



US006986522B2

(12) **United States Patent**  
**Sinclair et al.**

(10) **Patent No.:** **US 6,986,522 B2**  
(45) **Date of Patent:** **Jan. 17, 2006**

(54) **PORTABLE FOLDING BICYCLE**

(75) Inventors: **Clive Marles Sinclair**, London (GB);  
**Alexander Joseph Kalogroulis**,  
Coulsdon (GB)

(73) Assignee: **Daka Research Inc.**, Tortolla (VG)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/857,277**

(22) Filed: **May 28, 2004**

(65) **Prior Publication Data**

US 2005/0263979 A1 Dec. 1, 2005

(51) **Int. Cl.**  
**B62K 15/00** (2006.01)

(52) **U.S. Cl.** ..... **280/287**; 280/278

(58) **Field of Classification Search** ..... 280/278,  
280/287

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,623,749 A \* 11/1971 Jensen ..... 280/278  
4,460,191 A \* 7/1984 Ishibashi et al. .... 280/287

6,883,817 B2 \* 4/2005 Chu ..... 280/278  
2004/0032110 A1 \* 2/2004 Bigot ..... 280/287  
2004/0178604 A1 \* 9/2004 Ma ..... 280/278  
2005/0035570 A1 \* 2/2005 Chu ..... 280/278

**FOREIGN PATENT DOCUMENTS**

EP 0388540 A1 \* 3/1969  
EP 0505598 A1 \* 3/1991

\* cited by examiner

*Primary Examiner*—Lesley D. Morris  
*Assistant Examiner*—Marlon Arce-Diaz

(74) *Attorney, Agent, or Firm*—Curtis L. Harrington

(57) **ABSTRACT**

A folding bicycle presents a number of advantages over both conventional and other foldable bicycles. The folded size of 12 ×25×6 inches (305×635×153 millimeters) compares favorably to other folding bicycles, and its 11 lb. (eleven pound, or 5 kilogram mass) weight is significantly superior to even the closest lightweight model at eighteen pounds, and about half of the average portable bike weight of twenty-two pounds. The folded volume of the bike at 1800 square inches is slightly over one cubic foot. The portable bicycle has a folding stowage time of about 10 seconds, and a deployment time of about 6 seconds. A folding pedal and handle bar design contributes significantly to a folded lateral profile.

**10 Claims, 8 Drawing Sheets**

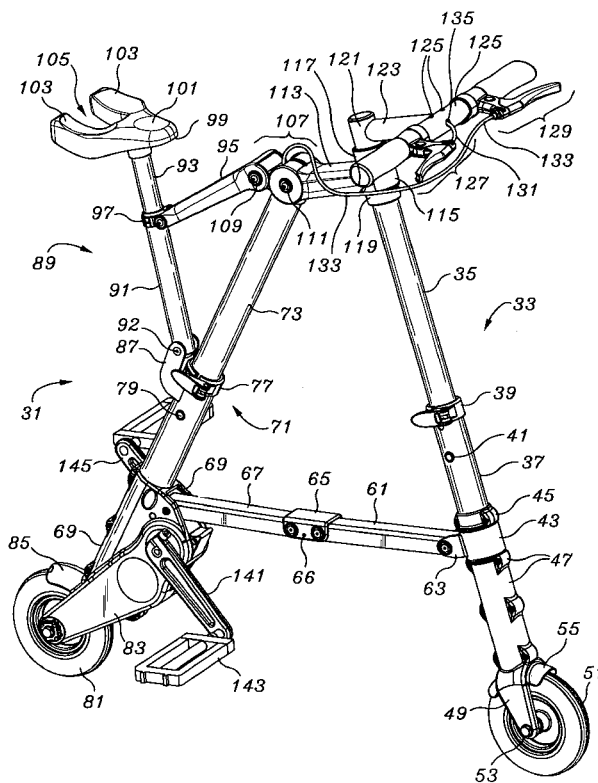


Fig. 1

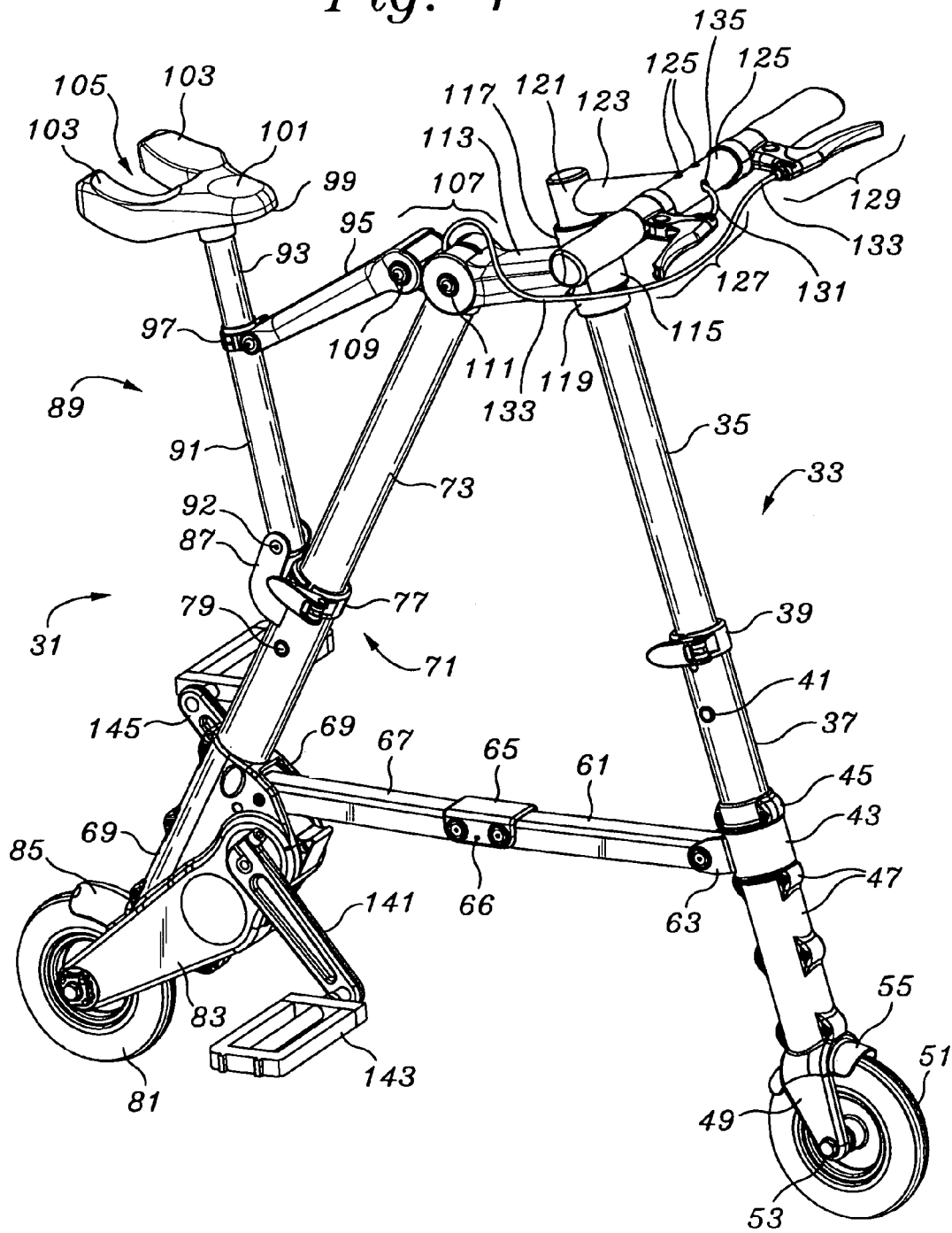


Fig. 2

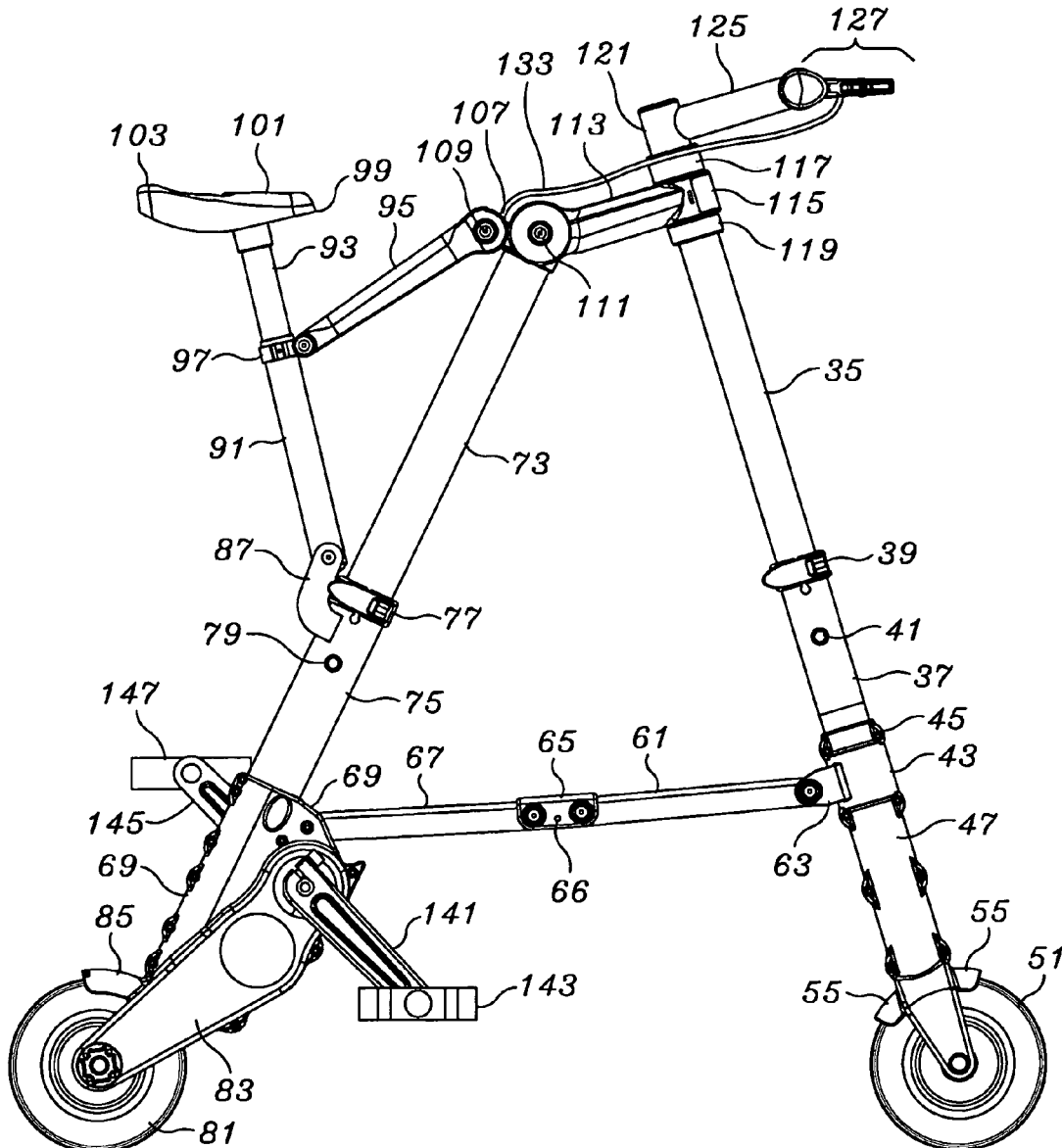


Fig. 3

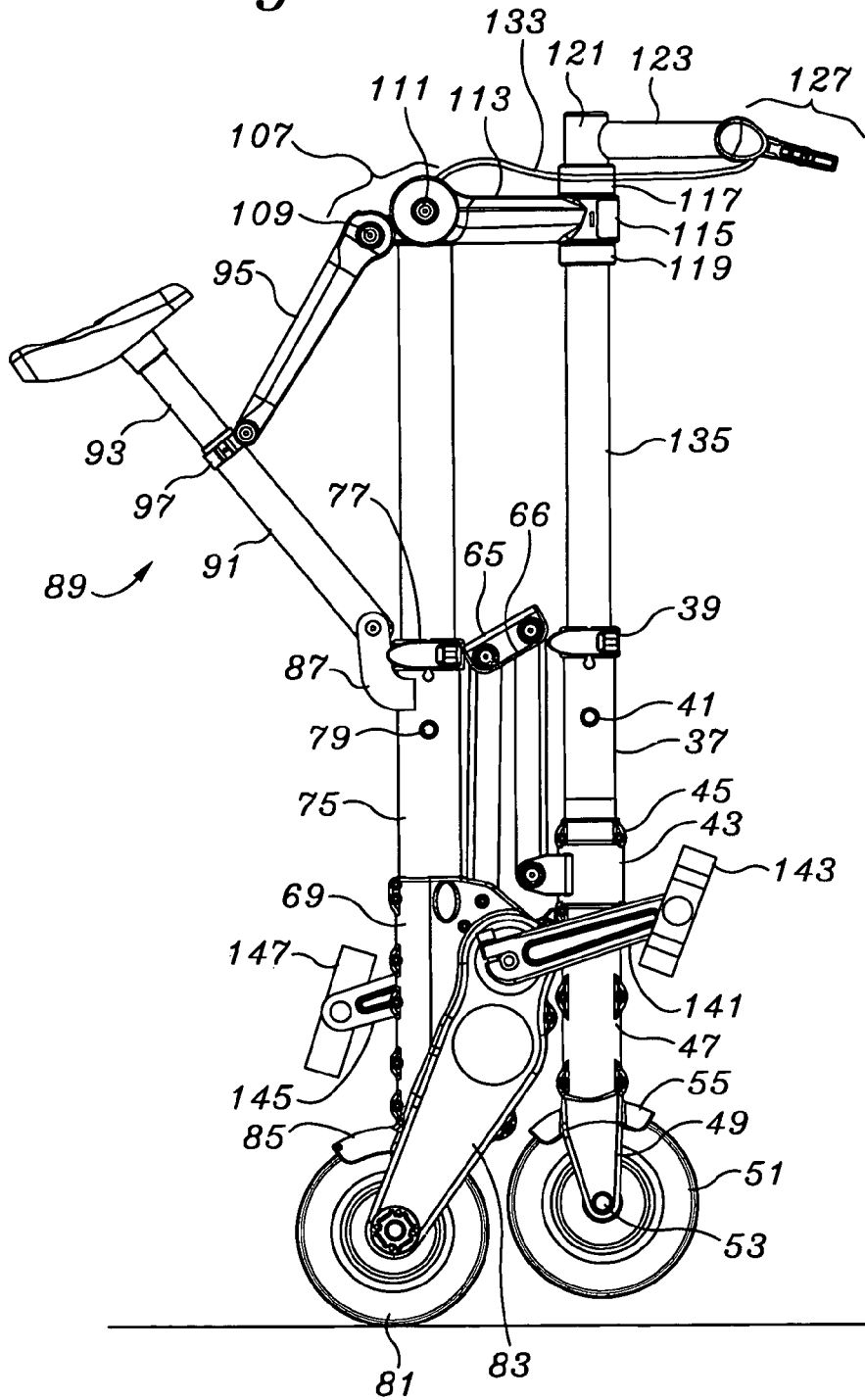






Fig. 8

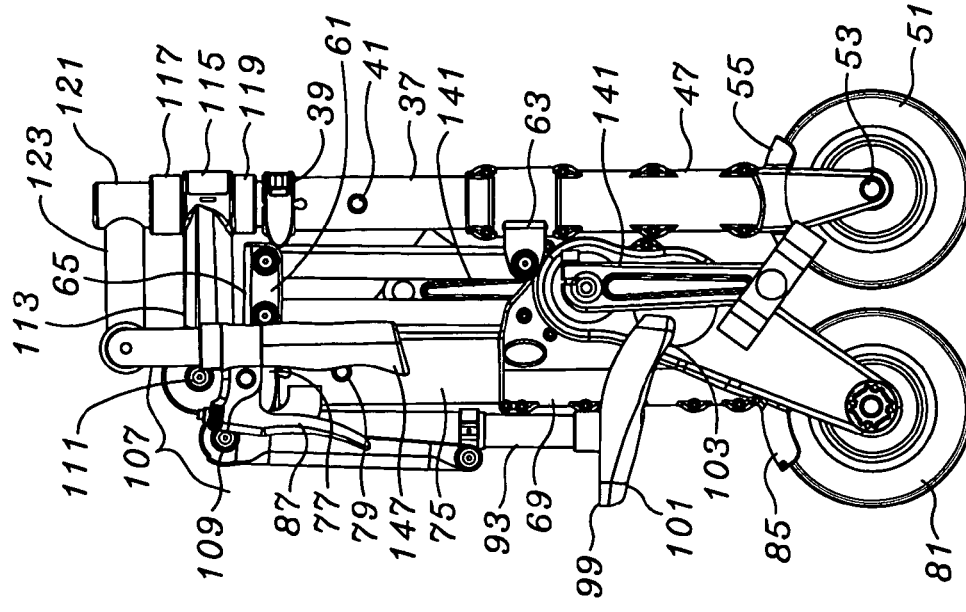


Fig. 7

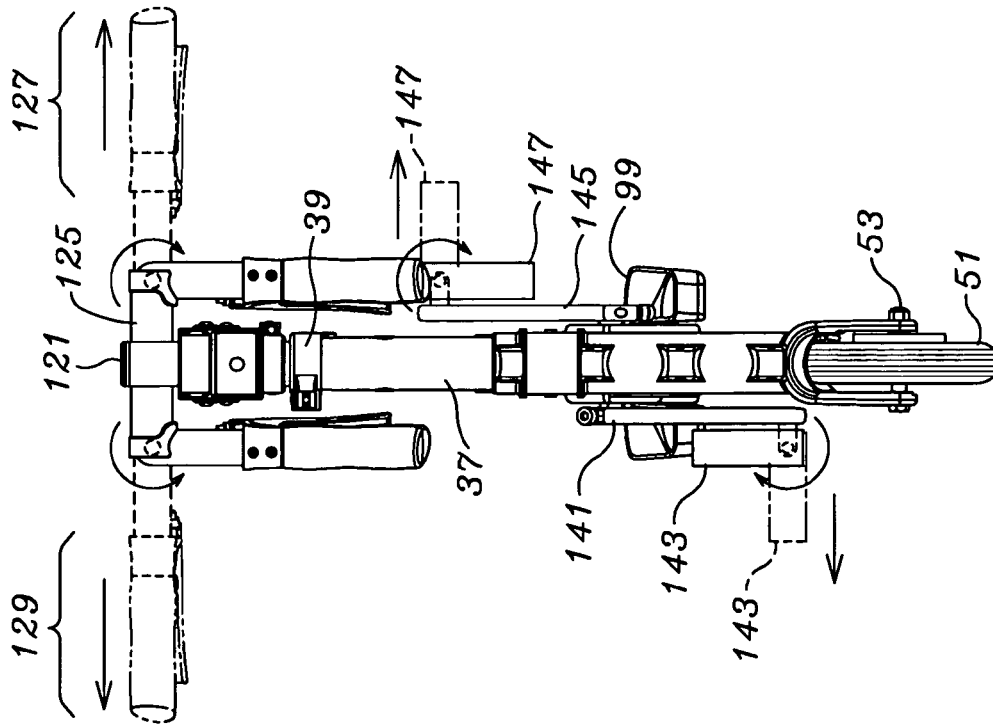


Fig. 9

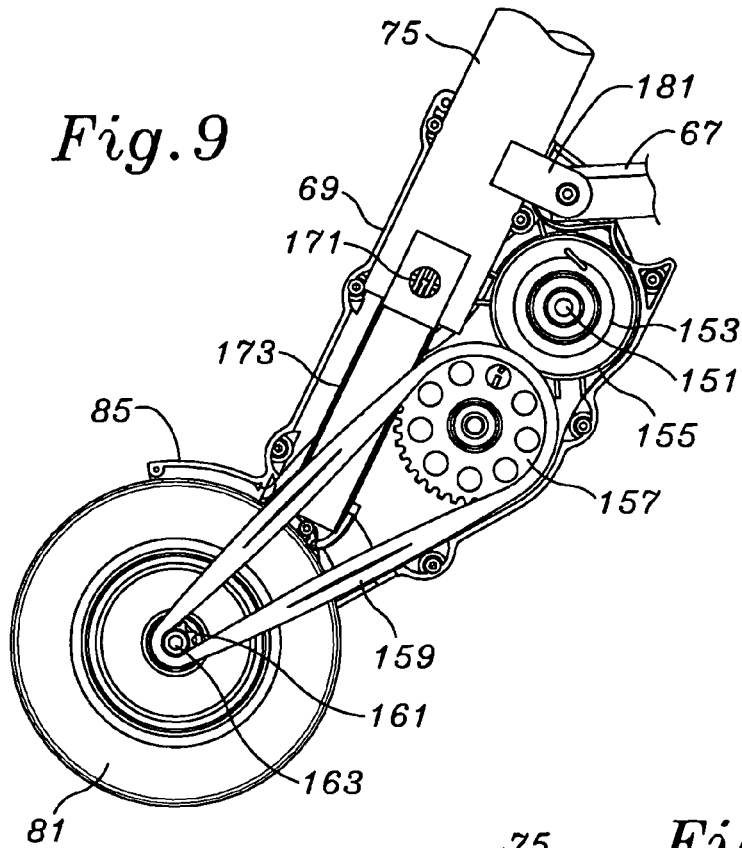
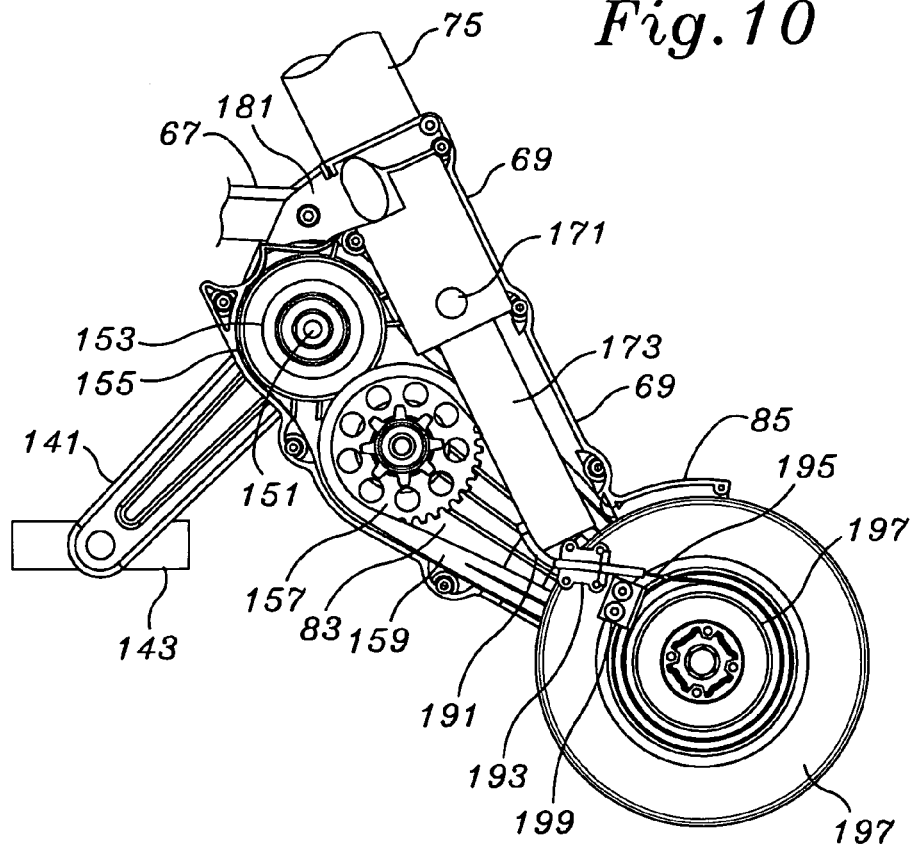
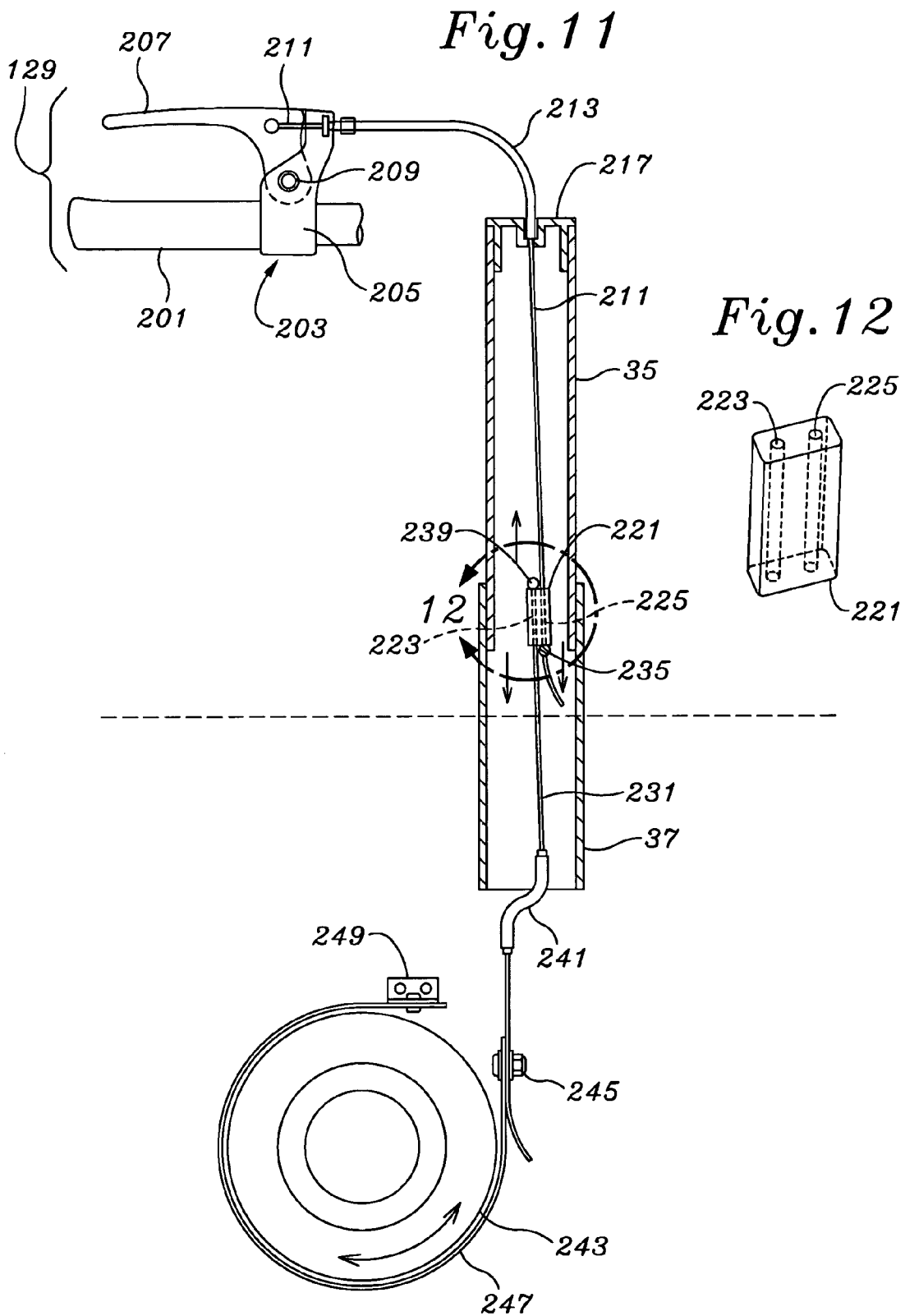


Fig. 10





1

**PORTABLE FOLDING BICYCLE**

## FIELD OF THE INVENTION

The present invention relates to improvements in the technology relating to personal transportation devices, and more particularly to folding bicycles which can fold to a position about the size of a purse or carry bag.

## BACKGROUND OF THE INVENTION

Bicycles have been made and sold for over one hundred years. Folding bikes are known and tend to allow a bike to be folded into a smaller yet still bulky or cumbersome size. Furthermore the folding bike can be typically heavier than a non folding similar bike. The provision of a bike that folds into a package small enough to be carried in a general purpose rucksack and light enough to be carried great distances if needs be, has not been available to any practical extent.

In general, bicycles ranging from high performance sports uses to standard personal transportation devices, bicycles have generally had only one limitation -- the space occupied when the bicycle is not in use. Lightweight bicycles are known, but the size has continued to present a problem. One of the main size limitations has been the wheels. Most conventional bicycles have front and rear wheels which range from twenty six to twenty eight inches in diameter. Even ignoring the other structural aspects of the bicycle, the front and rear wheel alone represent the size of two large refuse container lids.

Existing folding bicycle products tend to fold in several actions, often leaving an oiled chain exposed on the outside, and other components of the bike protruding. As a result, conventional folding bicycles can be dirty and dangerous to users and their clothing. Generally the existing bikes tend to remain bulky, even when folded.

One reason that light portable bicycles are especially valuable is the increased need for personal transportation to "fill in" the gaps in the public transportation system. This is especially true for work situations where a commuter may drive to a train station and disembark from a train station which is several miles from work. Even a small portable bicycle would need to be specially stored in the workplace. Carriage of the small bicycle on the train presents an even more severe problem, especially on train lines having a "standing room only" level of crowding. Although some busses have bicycle racks, the racks are too few for the high number of bicycles which should be used.

Another needed "breakthrough" area is that of facilitating bicycle usage by persons with lesser upper body strength. This involves the need for lighter weight and more compact size. The average portable bicycle weighs about twenty-two pounds. Even with a carrying case or backpack, a twenty-two pound weight is a significant weight for a small individual lacking upper body strength. Given that most individuals also have other items to carry, the twenty-two pound average weight is an addition rather than a total carry weight. As such, weight prevents a significant portion of the population from deriving the advantages of portable bicycle use.

In terms of utilization of a bicycle, much of the total picture for increased utilization involves the ability to store the bicycle for occasional uses for times such as when all the busses and trains may not be running. In this case, more continuous workplace storage will need to be facilitated. In large metropolitan areas the office space available to workers

2

continues to shrink. To be available as an "on demand" link, both storage and carriage will need to be facilitated.

## SUMMARY OF THE INVENTION

A folding bicycle presents a number of advantages over both conventional and other foldable bicycles. The folded size of 12 × 25 × 6 inches (305 × 635 × 153 millimeters) compares favorably to other folding bicycles, and its 11 lb. (eleven pound, or 5 kilogram mass) weight is significantly superior to even the closest lightweight model at eighteen pounds, and about half of the average portable bike weight of twenty-two pounds. The folded volume of the bike at 1800 square inches is slightly over one cubic foot. The portable bicycle has a folding stowage time of about 10 seconds, and a deployment time of about 6 seconds.

A folding pedal design contributes significantly to a folded lateral profile. Once folding is complete, the package stays automatically locked together. A brake design is very different to a conventional bicycle system and utilizes a banded drum for positive braking and which eliminates the need for periodic adjustment seen in conventional brake system.

The pedal drive uses a power transmission system having a two stage chain drive with a freewheel mechanism located on the crank axle rather than the rear wheel axle. Externally, conventional reflectors are replaced with retro-reflective decals so that the reflectivity will be present and not subject to damage as would a conventional reflector structure.

The folding bicycle herein has pushed the envelope in both size and weight to correspondingly make the advantage of a folding bicycle even more advantageous. With increased usage of the bicycle, the risk of theft can be virtually eliminated, and it can readily be taken away on holidays or occasional excursions with a reduced consciousness of being specially taken along. Users will tend to make the folding bicycle a normally carried item in backpacks, automobiles, office filing cabinets, brief cases, boats, apartments, car boots, cupboards, and more.

The folding bicycle herein has only four parts which are un-clamped and folded, (1) the main frame, (2) the handlebar, (3) the saddle, and (4) the pedals. The folding bicycle herein includes a design which provide the user with a reasonably compact product that can be used in different environments. Furthermore, the folding bicycle herein has its internal mechanisms concealed to eliminate protruding elements which could injure the user or causing damage to the user's clothing or storage structures. The compact, self-contained streamlined folding bicycle allows the user to handle and the product without affecting the user's daily routines. The quick folding and unfolding procedure enables the user to avoid using any significant time in the folding/unfolding process.

In addition, the increased use of a folding bicycle would reduce security to a minimal level as the user could take the bike with them as apposed to leaving it outside, therefore reducing the possibility of theft or vandalism. The size would also allow the bike to be taken onto public transport without it intruding into other people's space and would be manageable to the user.

The resulting folded bicycle has no projections or loose parts, and the folded package is easy to handle. The saddle forms a natural handle for the folded stowed structure. The drive mechanism is completely enclosed, meaning that carpets and upholstery are not marked. No vulnerable parts are exposed to damage and, most importantly, the cable runs are fully protected.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention, its configuration, construction, and operation will be best further described in the following detailed description, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of the folding bicycle in a deployed position;

FIG. 2 is a side view of the folding bicycle in FIG. 1 and illustrating further details of construction;

FIG. 3 is a side view in accord with the view of FIG. 2 and shown in a folded position at normal height;

FIG. 4 is a view in accord with the view of FIG. 3 and shown in a partially lowered position with respect to the upper components and with the seat tube brought to a horizontal position;

FIG. 5 is a view in accord with the view of FIG. 4 and shown with the seat brought slightly downward and with the front and rear telescoping tubes brought to a fully stowed position;

FIG. 6 is a view in accord with the view of FIG. 5 and shown with the seat brought to a vertical, fully stowed position, and with the handle bar connection member turned rearwardly 180°;

FIG. 7 is a front view of the bicycle in accord with FIG. 6 and illustrating the folding of handle and brake assemblies and pedals;

FIG. 8 is a side view of the fully folded bicycle shown in FIG. 7;

FIG. 9 is an expanded view of the drive mechanism with the right side of the crankcase housing removed;

FIG. 10 is an expanded view of the braking and drive mechanism with the left side of the crankcase housing removed;

FIG. 11 is a schematic view of the brake system of the front telescoping tube and front wheel; and

FIG. 12 is a perspective view of a double channel slide block used with the front telescoping tube and front wheel brake system.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The description and operation of the invention will be best initiated with reference to FIG. 1 which illustrates a side view of a folding bicycle 31 shown in its fully deployed position. Structures seen include a major triangular assemblage of structures including a collapsible triangular frame formed from a collapsible front steering tube assembly 33 that includes a telescopic inner tube 35 which telescopes with respect to a telescoping outer tube 37 and is secured by a quick release clamp 39, and a locking button 41 seen through its aperture. The front steering tube assembly 33 is rotatable within a front steering joint 43. Front steering joint 43 is flanked on its upper and lower sides by an upper fitting 45 and an expanded length lower fitting 47. Below the lower fitting 47 is a fork 49 which engages a front wheel 51 and its axle bolt 53. An abbreviated length fender 55 is seen. The lower fitting 47 is seen to have six reinforced areas which join two halves of the lower fitting 47 by bolting or riveting.

Pivotaly attached to the front steering joint 43 is a forward pivoting strut 61 which is attached to the front steering joint 43 by a pair of opposing ear lugs, only one ear lug 63 is seen in FIG. 1. The other end of forward pivoting strut is connected to a center joint 65.

Center joint 65 is in the form of a "U" shaped length of tubing with the side walls forming pivot ear lugs at points

near one end where forward pivoting strut 61 pivotaly connects to it. Center joint 65 will preferably have a locking button 66, or an internal bolt latch to insure that it positively engages forward and rearward pivoting struts 61 and 67 to keep them in alignment while the bicycle 31 is deployed. The locking button may have an internal block which is urged against the flat ends of the forward and rearward pivoting struts 61 and 67 when they are in co-axial position.

Pivotaly attached to the other end of the center joint 65 front steering joint 43 is a rearward pivoting strut 67 which is attached to the center joint 65 at its rear with the opposing side walls forming pivot ear lugs at points near the end opposite the connection to the forward pivoting strut 61. The orientation of the center joint 65 is that it enables the forward and rearward struts 61 and 67 to open and lie in a collinear relationship in linear alignment with the center joint 65 during its deployed orientation. In folding, as will be seen, center joint 65 is attached to enable it to rise as the forward and rearward struts 61 and 67 pivot angularly down with respect to the center joint 65.

The rearward most end of rearward strut 67 is attached into the upper portion of the crankcase housing 69 in an orientation that will enable rearward strut 67 to be angularly displaced upwardly with respect to the crankcase housing 69 on stowage. The crankcase housing 69 is attached to or around a collapsible rear tube assembly 71 which includes a rear telescopic inner tube 73 which telescopes with respect to a telescoping outer tube 75 and is secured by a quick release clamp 77, and a locking button 79 seen through its aperture.

The crankcase housing 69 forms a fork-like attachment to a rear wheel 81, along with a driven connection to be shown. On the right side of the crankcase housing 69 seen in FIG. 1, a flat removable housing cover 83 accommodates the internal driven connection. A rear fender 85 can also be seen.

Rearwardly adjacent the quick release clamp 77, is a seat tube fitting 87 having ear lugs which pivotaly engage a seat tube assembly 89 at the lower end of a telescopic outer tube 91, about a pivot axis 92. An inner tube 93 fits within the outer tube 91. At the top of the outer tube 91, a stay 95 is pivotaly connected to a fitting 97 at the top end of the outer tube 91. The fitting 97 does not slide, but is mounted to an exacting level on the outer tube 91. The fitting 97 includes a release (on the side opposite that shown in FIG. 1) to fix the upward and downward position of the inner tube 93 with regard to the outer tube 91 in order to set the height of a seat or saddle 99. Saddle 99 has a forward central portion 101 and a pair of rearwardly extending ischial supports 103 which define an accommodation slot 105 therebetween. The ischial supports 103 support the rider and the area which would otherwise be occupied by the accommodation slot 105 is typically not utilized during seated riding. The accommodation slot 105 enables the saddle 99 to extend partially around the rear of the crankcase housing 69 during stowage in order to take up slightly less space.

The other end of the stay 95, the stay 95 is pivotaly connected to a double fitting 107 which defines a pair of pivot axes. A first pivot axis 109 exists between the double fitting 107 and the end of the stay 95. A second pivot axis 111 exists between the double fitting 107 and the upper end of the rear telescopic inner tube 73. As will be seen, this double fitting 107 provides an offset which will allow a parallel relationship of the outer tube 91 with respect to the telescoping outer tube 75. The stay 95 has a general inverted "U" cross sectional shape both for increased strength, and to

allow it to accommodate the telescopic outer tube **91** more closely adjacent the telescoping outer tube **75** in the folded stowage position.

The double fitting **107** is also mechanically connected to an upper steering joint member **113** having its other end connected to a steering pivot **115**. The double pivot enables the upper steering joint member **113** to pivot with respect to the rear telescopic inner tube **73**. The steering pivot **115** also includes an upper spacer **117** and lower spacer **119** which helps to define and offset the other relationships. Lower spacer **119** limited the extent to which the telescoping inner tube **35** can fit inside the telescoping outer tube **37**.

Atop the steering pivot **115** is a boss **121** in the shape of a cylinder and from which a handlebar connection member **123** extends and attaches to a main handle bar support **125** having a pair of oppositely oriented handlebar locking buttons **126** which, as will be shown, are used to enable elements of the handle bar structures to be folded. At each end of the main handle bar support **125** is a right handle and brake assembly **127** and a left handle and brake assembly **129**.

A control cable **131** from right handle and brake assembly **127** enters an aperture **135** in the main handle bar support **125**. A control cable **133** from left handle and brake assembly **129** simply leads back to the front part of the double fitting **107**, where cable **133** enters the rear telescopic inner tube **73**. As will be seen, the right handle and brake assembly **127** and left handle and brake assembly **129** are axially displaceable from the main handle bar support to a position where they may be folded to a horizontal position.

Also seen in FIG. 1 is a right pedal crank **141** and right pedal **143**, as well as a left pedal crank **145** and left pedal **147**. The pedals **143** and **147** are shown in their unfolded, deployed position. Folding can involve movement of the pedals **143** and **147** typically toward their respective pedal cranks **141** and **145**, to a position where they may be pivoted or folded in a position roughly parallel to the crank. Other mechanisms can be used to achieve folding pedals, including buttons, latches, and the like. The pedals **143** and **147** will have the stability not to unfold while the bicycle **31** is deployed and in use.

Referring to FIG. 2, the elements identified in FIG. 1 can be more clearly seen. The shape of seat **99** and the spacing relationship of the first and second pivot axes **109** and **111** are seen. Both the spacing relationship of first and second pivot axes **109** and **111** and the size and shape of the stay **95** and tube **91** will permit a close parallel stowed relationship.

Referring to FIG. 3, the bicycle **31** is shown in a position where the steps necessary to fold it have been accomplished. The steps necessary to achieve the configuration shown in FIG. 3 includes merely the actuation of the locking button **66** and the raising of the center joint **65** upwardly to cause the forward and rearward pivoting struts **61** and **67** to begin to angularly pivot toward a more parallel relationship with respect to their adjacent telescoping front outer tube **37** and rear outer tube **75**. It should be noted that while a user is riding the bicycle **31** that the resultant forces on the wheels **51** and **81** will act to keep the forward and rearward pivoting struts **61** and **67** in alignment, as well as the mechanism of the locking button **66**.

Note that the front quick release clamp **39** is slightly above the rear quick release clamp **77** and that the front wheel **51** is slightly above the rear wheel **81**. This configuration occurs when the "A" frame is folded in and before the height of the bicycle **31** is reduced. This illustrates that the center joint's double pivoting connection enables some

upward and downward relative movement of the front telescoping outer tube **37** with respect to the rear telescoping outer tube **75**.

Referring to FIG. 4, it can be seen that the front quick release clamp **39** is now slightly below the rear quick release clamp **77** and that the front wheel **51** is level with the rear wheel **81**, and that the center joint **65** is also generally level with the ground. FIG. 4 especially illustrates that the locking buttons **41** and **79** have been pressed in to unlock the front telescoping inner tube **35** and rear telescoping inner tube **73** such that only their apertures can be seen, and that the quick release clamps **39** and **77** have been unlocked to allow the unlock the front telescoping inner tube **35** and rear telescoping inner tube **73** to telescopingly collapse into their respective front outer tube **37** and rear outer tube **75**. Note that as the rear telescopic inner tube **73** collapses with respect to the collapsible rear tube assembly **71** that more of the control cable **133** from left handle and brake assembly **129** will loop upwardly with respect to the top of the bicycle **31**.

The telescoping inner tubes **35** and **74** are shown only partially collapsed to emphasize the transition position of the telescoping outer seat tube **91**. At this middle position, note that the double fitting **107** has enabled pivot axis **109** to not only be rearwardly displaced with respect to pivot axis **111**, but that during the downward travel of the telescoping inner tubes **35** and **74** seen in FIGS. 3 and 4, that pivot axis **109** lies directly over and travels straight toward pivot axis **92**.

The seat telescoping outer tube **91** has reached a horizontal position and it may be that seat telescoping inner tube **93** may need to be slightly brought more telescopingly within seat telescoping outer tube **91** in cases where it is extended for taller riders, especially where the length of the outer tube **91** can accommodate a much longer extension of the inner tube **93** than is seen in FIG. 4. Note also that the fitting **97** does not move with respect to the outer tube **91** upon folded stowage.

Referring to FIG. 5, as has been mentioned, the stay **95** has an inverted "U" shape which is sufficient to partially cup or surround the seat outer tube **91**. Further, note that the pivot axis **109** of the double fitting **107** has covered over and is collinear with the pivot axis **92** of the seat tube fitting **87** (covered and by the pivot axis **109** and thus not seen). This enables both the stay **95** and the seat outer tube **91** to continue to pivot downwardly about a common pivot axis. This common pivot axis movement serves to further lock the telescoping inner tubes **35** and **74** in the stowed position with respect to the telescoping inner tubes **35** and **74**.

Quick release clamp **39** is shown in the open position and quick release clamp **77** is shown in the closed position. Locking the clamps **39** and **77** will further prevent any unintended deployment once the bicycle **31** is in the stowed position. Note the lower spacer **119** position with respect to the clamp **39**. The stabilized stowed position is achieved with wheels **51** and **81** level.

Referring to FIG. 6, the seat outer tube **91** is shown in a position of continued movement about the pivot axis **109** where the seat outer tube **91** is parallel to both the rear telescoping outer tube **75** and stay **95**. Note that the ischial supports **103** of the seat **99** are forward of the rearward most extent of the crankcase housing **69** due to the accommodation slot **105**. Again, the stay **95** is seen continuing to partially cup or surround the seat outer tube **91**.

Having achieved the position shown in FIG. 6, the next step in folding to stowage position is the turning of the main handle bar support **125** to a position 180° from that shown in FIGS. 1-5, so that the handle bar connection member **123** will lie rearwardly and over and generally parallel to the

upper steering joint member **113**. Note that the extra length of the control cable **133** from left handle and brake assembly **129** will actually facilitate the turning of the main handle bar support **125** by providing enough of a length to gently loop.

In the deployed position, the front telescopic inner tube **35** is fixed with respect to the telescoping outer tube **37** both by engagement of the quick release clamp **39** and the interlocking of the locking button **41**. Both of these structures are engaged when the bicycle **31** is in the deployed position. Once the bicycle **31** is begun to be folded, the locking button **41** and the release clamp **39** are disengaged. This leaves relative rotational displacement possible between the front telescopic inner tube **35** and the main handle bar support **125** affixed to it, with respect to the telescoping outer tube **37**.

Thus the user simply rotates the main handle bar support **125** by 180° to place the main handle bar support **125** directly over the upper steering joint member **113**. Once the main handle bar support **125** directly over the upper steering joint member **113**, the quick release clamp can be re-engaged to fix the position of the main handle bar support **125**. However, the folding down of the saddle **99** and the locking into place of the quick release clamp **77** would be sufficient to maintain folded stability. Only the locking button **41** aperture is seen as the locking button is depressed, within the annular space between the forward telescopic inner tube **35** and telescoping outer tube **37**, and on the side opposite the aperture through which it locks.

Once the main handle bar support **125** and handlebar connection member **123** are directly over the upper steering joint member **113**, the handlebar structures are in a position to be further compactly folded. In FIG. 1, a pair of pair of oppositely oriented handlebar locking buttons **126** were seen on the main handle bar support **125**. Each one of the pair of oppositely oriented handlebar locking buttons **126** is associated with the right handle and brake assembly **127** and left handle and brake assembly **129** located underneath it.

Referring to FIG. 7, a front view of the bicycle **31** seen in the position shown in FIG. 6 with the handlebar connection member **123** rotated rearward, is shown. The boss **121** is seen prominently, and the brake handles of the right handle and brake assembly **127** and left handle and brake assembly **129** (shown in dashed line format collinearly with the main handle bar support **125**, are seen to be pointed rearwardly. The arrows indicate that, after depression of the pair of oppositely oriented handlebar locking buttons **126**, the right and left handle and brake assemblies **127** and **129** are pulled axially outwardly until the fullest outward extent of movement is possible.

Each of the right and left handle and brake assemblies **127** and **129** are mounted within the main handle bar support **125** on a guide pins (not shown) so that they may be axially moved out of their respective end of the main handle bar support enough that only the pivoting action of the guide pins (not shown) hold them with respect to the main handle bar support **125**. The bottom portions of the ends of the main handle bar are removed to enable the right and left handle and brake assemblies **127** and **129** to fold down once they have moved to their outermost extent.

The solid line rendering of the right and left handle and brake assemblies **127** and **129** illustrate their having been pivoted downwardly to a position parallel with the front telescoping outer tube **37**. At the ends of the right and left handle and brake assemblies **127** and **129** closest to connection with the main handle bar support **125**, the freed, oppositely oriented handlebar locking buttons **126** can be seen. Upward rotation of the right and left handle and brake assemblies **127** and **129** will place oppositely oriented

handlebar locking buttons **126** into a depressed position automatically as they are raised and they will not need to be depressed in order to re-enter the main handle bar support **125**. The re-engagement of the clamp **39** is suggested, but it can be seen that the vertically downward position of the right and left handle and brake assemblies **127** and **129** lend additional stability to prevent unintended rotation of the handlebar connection member **123** and main handle bar support **125**.

Also seen in FIG. 7 are the folding of the right and left pedals **143** and **147**. Typically the unfolding may accomplished by a latch or by movement of the pedals slightly outwardly to an un-locked position and then folding toward the associated cranks **141** and **145**. Further, if a mechanism is utilized which will permit folding the pedals **143** and **147** only toward their respective cranks **141** and **145** and not away from them, a greater degree of stability during riding can be achieved. Folding the pedals **143** and **147** toward their respective cranks **141** and **145** creates roughly the same degree of horizontal compactness as the outermost extent of the upper vertically hanging right and left handle and brake assemblies **127** and **129**.

FIG. 7 and its solid line structures represents the full extent of folding of the bicycle **31**, and illustrates the lateral compactness achieved in the present inventive design. Referring to FIG. 8, a right side view similar to that seen in FIGS. 4-6 gives a visual impression of the forward to rear compactness and height compactness of the bicycle **31**. As before, the bicycle **31**, in the states shown in FIG. 8 has an overall dimension of 12x25x6 inches (305x635x153 millimeters).

Referring to FIG. 9, a closeup of the back half of the crankcase housing **69** taken from the perspective of the right side of the bicycle illustrates the mechanical internals of the crankcase. A crank axle **151** has a free wheeling clutch, including an inner clutch drive **153** immediately surrounding it. Inner clutch drive **153** is mechanically connected to an outer clutch drive **155** for rotation of the inner clutch drive **153** in one direction only.

Most typical bicycles locate the free wheeling clutch on the wheel axle. The free wheeling clutch is a disengagement between the crank axle **151** (and the cranks **141** and **145**) for times when the driven wheel **81** is spinning faster than the crank axle **151**. This enables the bicycle **31** to coast down hill without corresponding forward mechanical movement of the crank axle **151**, and cranks **141** and **145**.

Outer clutch drive **155** is mechanically connected to a main sprocket **157**. Main sprocket **157** has a chain **159** (shown schematically) connected to an axle sprocket **161** attached to an axle **163**. As can be seen by comparing FIG. 9 to FIGS. 4 and 5, the flat removable housing cover **83** (in addition to the right side half of the crankcase housing **69** upon which crankcase housing **69** fits) completely isolates the chain **159** from any possible contact with the user. Chain contact is a major source of soiled and destroyed clothing, and can cause accidents. Both the wheels **51** and **81** are preferably made of a solid polymeric material and thus the need for servicing or any reason to open the crankcase housing **69** should be largely eliminated.

Details of engagement of the lower end of the rear telescoping outer tube **75** are seen. An engagement structure **171** contacts and bears against the rear telescoping outer tube **75** and has a lower member **173** to engage structures in the left half of the crankcase housing **69** shown. Also exposed is an ear lug **181** which lies just inside an opening the crankcase housing **69** seen in FIG. 1. Ear lug **181** enables

the rearward pivoting strut **67** to move angularly from the deployed position seen in FIG. **1** to the foldably stowed position seen in FIG. **8**.

Referring to FIG. **10** a view oppositely oriented with respect to FIG. **9** is taken against the right half of the crankcase housing **69** and its attached flat removable housing cover **83**. This view illustrates the terminal portions of a braking system. A shielded cable **191** emanates from an aperture or slot in the lower member **173**. The cable may include a bracket **193** which is preferably attaches the outer shielding of the shielded cable **191** to the removed left half of the crankcase housing **69** in order to stabilize and control the end of the shielded cable **191**.

The shielded portion of the shielded cable **191** is seen to extend slightly beyond the bracket **193**, and then terminate. At the termination, an inner wire core **195** extends from the end of the shielding in a direction tangential to a brake drum **197**, then surrounding the brake drum **197**, and terminating at a bracket **199**.

Like bracket **193**, the bracket **199** appears to float, but is in fact attached to the left half of the crankcase housing **69** which has been removed to reveal the components of the brake system. Both the brackets **193** and **199** are used to control the angle and resting position of the inner wire core **195** as it surrounds the brake drum **197**. It is important that during non-brake operation of the bicycle **31** that the inner wire core **195** enable friction free movement of the brake drum **197**. The brackets **193** and **199** control of the angle of approach around both sides of the brake drum **197** achieve this.

Note that with regard to FIG. **10**, the normal forward motion of the bicycle **31** occurs from right to left and that the wheel **81** turns counterclockwise. Tightening of the inner wire core **195** by withdrawing it into the shielded portion of the shielded cable **191** will produce a pulling of the inner wire core **195** against the bracket **199**. The brake drum **197** then somewhat frictionally moves against the inner wire core **195** in a way to very slightly tighten it further against the bracket **199**.

If the direction of movement were reversed, the friction of the brake drum **197** would tend to pull the inner wire core **195** away from the termination of the shielding of the shielded cable **191** can tend to counteract the force used to withdraw the inner wire core **195** and weaken the braking from the standpoint of the user. Thus, the configuration shown enhances the manual pressure used to affect braking while using brackets to control the angularity and degree of approach of the inner wire core **195** with respect to the brake drum **197**. So long as the inner wire core **195** is effectively spring loaded to return to a rest position with sufficient slack, the non-brake operation should be effectively friction-free.

Referring to FIG. **11**, a schematic drawing of one possible realization for the braking system for the front wheel **51** is shown. Whereas the rear wheel **81** included a shielded cable which increasingly protrudes from the double fitting **107**, the braking system for the front wheel **51** doesn't have the protrusion action but rather includes a different method to achieve collapsibility. Typically, the left handle and brake assembly **129** is used to brake the front tire **51**.

As can be seen with the larger detail, the left handle and brake assembly **129** includes a handle **201** and a brake assembly **203** mounted thereon. Brake assembly **203** includes an attachment fitting **205** and a lever **207** which is set to pivot with respect to the attachment fitting **205**. Typically the lever **207** will include a spring (not shown) which will urge the lever **207** away from the handle **201** and into a position in which it is shown unless a user manually

actuates it. The springs typically used are coil springs surrounding a pivot point **209** between the lever **207** and brake assembly **203**.

A first length of raw cable **211** is positioned with respect to a shielded cable **213** so that movement of the lever **207** will pull the first length of raw cable **211** through the shielded portion. The short length of shielded cable **213** terminates at a plate **217** so that movement of the first length of raw cable **211** beyond the extent of the plate **217** will pull the raw cable **211** toward the plate **217**.

Plate **17** or its equivalent can be introduced anywhere above the lower spacer **119** and such that any movement of the telescopic inner tube **35** with respect to the telescoping outer tube **37** will not interfere with the first length of raw cable **211**. In the example of the inventive bicycle **31**, the plate **217** or similar structure can be placed at the handlebar connection member **123**, boss **121** or main handle bar support **125**, or even within the telescopic inner tube **35**.

Telescopic inner tube **35** is shown schematically with respect to the telescoping outer tube **37**. The other surrounding structures are simply not shown so that the clarity of action can be emphasized. The first length of raw cable **211** extends through a double channel slide block **221**. Referring to FIG. **12**, the double channel slide block **221** is a small unitary volume of material having a pair of bores, including first bore **223** and second bore **225**. The first and second bores should be made of sufficient diameter that both the first length of raw cable **211** and a second length of raw cable **231** can slide through easily, but not so large that termination beads can enter, jam or pass through.

The main idea for double channel slide block **221** is that any slack in the first or second lengths of raw cable **211** or **231** will result in at least one of them sliding through the double channel slide block **221** to relieve bunching. Without the double channel slide block **221**, a single length of raw cable would at best be forced to spiral about the inside of the telescopic inner tube **35** or the telescoping outer tube **37**, or pinched at their junction.

The first length of raw cable **211** is shown extending through bore **225** of the double channel slide block **221** and terminates at a termination bead **235** at the outside of the other end of the through bore **225**. Second length of raw cable **231** is shown extending through bore **223** of the double channel slide block **221** in the other direction and terminates at a termination bead **239** at the outside of the other end of the through bore **223**.

Beyond the double channel slide block **221**, the second length of raw cable **231** is shown extending through bore **223** of the double channel slide block **221** and through the bottom of the front telescoping outer tube **37**. An optional fixed length of raw cable channel **241** or some other physical path directing device can be used to position the remaining structures with respect to a brake drum **243**.

The other structures may include the continuation of the raw cable about the brake drum **243**, or a fitting **245** may be provided to make length adjustments with respect to a specialized band **247**. The band **247** (or cable) may be fixed with respect to a bracket **249**. The direction of normal forward motion of the brake drum **243** is shown in either direction to emphasize that the front wheel may be made to turn in a direction which might mitigate the force applied by the lever **207**. This may depend upon the other mechanics employed in the front brake system.

The operation of the schematic of FIG. **11** is as follows. Once folding of the bicycle **31** begins, the telescopic inner tube **35** will begin to move downward with respect to the telescoping outer tube **37**. The first length of raw cable **211**

will move toward the second length of raw cable **231**. Because the termination beads **235** and **239** move away from the double channel slide block **221**, both the first and second lengths of raw cable **211** and **231** can slide past each other within the double channel slide block **221**.

If the double channel slide block **221** is made of metal, and if the bicycle **31** is foldably stowed in a position where the telescopic inner tube **35** and telescoping outer tube **37** are vertical, it is likely that the double channel slide block **221** will move downward with the raw cable **211** as the second length of raw cable **231** will move through the bore **223** and upward toward the plate **217**. Thus, even where one cable predominantly moves through the double channel slide block **221** while the other may remain fixed through gravity or the like, the double channel slide block **221** will act as a guide for the other cable. In any event, the double channel slide block **221** helps to organize and direct the first and second raw cables **211** and **231** with respect to each other.

Upon re-deployment and unfolding of the bicycle **31**, the tensile force link between the first and second raw cables **211** and **231** will automatically be re-established. It should be noted that upon deployment, the locking button **41** will re-engage only upon a full extension of the telescopic inner tube **35** with respect to the telescoping outer tube **37**, and therefore the relative lengths of the tubes **35** and **37** will be the same each time the bicycle **31** is deployed. As such, multiple deployments and foldable stowage operations will not upset the exactitude of the connection between the first and second lengths of raw cable **211** and **231**.

While the present invention has been described in terms of a portable folding bicycle, & more particularly to a particular set of mechanical structures which exhibit maximum compactness, ease of deployability and stowage and light weight, the mechanisms disclosed can be applied to other devices.

Although the invention has been derived with reference to particular illustrative embodiments thereof, many changes and modifications of the invention may become apparent to those skilled in the art without departing from the spirit and scope of the invention. Therefore, included within the patent warranted hereon are all such changes and modifications as may reasonably and properly be included within the scope of this contribution to the art.

What is claimed:

1. A portable folding bicycle comprising:
  - a collapsible front tube assembly having a first end and a second end supporting a front wheel;
  - a collapsible rear tube assembly having a first end pivotally linked to said first end of said collapsible front tube assembly and a second end supporting a rear wheel;
  - a crankcase housing supported by said rear tube and drivably connected to said rear wheel; and
  - a foldable link connected between said front tube assembly and said rear tube assembly at locations closer to said second ends of said front and rear tube assemblies than said first ends of said front and rear tube assemblies.
2. The folding bicycle as recited in claim 1 wherein said foldable link further comprises:
  - a forward pivoting strut having a first end pivotally attached to said collapsible front tube assembly, and a second end;
  - a rearward pivoting strut having a first end pivotally attached to said collapsible rear tube assembly, and a second end pivotally linked to said second end of said forward pivoting strut.

3. The folding bicycle as recited in claim 1 and further comprising:

- a collapsible seat tube having a first end pivotally connected to said collapsible rear tube assembly and a second end;
- a seat supported by said second end of said collapsible seat tube; and
- a rear tube link having a first end connected to and displaced from said first end of said collapsible seat tube, and a second end attached adjacent said first end of said collapsible rear tube assembly.

4. The folding bicycle as recited in claim 3 wherein said seat includes a rearward accommodation slot to facilitate fitting around said collapsible rear tube assembly in a folded position.

5. The folding bicycle as recited in claim 3 wherein said rear tube link second end pivots about a first pivot axis laterally displaced from said collapsible rear tube assembly.

6. The folding bicycle as recited in claim 5 wherein said collapsible seat tube first end pivots about a second pivot axis laterally displaced from said collapsible rear tube assembly and wherein said first pivot axis and said second pivot axis are displaceable toward each other to a collinear relationship.

7. The folding bicycle as recited in claim 1 wherein said collapsible front tube assembly further comprises an upper telescopic inner tube having a first end and a second end and carried within a lower telescoping outer tube having a first end and a second end, and further comprising a locking structure for selectably fixing an axial displacement of said upper telescopic inner tube with respect to said lower telescoping outer tube and for fixing relative rotation of said upper telescopic inner tube with respect to said lower telescoping outer tube, and wherein said front wheel is supported adjacent said second end of said lower telescoping outer tube.

8. The folding bicycle as recited in claim 1 wherein said collapsible rear tube assembly further comprises an upper telescopic inner tube having a first and a second end and carried within a lower telescoping outer tube having a first end and a second end, and further comprising a locking structure for selectably fixing an axial displacement of said upper telescopic inner tube with respect to said lower telescoping outer tube and wherein said rear wheel is supported adjacent said second end of said lower telescoping outer tube.

9. The folding bicycle as recited in claim 8 and further comprising a collapsible seat tube having a first end pivotally connected to said collapsible rear tube assembly adjacent an upper end of said lower telescoping outer tube, and a second end;

- a seat supported by said second end of said collapsible seat tube; and
- a rear tube link having a first end connected to and displaced from said first end of said collapsible seat tube, and a second end attached adjacent an upper extent of said upper telescopic inner tube of said collapsible rear tube assembly.

10. The folding bicycle as recited in claim 1 wherein at least one of said front and rear wheels includes a brake drum and further comprising a cable at least partially encircling said brake drum and enabled to tighten around said brake drum to brake said rear wheel.