion 8, a front frame portion 18 connected to, and foldable relative to, the central frame portion 12, the front frame portion 18 comprising a pair of arms 22, and a pair of front wheels 20, each front wheel 20 connected to an arm 22 of the front

frame portion 18. The bike 10 is shown in Figure 1 in its unfolded position, ready to use. The cyclist sits in a comfortable position in the seat 14.

The bike 10 has a bottom arm axle 34, with the central frame portion 12 and the front frame portion 18 connected to the bottom arm axle 34 and so designed that the front frame portion 18 can rotate around the bottom arm axle 34. A suitable locking mechanism can be used to lock the two frame portions 12 and 18 in the unfolded and folded configurations, as described in detail below. In use, as shown in Figure 1, the two frame portions 12 and 18 are locked in the unfolded configuration. When the user wishes to fold the bike 10 away, then the user can unlock the mechanism, fold up the bike 10 and then relock the mechanism, keeping the bike 10 locked in the folded position.

The bike 10 has three main frame components, the front frame portion 18, the central frame portion 12 and the rear frame portion 8. The front frame portion 18 and the rear frame portion 8 both fold relative to the central frame portion 12, when the bike 10 is being folded away. The rear frame portion 8 (a rear swingarm) can also fold up and under, housing the rear wheel between the central frame tubes. The folding/locking mechanisms are on quick-release spring loaded clips. These are lifted which allows the parts to swing and when both folding and unfolding the front and rear ends the fold/unfold clips into place without further action from the user.

The user operates the bike 10 by sitting in the seat 14 and pedalling a pair of pedals (not shown for reasons of clarity) which turn a gear wheel 40. The gear wheel 40 is connected by a front chain 42 to a central idler cog, rotating on the rear swingarm folding axle, which drives the rear chain to drive the rear wheel 16. Gearing of the ratio between the gear wheel 40 and the rear wheel 16 can be provided by sets of different ratio gear wheels located at one or both ends of the chain 42, as is conventional on bicycles and also by changing the gears on the central idler gear. The user can grasp the handles 44 as they are seated in the seat 14 and steering is accomplished by turning the handlebars, as per a regular bicycle but instead linking to each front wheel by a flexible push/pull cable. The tilting the bike 10, is achieved in the same way as a regular 2-wheeled bicycle by steering and counterbalancing.

Figure 2 shows more detail of the front frame portion 18. As shown in Figure 2, the arms 22 of the front frame portion 18 are parallel to each other, when the rocker mechanism 24 is in its locked configuration. In this preferred embodiment of the rocker mechanism 24, the rocker mechanism 24 comprises a pivoted crossbar 26 that is perpendicular to the arms 22 of the front frame portion 18 and is connected at each end to a respective arm 22 via a respective tilt link 28. When the rocker mechanism 24 is in its locked configuration, the crossbar 26 is prevented from pivoting. The arms 22 are locked parallel for extra stability when the bike 10 is stationary or pulling away.

The rocker mechanism 24 further comprises a pair of movable pins 36, seen in Figure 3, that are arranged to engage with corresponding holes 38 present in the crossbar 26 and when the rocker mechanism 24 is in its locked configuration, the crossbar 26 is prevented from pivoting by the movable pins 36 being located in the corresponding holes 38 in the crossbar 26. The pins can be retracted into the rocker mechanism 24 in order to allow the crossbar 26 to move freely, pivoting up and down around a pivot 25. As one of the arms 22 rises, the other arm 22 will fall, as the bike 10 is tilted by the rider.

The front frame portion 18 also further comprises a second pair of upper arms 30 and a pair of brackets 32, each bracket 32 connected to a respective arm 22 and a respective upper arm 30. These can be seen in Figure 2 and provide additional stability to the front frame portion 18, when the bike 10 is turning under the action of the rider leaning to the left or to the right in order to steer the bike 10. Each front wheel 20 is mounted on a respective bracket 32 along with a respective front brake mechanism 48. Each of the upper arms 30 in the front frame portion 18 connect at one end to a bracket 32 and at the other end to the rocker mechanism 24.

Figure 3 shows more detail of the rocker mechanism 24, with the crossbar 26 shown as a transparent object in order to more clearly explain the workings of the components of the rocker mechanism 24. The crossbar 26 pivots around the central pivot 25 and is connected at each end to a respective tilt link 28. Each tilt link 28 connects at the opposite end to a respective arm 22, which are the lower arms 22 that connect from the rocker mechanism 24 to



a bracket 32 on which a front wheel 20 is mounted. Visible in Figure 3 are the upper arms 30 which also connect from the rocker mechanism 24 to a bracket 32 on which a front wheel 20 is mounted.

The movement of the crossbar 26 can be prevented by the pins 36, which engage in holes 38 in the crossbar 26. When the pins 36 are engaged in the holes 38, then the crossbar 26 cannot turn about the pivot 25 and is stationary. This means that the two arms 22 to which the crossbar 26 is connected via the tilt links 28 cannot move relative to each other, essentially being locked parallel to each other. In this configuration, the bike 10 is ideally arranged for extra stability such as when stationary or pulling away, or when the rider is using extra effort such as when going uphill or when travelling on a long straight stretch of road.

When the pins 36 are withdrawn, then the crossbar 26, which is at right angles to the direction of the arms 22, is able to turn around the pivot 25. This allows the arms 22 to move relative to each other. As one side of the crossbar 26 rises then the other side lowers and the connected arms 22 will move in the same corresponding manner. This allows the front wheels 20 to be tilted, and helps allow steering of the bike 10.

Figure 4 shows further detail of the rocker mechanism 24, viewed in close-up from above. This Figure shows detail of the elements within the rocker mechanism 24 that allow the bike rider to switch between the two different configurations of the rocker mechanism 24, switching between the locked and unlocked configuration of the crossbar 26, which control whether the lower arms 22 of the front frame portion 18 are able to move relative to each other or not. The crossbar 26 is shown in this Figure in the configuration where the crossbar 26 is free to tilt up and down, allowing relative movement of arms 22 and therefore allowing the bike 10 to be easily tilted by the rider.

The rocker mechanism 24 includes a frame 50 and a slider 52 that can move relative to the frame 50. The pins 36 are mounted on the slider 52 and the movement of the slider 52 relative to the frame 50 controls whether the pins 36 are engaged in the holes 38 of the crossbar 26 or not. The slider 52 is spring-loaded by springs 54 that are tending to push the slider 52 backwards

away from the crossbar 26 and withdraw the pins 36 from the holes 38. The slider 52 can be moved using a cam 56 which is cable operated by the rider of the bike 10 using a cable 58.

The slider 52, cam 56 and cable 58 together form a user operable  
5 mechanism 46 that can be used to switch the rocker mechanism 24 between the unlocked configuration allowing the arms 22 to move relative to each other and the locked configuration preventing the arms 22 from moving relative to each other. This allows the rider of the bike 10 to be able to switch between the configurations while they are riding the bike 10, since the cable 58 can be  
10 controlled using a suitable lever that is positioned on the handlebars. The cable 58 moves the cam 56, which will either push the slider 52 towards the crossbar 26 or allow the springs 54 to push the slider 52 away from the crossbar 26.

Figure 5 is another view of the front frame portion 18 and the wheels 20,  
15 which shows the tilting of the wheels 20 under the action of the rider tilting the bike 10 as the bike 10 is being pedalled along. As can be seen in this Figure, the two arms 22 that are connected to the wheels 20 have moved relative to each other and are no longer parallel. Similarly the upper arms 30 have also moved relative to each other and are also no longer parallel to each other. This  
20 is achieved by the movement of the crossbar 26 within the rocker mechanism 24.

The crossbar 26 is here free to move around the pivot 25 and this implies that the pins 36 are currently withdrawn from the holes 38 and are not preventing the crossbar 26 from tilting up at one side and down at the other  
25 side. While the rider is sat of the seat 14 of the bike 10, the rider would normally operate the bike 10 in this configuration, with the crossbar 26 free to tilt and therefore with the arms 22 able to move relative to each other, allowing the bike 10 to be steered easily. The rider has access to the lever that controls the cable 58 which is connected to the rocker mechanism 24 and can switch  
30 the configuration at any time.

Each of the two arms 22 is connected at one end to a front wheel 20 and at the other end to the axle 34. The connection to the axle 34 is such that

each arm 22 can rotate around an axis through the axle 34 independently of the other arm 22, this is part of the mechanism that allows the relative movement between the two arms 22. As the crossbar 26 is tilted, pushing down one arm 22 relative to the other arm 22 which moves upwards through the connection of the tilt links 28, the arms 22 will rotate around the axis through the axle 34. This creates a leaning effect on the front wheels 20, as shown in Figure 5. Since the wheels 20 engage the road surface, the relative movement between the arms 22 forces the wheels 20 to tilt to accommodate the movement of the arms 22.

Figures 6 to 9 illustrate the folding of the bike 10. The folding of the bike 10 is accomplished by the front frame portion 18 being folded down and under the central frame portion 12, with the axis of folding running perpendicular to the longitudinal axis of the bike 10. In Figure 6, a locking cam 60 can be seen, which is used to lock the slider 52 into the locked configuration, with the pins 36 extending into the holes 38 on the crossbar 26 and preventing the crossbar 26 from moving. The arms 22 are therefore locked in their parallel position and cannot move relative to each other. The locking cam 60 is engaged by the rider in preparation for the folding of the bike 10.

In Figure 7, an index plunger 62 is released by being pulled outwards, which effectively allows the two frame portions 12 and 18 to be folded relative to each other. The two frame portions 12 and 18 are able to turn about the axle 34, which defines the axis of rotation for the two frame portions 12 and 18. The rider pulls out the index plunger 62 to begin the process of folding bike 10 away. The index plunger 62 is spring loaded and has a "park" feature so that the index plunger 62 remains disengaged when turned 45 degrees. The rider pulls out the index plunger 62 and then turns the plunger 45 degrees in order to lock the plunger 62 in the open position.

Figure 8 shows the bike 10 as it is started to be folded up. The rider has pulled out the index plunger 62 and the rider can now start to fold the bike 10 around the axis through the axle 34. The front frame portion 18 of the bike 10 is folded down and under the central frame portion 12 during the folding action. The whole sub-frame 18 is free to rotate with the arms 22 and the

wheels 20. The cam 56 and the cable 58 remain on the rear frame portion 12. All of the components that make up the front frame portion 18 and all of the components mounted on that frame portion 18 will rotate together during the folding action.

- 5           Figure 9 shows part of the bike 10 after the folding action has been completed. A second index plunger 64 automatically locks the two frame portions 12 and 18 in the folded position, working on the same principle of the first index plunger 62 and can be released for unfolding.

## CLAIMS

1. A folding bike (10) comprising:
- 5       • a central frame portion (12),
  - a seat (14) mounted on the central frame portion (12),
  - a rear frame portion (8) connected to, and foldable relative to, the  
      central frame portion (12),
  - a rear wheel (16) connected to the rear frame portion (8),
  - 10      • a front frame portion (18) connected to, and foldable relative to,  
      the central frame portion (12), and comprising a pair of arms  
      (22),
  - a pair of front wheels (20), each front wheel (20) connected to an  
      arm (22) of the front frame portion (18), and
  - 15      • a rocker mechanism (24) connected to each arm (22) of the front  
      frame portion (18), the rocker mechanism (24) having an  
      unlocked configuration allowing the arms (22) to move relative to  
      each other and a locked configuration preventing the arms (22)  
      from moving relative to each other.
  - 20
2. A folding bike according to claim 1, wherein the arms (22) of the  
front frame portion (18) are parallel to each other, when the rocker mechanism  
(24) is in its locked configuration.
- 25       3. A folding bike according to claim 1 or 2, wherein the rocker  
mechanism (24) comprises a pivoted crossbar (26) that is perpendicular to the  
arms (22) of the front frame portion (18) and connected at each end to a  
respective arm (22) via a respective tilt link (28), and wherein when the rocker  
mechanism (24) is in its locked configuration, the crossbar (26) is prevented  
30      from pivoting.
4. A folding bike according to claim 3, wherein the rocker  
mechanism (24) further comprises a pair of movable pins (36) arranged to

engage with corresponding holes (38) present in the crossbar (26) and wherein when the rocker mechanism (24) is in its locked configuration, the crossbar (26) is prevented from pivoting by the movable pins (36) being located in the corresponding holes (38) in the crossbar (26).

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8. A folding bike according to claim 4, wherein the rocker mechanism further comprises a frame (50), the frame (50) mounting a movable slider (52), wherein the movable slider (52) mounts the pins (36) arranged to engage with corresponding holes (38) present in the crossbar (26).

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6. A folding bike according to any preceding claim, wherein the front frame portion (18) further comprises a second pair of upper arms (30) and a pair of brackets (32), each bracket (32) connected to a respective arm (22) and a respective upper arm (30).

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7. A folding bike according to any preceding claim, and further comprising a bottom arm axle (34), the central frame portion (12) and the front frame portion (18) connected to the bottom arm axle (34) and wherein the front frame portion (18) can rotate around the bottom arm axle (34).

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8. A folding bike according to any preceding claim, and further comprising a user operable mechanism (46) arranged to switch the rocker mechanism (24) between the unlocked configuration allowing the arms (22) to move relative to each other and the locked configuration preventing the arms (22) from moving relative to each other.

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**Application No:** GB1515605.2

**Examiner:** Mr Philip Osman

**Claims searched:** 1-8

**Date of search:** 24 February 2016

**Patents Act 1977: Search Report under Section 17**

**Documents considered to be relevant:**

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-5 & 8	EP2127920 A1 (YAMAHA) See abstract and figures
A	-	CA2290715 A1 (DESIGN CO) See abstract and figures
A	-	DE3611417 A1 (FICHTNER) See English language abstract and figures
A	-	CN204150182 U (YANG) See English language abstract and figures
A	-	JP2015229388 A (RESC LTD) See English language abstract (WPI 2015-18585N) and figures
A	-	GB2450740 A (ZAVOLNYI) See abstract and figures

**Categories:**

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>X</sup> :

Worldwide search of patent documents classified in the following areas of the IPC

B62K

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI



**International Classification:**

<b>Subclass</b>	<b>Subgroup</b>	<b>Valid From</b>
B62K	0005/10	01/01/2013
B62K	0005/05	01/01/2013
B62K	0015/00	01/01/2006