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Folding Bicycles: A Treatise

by Dr. David T. Hon

www.dahon.com

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FOLDING BICYCLES

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FOLDING BICYCLES

A. PREFACE

The Folding Bicycle has many practical and potential uses in recreation and daily life, and it may be the fastest growing category in the bicycle industry. Today, of all the hundred million bicycles produced annually, a whopping ~10%, about 10 million units, are folding bicycles. This article attempts to present a comprehensive and unbiased recent history of the Folding Bicycle, and a technical review of the dazzling supply of diverse products on today's market with their various international supply chains. It hopes to be a guide for the millions of committed or interested consumers, as well as the thousands of inventors, engineers, businessmen, advocates and regulators everywhere. Credits are given where due. Ample pictures are included (for general readers), as well as references and links for the studious. (Corrections and suggestions are sincerely welcome.)

B. **DEFINITION**

A Folding Bicycle is defined as a two-wheeled vehicle, with pedals, which can be folded up or otherwise reduced into a more manageable shape/size package or set of packages for ease of storage or portage. That includes take-apart bikes. Some Folding Bicycles are also electrically empowered (Folding E-Bicycle). A Folding Bicycle (or Folding E-Bicycle) is legally defined as a bicycle (or Electric Bicycle, respectively) in all nations, having to comply with all relevant safety standards to be roadworthy.

C. **GROWING MARKET**

Most any gadget can become more useful if it is foldable. People around the world are increasingly concerned with health and pollution in recent years. The bicycle itself is already a most useful and popular gadget with a market of about 100 million units/year. The Folding Bicycle is one of the fastest growing bicycle categories because of its many practical and conceivable uses in recreation and personal mobility. Typical consumers would include owners of Rvs, boats and planes, as well as car owners who wants to hit the bike trail out-of-town; urban commuters, sometimes in conjunction with the car or public transit; or average citizens who want to be green, convenient, healthy or even, in some markets, “trendy”. Many Folding Bicycle clubs have sprung up in some countries, drawn together by shared interests.
About 10 million units of Folding Bicycles are estimated to be sold annually, in Asia, Europe and elsewhere (in that order). As a relatively young category, the Folding Bicycle is still not a part of general bicycle statistics in most countries, despite its booming market share. But there are various other sources for the estimated sales volumes in various markets, and these are presented in Appendix 1, which shows the annual production of main suppliers of folding pedals.

(See Appendix 1)

The growth trend is expected to continue, in a world of growing health and environmental awareness. In some cities in Asia, it appears that every fourth bike on the street is a small-wheeled folder. Many are seldom ever folded. Almost all manufacturers now carry some models of Folding Bicycle by market demand.
However, engineers and manufacturers everywhere are still being challenged to close the gap with regular bicycles in performance and safety.

D. **SUPPLY CHAINS**

Having largely developed during the first half of the last century, the manufacturing of the bicycle is surprisingly sophisticated, despite its affordable prices. The center of gravity of bicycle manufacturing, which is relatively labor-intensive, has moved, since the end of the last world war, from Europe and North America to Japan, then to Taiwan, and then, in recent decades, to China. The move to China ("Factory of the World") was overwhelming, partly because of timely Taiwanese investments in funds and know-how, and partly due to China's own massive domestic market. In recent years, however, due to rising costs, China is losing some orders to its neighbors in South-east Asia, including Thailand, Bangladesh, Indonesia, Vietnam and Cambodia, thanks partly to the EU's anti-dumping policies designed ostensibly to help developing countries but mainly to protect their own thinning bike industry. Manufacturing technology has been slowly transferred to Asia. Indigenous technologies are sprouting up in recent years in areas where intellectual property protection has gradually become more serious, particularly in Taiwan, under intense pressure from the US in the 90s. The Taiwanese now seem to manage the lion's share of Asian bicycle factories, especially the more reputed ones. China's poor IPR record limits the cooperation with and technological transfer from the outside, quite unbeknownst to the Chinese authorities.

Developed countries, while gradually losing their bicycle manufacturing capacities, have continued to excel in designing and marketing. The twain must find ways to work together in this fast shrinking and competitive world – to take advantage of geo-economics while protecting themselves. That is particularly true with inventors and entrepreneurs who seek relevancy and business success.

Over 100 Folding Bicycle brands are on the market, and the number is growing. Folding Bike Manufacturer Directory - The Folding Cyclist. 2015. *Folding Bike Manufacturer Directory - The Folding Cyclist*. [ONLINE] Available at: http://www.foldingcyclist.com/folding-bike-manufacturer-directory.html. [Accessed 25 November 2015].

Different brands have different "supply chain strategies" behind the scenes that can fundamentally affect their products and services. A supply chain may be made up of three links, namely: design, production, and marketing. "Design" includes invention, engineering and product aesthetic design. It has to be a non-stop effort to improve, like anything. "Production" includes tooling, mass production and quality assurance. "Marketing" includes planning and execution of marketing/sales policies. Five different types of supply chains might be recognized (and nice to know):

1. International companies who manage all three links; design, manufacturing and marketing. This type has the most vertical integration and can theoretically supply the best products and services for the costs; but economy-of-scale and geo-economy can be serious challenges. (This type include: Di Blasi, Dahon, Brompton, Oyama, Giant, bike Friday, Ubike, Jango.)
2. Marketers with Designs. Marketers who do their own designs, place orders with original equipment manufacturers (OEM). Theoretically better than 1 above in division of labor. (Montague, Birdy, Raleigh, Tern, Allen Sport) Communication and shortage of over-lapping expertise can bring nagging problems.
3. All links independent. All three chain links are handled by different companies. This type can theoretically be a nice synergy between East and West and can produce good innovative products. But problems mentioned for 2 above can be exacerbated. (Birdy, Pacific, Ubike)

4. Importers from OEM. Western importers who buy from Asian OEM manufacturers with little designing from either party. Copying is the key. They survive by aggressive pricing and promotion.
5. OEM manufacturers, mostly from China, who offer Folding Bicycle with their own logos, and touting "factory direct" on the Internet and other mass outlets. While typically new to quality assurance and marketing protocols, they are most price competitive. (Find them in Alibaba and Aliexpress). Again, copying is the name of the game; legal entanglement is frequent.

E. **RECENT HISTORY**

The first Folding Bicycle patent was filed by an American inventor, Emmit G. Latta on September 16, 1887. Since then, there have been innumerable inventors, manufacturers and marketers from many developed countries, attempting to offer improved compactness and/or ride for the bicyclist (including soldiers). Some patents are more practical than others. The tide of Folding Bicycles has flowed and ebbed a few times in various countries. The latest wave, started slowly since the 70s by the likes of Diblasi, Raleigh and Bickerton, (continued by Dahon, Brompton and Montague in the 80s; Bike Friday and Birdy in the 90s) has been growing unabated to the millions sold annually world-wide nowadays. Dahon, the biggest producer, has had the most influence on the market, with dozens of its 300+ patents having now become commonplace in the industry.

(A list can be found in Appendix B)

There has been a number of well researched books on the history of the bicycle, such as “Science of the Bicycle” by Prof Gordon Wilson, and a more recent one “Bicycle Design” by Hadland and Lessing, MIT press 2014, in which the Folding Bicycle is briefly mentioned. A brief history of the Folding Bicycle, going back to its inception over 100 years ago, has been given in The History of the Folding Bike - The Folding Cyclist. 2015. *The History of the Folding Bike - The Folding Cyclist*. [ONLINE] Available at: http://www.foldingcyclist.com/folding-bike-history.html. [Accessed 25 November 2015]. , among others.
These are useful readings for the present in-depth article.

F. TECHNICAL DISCUSSION

1. General Criteria for Folding Bicycles

a) Compactness in the "folded" configuration is the primary objective of any Folding Bicycle. But there are several different criteria about "compactness", including, in decreasing popularity: a) the least volume, B) the least footprint while standing erect, and C) the most manageable shapes/sizes (as in the case of a take-apart Folding Bicycle). Each one has its own merits for this fast developing category.

b) Convenience in folding/unfolding is an important selling point.

c) Strength, stiffness and durability are essential for safety and riding efficiency. These criteria cannot be overemphasized, and they remain the greatest challenge for Folding Bicycle designers, especially those Folding Bicycles with many hinges.

d) Wheel size is a dilemma. Most Folding Bicycles have small wheels for compactness, but this is more or less at the expense of comfort and performance, if not safety. So it has to be a compromise, depending on intended utility.

e) Being light-weight is needed for portage, obviously.

f) Cost effectiveness, of course.

g) Aesthetics is more important for commercial success than most inventors think.

Unfortunately, most of these criteria are largely mutually conflicting even for regular bikes, let alone for the Folding Bicycle with its many joints and transformations. And they present serious challenges to engineers and manufacturers for a product that is often compared with The Bicycle (sometimes called "man's greatest invention"), no matter how "unfairly" it may seem. Indeed, at their best, most small-wheeled folders still compromise something for compact foldability at this time in our technical history. But the gap is closing. Folding Bicycles with bigger wheels have their own disadvantages and attractiveness.

2. Six Design strategies

With a "low" technical threshold (deceivingly so, perhaps), thousands of distinct patents have been granted related to the Folding Bicycle since the late 19th century. Only a small percentage have made it to the market, fewer lasted for long. Many of these are concerned with the fundamental strategy in folding of the frame/handlebar system itself, according to the optimal criteria perceived by the inventor; the rest of the components are mostly stock items (correctly so, economically), except for pedals, handlebars, cranks and accessories. These various strategies can roughly be grouped into 5 to 6 main categories, with occasional hybridization. These are:

a) Mid-frame horizontal fold. (eg. :Raleigh 1970's, Bickerton 1970s, Dahon 1980s, Oyama 1990s, KHS 2000s, Tern 2010s, etc.); this approach is the most intuitive, and therefore comprises the vast majority of today's Folding Bicycles on the market.

Fig.1

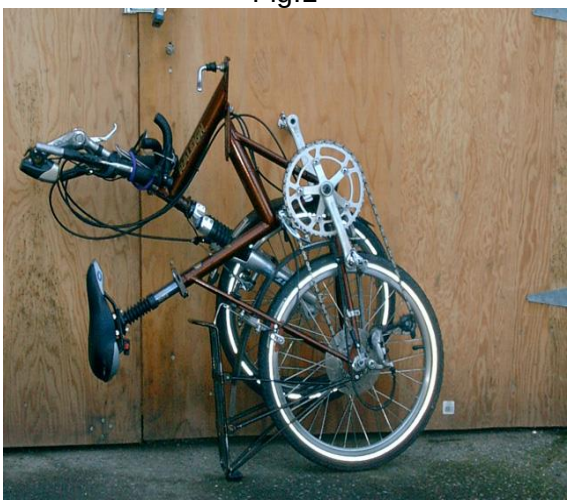


Fig.2

Raleigh Twenty in the 1970's (has as solid a ride as can be expected for this 20"; folds large, though) http://www.raleigh.co.uk/
Photo from: Sheldon Brown's Raleigh Twenty Bicycle Page. 2015. *Sheldon Brown's Raleigh Twenty Bicycle Page*. [ONLINE] Available at: http://www.sheldonbrown.com/raleigh-twenty.html. [Accessed 25 November 2015].

Fig.3

Fig.4

Bickerton 1970s (ride is very soft, but folds smaller than Raleigh Twenty)
http://www.bickertonportables.co.uk/
Photo from: Bickerton (bicycle) - Wikipedia, the free encyclopedia. 2015. *Bickerton (bicycle) - Wikipedia, the free encyclopedia*. [ONLINE] Available at: https://en.wikipedia.org/wiki/Bickerton_(bicycle). [Accessed 25 November 2015].

Fig.5

Fig.6

Dahon 1980s (has as solid a ride as can be expected for this 16”; folds compact)
www.dahon.com
Photo from: Dahon Classic III 1988 folding bicycle Bootiebike. 2015. *Dahon Classic III 1988 folding bicycle Bootiebike*. [ONLINE] Available at: http://bootiebike.com/dahon/dahon.htm. [Accessed 25 November 2015].

Fig.7

Fig.8

KHS mid 2000s (has as solid a ride as can be expected for this 16”; folds moderately small) http://khsbicycles.com/

Photo from: KHS Latte | BikeShopHub Blog. 2015. *KHS Latte | BikeShopHub Blog*. [ONLINE] Available at: http://www.commutebybike.com/2005/12/08/khs-latte/. [Accessed 25 November 2015].

Fig.9

Fig.10

Citizen 2010s (has as solid a ride as can be expected for this 20”; folds moderately small)
www.citizenbike.com
Photo from: Citizen, Tokyo – Folding Bike Review | The Folding Pilot. 2015. *Citizen, Tokyo – Folding Bike Review | The Folding Pilot*. [ONLINE] Available at: http://www.thefoldingpilot.com/folding-bike-review/tokyo-citizen-folding-bike-review/. [Accessed 25 November 2015].

Fig.11

Fig.12

Tern 2010s (has as solid a ride as can be expected for this 20”; folds compact)
www.ternbicycles.com
Photo from:
Tern Verge X18 Folding Bike 2015 | Triton Cycles. 2015. *Tern Verge X18 Folding Bike 2015 | Triton Cycles*. [ONLINE] Available at: http://www.tritoncycles.co.uk/urban-bikes-c4/folding-bikes-c155/tern-verge-x18-folding-bike-2015-p11416. [Accessed 25 November 2015].

b) Vertical fold on horizontal axes,

i. to achieve a small footprint, analogous to an upright pair of scissors (e.g.: Bridgestone's Picnicker 1970s,Strida 1990s, etc.),
ii. to achieve folding speed (e.g.: Picnicker 1970s, Dahon Jifo& EEZZ 2010s)

Fig.13

Fig.14

Bridgestone Picnica, 1970's (this 14" has a soft ride, but better than the original Bickerton; folds upright quickly with a moderate footprint)
https://en.wikipedia.org/wiki/Bridgestone_Picnica
Photo from: Twowheels+: Picnica. 2015. *Twowheels+: Picnica*. [ONLINE] Available at: http://twowheelsplus.blogspot.hk/2012/04/picnica.html. [Accessed 25 November 2015].

Fig.15

Fig.16

Strida 1990s (this 14” rides more solid than the Picnica but the geometry is a bit “special”. It folds up quickly with a small footprint.) www.strida.com
Photo from: Review: A Day with the Strida Folding Bike [Verdict: Wear a Cup] - Boing Boing. 2015. *Review: A Day with the Strida Folding Bike [Verdict: Wear a Cup] - Boing Boing*. [ONLINE] Available at: http://gadgets.boingboing.net/2009/04/23/review-a-day-wthe-st.html. [Accessed 25 November 2015].

Fig.17

Fig.18

Fig.19

Fig.20

Dahon Jifo & EEZZ 2010s (has as solid a ride as can be expected for this 16”; folds extremely quickly.) www.dahon.com
Dahon Eezz 2015 Folding Bike. 2015. *Dahon Eezz 2015 Folding Bike*. [ONLINE] Available at: https://www.moorescycles.co.uk/dahon-eezz-2015-folding-bike.php#. [Accessed 25 November 2015].

c) Flip fold of the rear triangle underneath (e.g.: DeBlasi 1970s, Brompton 1980s, Dahon Curl 2010s).
   i. To attain optimal compactness by volume,
   ii. To attain a fair folding speed.

Fig.21

Fig.22

Size: 68cmx64cmx21cm
DiBlasi (this pioneering design folds up very quickly (almost like the Dahon Jifo and Eezz), but the ride is soft, thanks to the many small tubes connected together rather simply. www.diblasi.de

Photo from: Folding bicycle mod. R22P. 2015. *Folding bicycle mod. R22P*. [ONLINE] Available at: http://www.diblasi.it/VisImg.asp?Prd=R22&Cod=Z.R22P&Lng=en. [Accessed 25 November 2015].

Fig.23

Fig.24

Size: 57cmx59cmx27cm
Brompton17" 1980s (probably the most compact Folding Bicycle for decades, the ride is fine except for the bobbing action due to the rear suspension's unconventional position for the pivot) www.brompton.com
Photo from: Brompton - Walton Street Cycles. 2015. *Brompton - Walton Street Cycles*. [ONLINE] Available at: http://spoke.co.uk/3-brompton. [Accessed 25 November 2015].

Fig.25

Fig.26

Size: 57cmx55.5cmx28cm
Dahon Curl 2015（slightly more compact than the Brompton, this 17” bike has as solid a ride as a hard-tail)
Photo from: http://bikesworld.gr/category/brands/dahon/

Fig.27

Fig.28

Dahon Curl 2013 (not yet marketed)
Photo from: Folding Style ©: Dahon Curl, Clinch and Qix - Dahon New Models 2015 - Taipei Cycle Show 2014 Coming Soon. 2015. *Folding Style ©: Dahon Curl, Clinch and Qix - Dahon New Models 2015 - Taipei Cycle Show 2014 Coming Soon*. [ONLINE] Available at: http://www.foldingstyle.net/2014/02/dahon-curl-clinch-e-qix-dahon-new.html. [Accessed 25 November 2015].

d) Telescopic frame tube (e.g.: Giatex 2000’s, etc.).
   i. To attain frame adjustability for various sizes of riders,
   ii. To retain frame strength/stiffness.

Fig.29

Fig.30

Giatex (Much can be said about this strategy, but the feed-back has not been flattering. After 15 years, is it still being produced?) www.giatex.com
Photo from: 成車~~~~GIATEX 6速 ~~~伸縮車~~~ @ 山姆家族自行車生活館 :: 痞客邦 PIXNET ::. 2015. *成車~~~~GIATEX 6速 ~~~伸縮車~~~ @ 山姆家族自行車生活館 :: 痞客邦 PIXNET ::*. [ONLINE] Available at: http://sam1001family.pixnet.net/blog/post/2504365. [Accessed 25 November 2015].

e) Take-apart at various places of the bike (e.g.: Compax 1940, Moulten 1970s, Montague 1980s, bike Friday 1990s,etc).Compax & Paratroopers "The Folding Bikes", www.**moultonbicycles**.co.uk/, https://www.**bikefriday**.com/

i. To retain maximum frame strength/stiffness,
ii. To attain more manageable storage/portage form factors.

Because of the relatively heavier weight of an E-Folding Bicycle, this approach can be particularly attractive in transforming it into smaller chunks for easier transport or storage.

Fig.31

Fig.32

Montague (this 26”has as fairly solid ride, except for the relatively weak torsional coupling between the BB and the head tubes (see why below in article); “folds” compact, if a bit involved.) www.montaguebikes.com
Photo from: Montague Folding Bikes NYCeWheels.com. 2015. *Montague Folding Bikes NYCeWheels.com*. [ONLINE] Available at: http://www.nycewheels.com/montague-folding-bikes.html. [Accessed 25 November 2015].

f) Use of Cables to replace tubes or hinges. There have a number of such patents and obscure products. Caution must be used to avoid past mistakes.

g) Hybridizaton of the above, such as the Brompton and the Dahon Curl that combines approaches 1 and 3 above. Montague and Airnimal, for example, combine 1 and 5 above.

h) Electric bikes and scooters are growing fast. E-Folding Bicycles can be achieved by adding DIY motor units.

Fig.33

Dahon BYA412 DIY
Photo from:[bbs.77bike ONLINE] Available at: http://bbs.77bike.com/read.php?tid=135980 [Accessed 25 November 2015]

Fig.34

Fig.35

DIY
Photo from: [Club Autohome ONLINE] Available at: http://club.autohome.com.cn/bbs/thread-c-458-35401174-1.html [Accessed 25 November 2015]

Many new E-Folding Bicycles are being introduced, getting better by the year.


Fig.36

Fig.37

Dahon Boost

Photo from: Dahon Boost electric folding bike NYCeWheels.com. 2015. *Dahon Boost electric folding bike NYCeWheels.com*. [ONLINE] Available at: http://www.nycewheels.com/dahon-folding-bike-boost-electric.html. [Accessed 25 November 2015].

Fig.38

Fig.39

Brompton electric bike

Photo from: Brompton electric bike by NYCeWheels NYCeWheels.com. 2015. *Brompton electric bike by NYCeWheels NYCeWheels.com*. [ONLINE] Available at: http://www.nycewheels.com/brompton-electric-bike.html#tabs. [Accessed 25 November 2015].

i) Other useful techniques:

i. Single-sided fork, front or rear, has been used by a number of designers to effectively reduce the folded width

Fig.40

Fig.41

Strida IF MODE
Photo from: IF Mode Folding Bike Folds in Seconds but Rides Like a Normal Bike : TreeHugger. 2015. *IF Mode Folding Bike Folds in Seconds but Rides Like a Normal Bike : TreeHugger*. [ONLINE] Available at: http://www.treehugger.com/bikes/if-mode-folding-bike-folds-in-seconds-but-rides-like-a-normal-bike.html. [Accessed 25 November 2015].

Fig.42

Mando Footloose www.mandofootloose.com

ii. Rolling wheels are installed for some Folding Bicycles for ease of portage when folded (Brompton 1980's, Dahon 1980s, 2010's. Because of the relatively heavier weight of an E-Folding Bicycle, rolling wheels are especially desirable.

Fig.43

Dahon Flatpack 2010's
Photo from: 達鋐股份有限公司:::WELCOME Acme Sports Marketing & Distribution. 2015. *達鋐股份有限公司:::WELCOME Acme Sports Marketing & Distribution*. [ONLINE] Available at: http://www.acme-sports.com.tw/html/tech/technews_content.asp?Page=10&kind=5. [Accessed 25 November 2015].

Fig.44□□ Carryme Folding Bicycle□
Photo from: CarryMe USA SD Single Speed Portable Folding Pedal Bicycle. 2015. *CarryMe USA SD Single Speed Portable Folding Pedal Bicycle*. [ONLINE] Available at: http://www.bootic.com/give-5-to-cancer/sporting-goods/outdoor-recreation/cycling/sun-flare-systems-marine-rv-sos-in-a-box-solar-generator-copy. [Accessed 25 November 2015].

iii. Fast hand tool to replace cam-action quick-releases– to improve the strength, stiffness of the Folding Bicycle, and to enable the folding up of a larger range of frames. (Dahon Flatpack and Datool 2010s)

Fig.45

Dr.Hon Cure-All Tool
Photo from: Welcome to BikeCorp - Products. 2015. *Welcome to BikeCorp - Products*. [ONLINE] Available at: http://www.bicorp.com.au/ProductDisplay.aspx?Product=DAHCAT. [Accessed 25 November 2015].

3.Materials for Frame/Fork/Handlebar

The choice of material for Folding Bicycles is largely similar to that for regular bicycles, but delayed perhaps by a couple of decades. In decreasing order of popularity nowadays

Fig.46

Fig.47

, they are: steel, aluminum, carbon fiber, titanium, magnesium.

a. The majority of Folding Bicycles today are built of either steel or aluminum alloy, with the latter gaining quickly on the former due to its inherent advantages and general cost reduction.
b. In an effort to further reduce the weight of a Folding Bicycle, half a dozen or so manufacturers have logically attempted to use carbon fiber composites. The challenge is in the reliable coupling of carbon fiber with the metal parts, hinges, etc. These frames have not been met with roaring successes so far, arguably from inadequate design, production and marketing commitments. But it is only a matter of time until carbon fiber will share the limelight among high-end Folding Bicycle products. See, for example, Allen Sports' Ultra X Superlight. Amazon.com : Allen Sports Ultra X Superlight Carbon 20 Speed Folding Bicycle, Carbon, 12-Inch/One Size : Sports & Outdoors. 2015. *Amazon.com : Allen Sports Ultra X Superlight Carbon 20 Speed Folding Bicycle, Carbon, 12-Inch/One Size : Sports & Outdoors*. [ONLINE] Available at: http://www.amazon.com/Allen-Sports-Superlight-Folding-Bicycle/dp/B00LVP6ZWK. [Accessed 25 November 2015].
c. Many companies in the last couple of decades have attempted to produce magnesium bike frames, including Folding Bicycles. See:

- https://en.wikipedia.org/wiki/Bicycle_frame#Magnesium
- http://www.paketabike.com/

Also, search for "magnesium folding bike". The density and tensile strength of good magnesium alloy are both about 70% of those for aluminum alloy 6061. For the same weight and dent-resistance, one can get larger tube diameters for higher stiffness. That makes magnesium theoretically more suitable than aluminum for most bicycles and Folding Bicycles. Furthermore, unlike in aluminum, properly cast magnesium parts have little porosity and thus have good weldability and reliability. Forged or melt-forged magnesium is strong and can replace aluminum in many applications. Its formerly notorious oxidation problem is now largely controlled with the alloying of rare earths, and proper coating. It is not very expensive, being the most common element on planet Earth. (from "Magnesium" comes "Magma" which makes up most of the Earth's core.) Magnesium has replaced as much as 70% of aluminum in auto parts with Toyota cars as of 2007. Unfortunately, the supply of bicycle-grade tubes from China (the main supplier of Magnesium and rare earths in the world) is not yet stable, and the welding technology is not yet mature in the bike industry (which is not known for big RnD budgets.) Many who have attempted to take the bull by the horns have paid the price as pioneers or martyrs. Magnesium is like aluminum alloy was with the bike industry 40 years ago. It is not a matter of feasibility, but only a matter of production engineering. Magnesium wheels are already very common. We will see many magnesium frames, as well as parts, in the years ahead. Inherently, magnesium has the potential to rival (or even beat out) other materials in certain mid- to high-range bicycles eventually. (Try searching for "magnesium bike rims", "…frame" and "…parts.)

e. Titanium has enjoyed a lot of hype for decades, carried over from the aerospace industry, based on its impressive strength-to-weight ratio as well as maturity in production. Search for "Brompton titanium" and "Helix" (under development). Many titanium folding frames are being offered for DIY. However, because of high costs, Titanium frames and parts will probably remain only a high-class option in the near future.

Table 1 compares the density and tensile strengths of 5 frame materials. The fourth column "specific strength" is obtained by dividing the third column by the second column. The advantage of carbon fiber composite is not as "fantastic" as indicated numerically here, as fibers are directional (as opposed to being isotropic for metals),

and each tubing must face multiple directional requirements (at least 4, two torsional and two flexial; sometimes a fifth direction, tensile) and would end up using several times more fibers. By the same token, though, carbon fibers can be applied judiciously anywhere, especially around hinges, to counter stress concentrations. All told, carbon fiber composite can provide the lightest frame for any strength/stiffness requirements.

Table 1

	density (g/cm 3)	tensile strength(Mpa)	specific strength(σb/ρ)
Steel	7.85	470	60
Al6061	2.73	310	113
Carbon	1.8	3500	1944
Mg	1.74	250	144
Ti	4.5	450	100

4.Structural Design

a. Traditional bike principles should be adhered to. The construction of various types of bicycle is evolved over a century, and is generally considered fairly optimized on the basis of ergonomics and physics. Folding Bicycles and EFolding Bicycles are bicycles and thus should follow traditional technology where interactions with the rider and the road are concerned. The main parameters of a bicycle are: wheel base, seat tube height and angle, fork angle and off-set, handlebar position, strength/stiffness, etc. Each should fall within a small range for body size and intended use (MTB, road, utility, etc.). Otherwise performance will suffer.

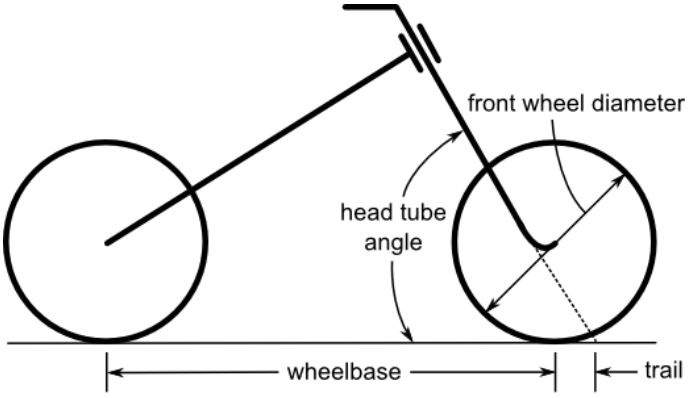


Fig.48

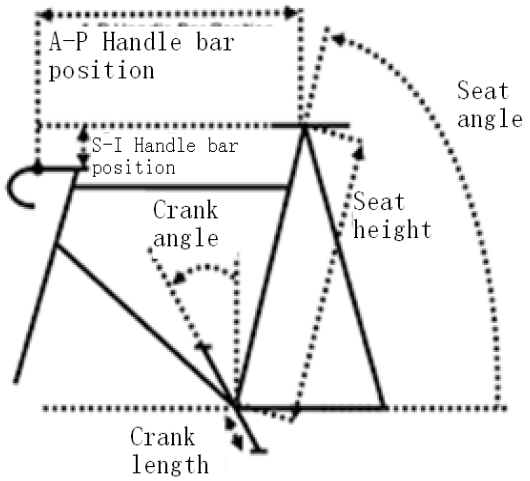


Fig.49

b. With any bicycle, strength of the frame/handlebar system is vital for safety of the rider. That is widely recognized.

c. Fewer people, however, recognizes that stiffness of the frame/handlebar system is equally vital--for peddling efficiency and good handling and, perhaps eventually, for safety as well. The most important stiffness requirements of any bicycle are those between the BB (where pedaling forces are applied) and the 2 wheel axles (which connect to the ground via the wheels/tires). This is to be followed by the stiffness between the BB and the handlebar (where the rider balances himself while pedaling hard, quite apart from steering). Stiffness of the seat tube is relatively secondary, lucky for Folding Bicycle's. The whole frame/handlebar system (along with the forks and wheels/tires) must be laterally and torsionally, as well as vertically, stiff during pedaling, when the bike swings from left and right rhythmically. As much as 20% of the pedaling forces could be vectored horizontally. Less but still significant forces are applied to the handlebar--in hard drives. Any excessive flexibility of the frame/handlebar system while pedaling would be at the expense of forward propulsion. Unfortunately, some Folding Bicycle designers have opted to eliminate or abbreviate the chain stays or the down-tube in the interest of reducing size or weight. Additionally, A flexible Folding Bicycle would unwittingly mete out extra and repetitive punishment to the many hinges, causing rattles and eventually shortened lives, thus becoming a safety issue as well. Stiffness of Folding Bicycle cannot be over-emphacized.

d. For small wheeled Folding Bicycle, the longer handlebar system must be strong /stiff. The same is true with the seat post. Again, this is necessary for a good ride as well as for ergonomic and safety, especially for taller/heavier riders.

e. Welded tubes are best. Regular bikes, evolved over decades, are now primarily built with tubes welded (or otherwise strongly coupled) together. Tubes, as a kind of closed shell, is known in Physics to provide the maximum strength- and stiffness-to-weight ratio in all vectored directions when properly structured. Take for example, the torsional strength around the axis of a tube.

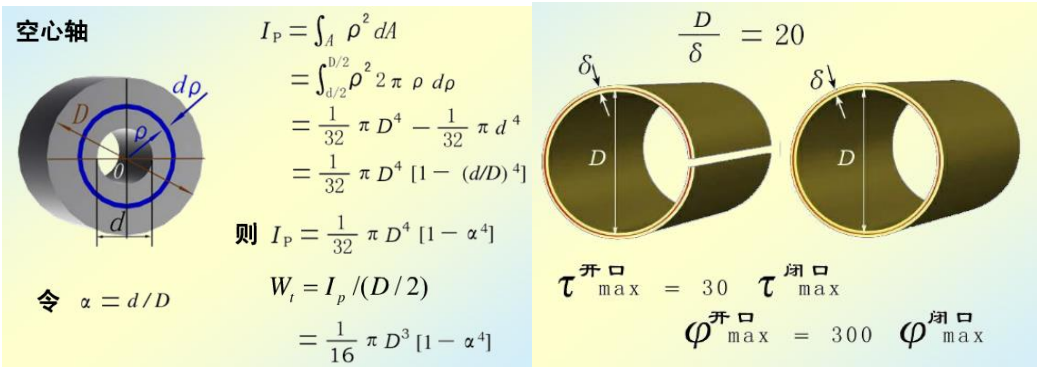


Fig.50

However, if you slit the tube axially, it becomes a curved sheet, and your torsional strength would be reduced by hundreds of times to yyy. It can reclaim its torsional rigidity only by grossly increasing its thickness, and thus the weight—something you do to a bike only as a last resort. This problem is found in many electric bikes with mid-motors. The motor and gears, along with the crank spindle, are housed in an integral casing to which the down-tube, seat-tube and chain-stays are connected by bolts and nuts --instead of by welding. Most casings themselves are put together with screws (instead of welding), further exacerbating the problem. The whole bike frame would tend to be "soft" even new and gets worse with time, unless excessively strong structures are provided. A (better) approach is to have the mid-motor unit where the crank shaft (an integral part of the motor unit) be inserted and affixed into the BB tube of a regularly-welded frame. This approach makes a lot more sense from the point of view of strength/stiffness and weight of the entire vehicle. The cost should also be lower.

There are other examples with EB designs where tubes are incorrectly replaced by thick plates—losing stiffness while gaining weight. An example with Folding Bicycle is where the seat tube is off-set from the BB tube, (whereas, in traditional frames, the seat tube is terminated at the BB tube with solid welding. Sometimes, nowadays, the two tubers are barely touching. This would lead to significant "decoupling" between the BB and the seat tube, leading to a softness (around a front-rear axis of rotation) between the BB (where pedaling forces are applied) and the rear wheel (which touches the ground).

f. Some designers have tried to replace certain tubes (or hinges) in a frame by cables. Unfortunately, each of these components normally provide stiffness of all force components in order to make up a stiff frame. The torsional forces, especially for the down-tube, cannot possibly be replaced by a cable at all. Few such products have survive the market for long. A cable, if employed, can only be used to reinforce a frame that is otherwise already sufficiently stiff where it matters.

g. CEN tests useful for desigers. Take a good look at CEN frame and handlebar tests in a lab for bicycles. They would give you an idea how the bike is supposed to be used and abused. (The JIS tests tend to emphasize only on the vertical forces, and is slowly becoming obsolete even in Asia.)

h. Rear suspension should respect traditional wisdom. If rear suspension is needed, then one must follow regular bicycle physics. It must be properly pivoted above the BB tube just below the chain. (See, for example, "Bicycle Suspension" in Wikipedia). Otherwise, excessive bobbing of the bike while pedaling will be innevitable, leading to notorious inefficiency.

i. For force analysis, the computer tool "finite element analysis" (FEA) is most suitable for Folding Bicycles, which are more complex than a regular bicycle. As an experimental R/D tool, electronic stress detectors

are used during stress tests by some engineers. Any structural design can be optimized quickly without having to rely solely on trial and error, which is more costly and time consuming.

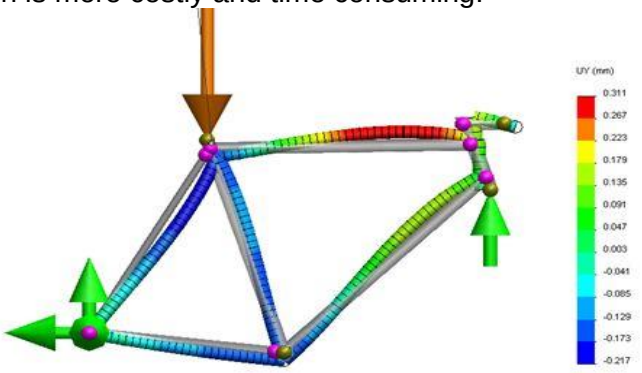


Fig.51

j. 3-D printing using plastics is becoming more popular for aesthetic and geometric modeling. Metal materials are increasingly available, and 3-D printing may become useful even for strength/stiffness tests in the near future.

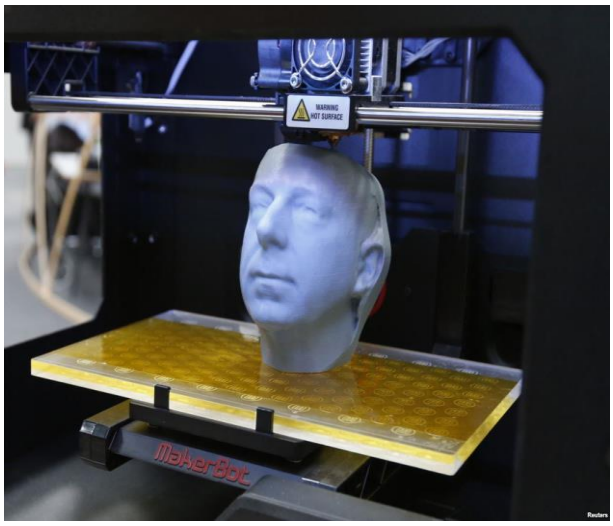


Fig.52

5.Other Foldable Components

Other than the frame/fork/handlebar system, certain other bicycle components must also be reengineered to attain the needed rideability and foldability as well as safety.

a.Seat-post

1. That's an easy one – nowadays. This is most often achieved by telescopically lowering the upper seat post into the lower seat tube which is offset from the bottom brackets. Bickerton first introduced this off-center concept in the 1970s.Multiple telescopic sections were also introduced by Dahon, thus accommodating taller riders. Before that, all bicycle seat tubes terminated at the bottom brackets and were the chief obstacle for minimizing the seat in small-wheel Folding Bicycles. (See, for example, Raleigh Twenty in the early 80s).

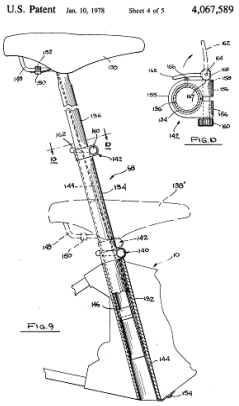


Fig.53

DAHON filed in 1976, US patent No.4067589

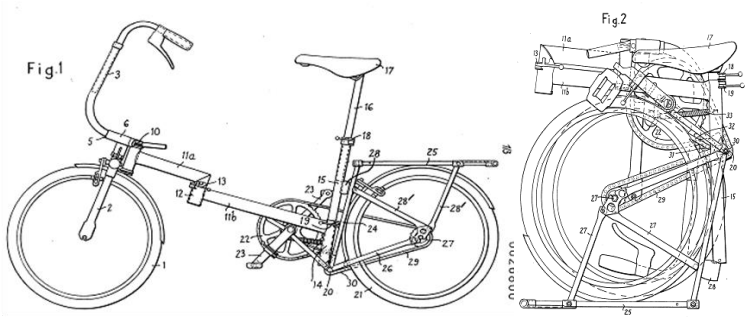


Fig.54

Brompton filed in 1979, EP patent No.0026800（notice the handlebar system）

Fig.55

Fig.56

Bickerton folding bike in 1980s

2. A few products fold the seat-post forward (Diblasi1970's, bike Friday 2010s) or sideways (Dahon Curl, 2015).

Fig.57
Diblasi 1970's

Fig.58
Bike Friday 2010s
www.bikefriday.com

Fig.59

Fig.60

Dahon Curl, 2015

3. An oval or tear-shaped cross-section for a seat-post is very suitable for a small-wheeled Folding Bicycle because of its typical length. An example can be found in Decathlon's latest offering.

Fig.61

Fig.62

Decathlon's Tilt700

DECATHLON. 2016. Tilt 700 Folding Bike - Grey - | Decathlon . [ONLINE] Available at: http://www.decathlon.co.uk/tilt-700-folding-bike-grey-id_8300175.html. [Accessed 25 Novermber 2016].

b) **Handlebar**

1. the most common handlebar-post (also called "handle post") design involves the base (connected to the fork tube) which, when unlatched, can be folded down in one sweeping action around an axis at ~45°with the frame's plane, resulting in the folded handlebar placed **alongside** the front wheel. This was first patented and produced by Dahon in the early 80s, later licensed to a number of other Folding Bicycle manufacturers. Upon its expiration in the early 90s, this design quickly replaced most other designs to become almost "standard" in the industry, evolving with only minor changes (in the latch).

2. There are exceptions. The left and right folding of the handlebar downwardly and/or rear-wardly (strictly) for geometrical reasons. (See, for example, the early Brompton and IF Mode.)
3. Handlebar adjustment is desirable for the rider's ergonomy and for use by multiple riders. Patents involving the handlebar's adjustable height (Dahon, early 1980s,patent No. US4422663), brake-levers' angle (Dahon, 2000s, patent No. CN01271320.1) and handlebar's reach (2015, patent No.CN201420107275.0) have made foldable bikes more ergonomic. (Dahon 1980s, 2000's, 2014; most Folding Bicycle have some degree of adjustment nowadays)

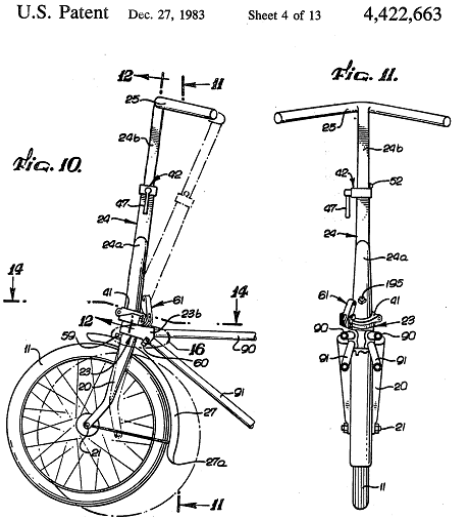


Fig.63
Dahon patent in 1980s

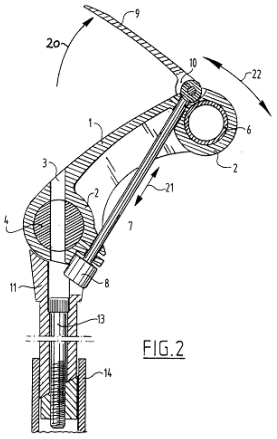


Fig.64
Gazelle's adjustable handlebar in 1996, patent no.EP0736447

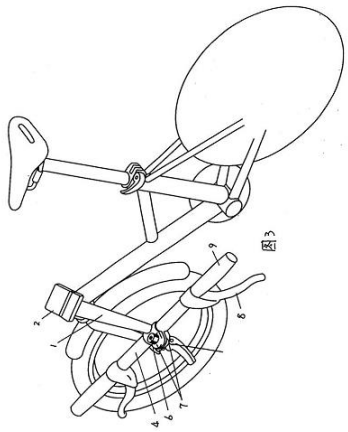


Fig.65

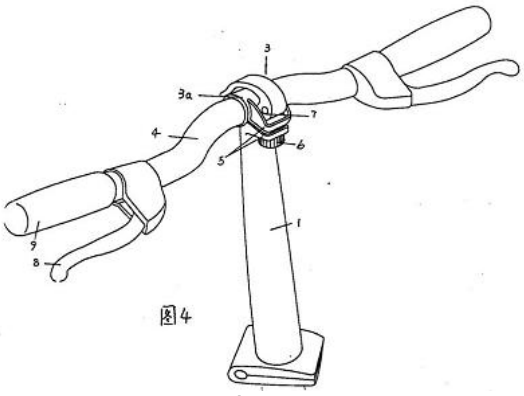


Fig.66

Dahon patent in 2000s

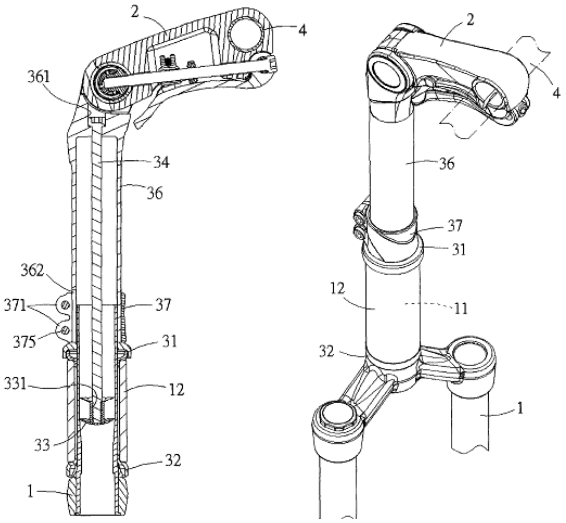


Fig.67
Xinlong's handlebar 2007

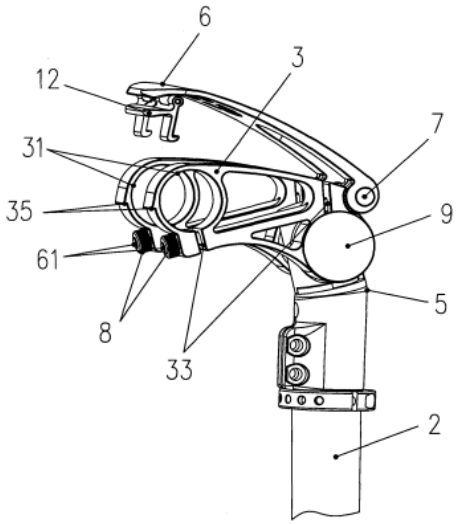


Fig.68

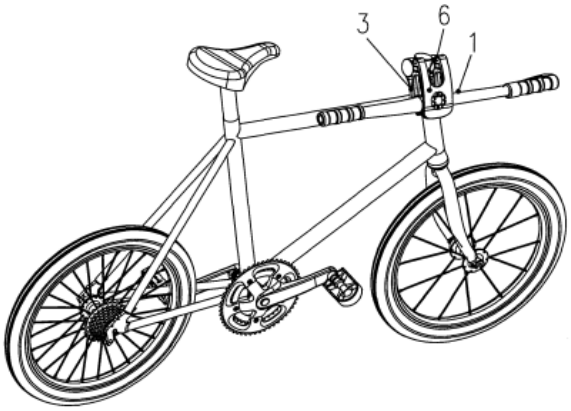


Fig.69
Dahon's handlebar 2014

c) **Pedals**

1. Almost all foldable pedals today involves a shortened axle system on which the pedal is folded 90°--first introduced by Di Blasi in the 1970s.Though the principle works, most such pedals being marketed today are not strong enough to pass official strength tests. Space reduction in folding is also limited. The only advantage is cost. The strength/durability problem can be resolved by simply replacing the current cheap bearings with better ones.
2. Brompton's unique foldable pedal design, which uses a single large bearing, appears to pass the required tests. It also folds more prone than most other ones by about three centimeters (!). But it is not widely adopted in the industry because of its higher cost, and cheap copies have not been commercially successful. However, the effective area of the pedal in use is relatively small and displaced outwardly from the crank by almost an inch, raising questions of ergonomics. Additionally, the bearing is inherently overworked and the pedal suffers from small but increasing amounts of looseness with normal use. These 3 shortcomings

have since been remedied by DAHON's "Curl Folding Pedal".

Fig.70

Fig.71

3. For obvious reasons, some pedals for Folding Bicycles are detachable from the crank. These can provide greater strength and compactness, as well as flexibility in the selection of the type of pedals (toe clips, e.g.), and has attracted a small but growing following among manufacturers and serious cyclists. For them, the additional trouble in attaching and detaching is apparently acceptable. Companies offering detachable petals include MKS, Wellgo and Dahon, among others.

(MKS: patent no.JP3682182,in 1999; Wellgo: patent no.CN200820140240.1,in 2008; Dahon: No. CN201010161406.X in 2010)
Other expired patent include: US patent No.5586472, 1995.
JP patent No.10-027806, 1998
http://www.nycewheels.com/p-pedal-removable-mks-sv.html
http://www.allez-bid.com/store/Wellgo_Quick_Release_Pedal_QRD_M111_320g_6_colors
http://www.bikerumor.com/2012/06/22/video-new-dahon-jifo-16-pocket-sized-singlespeed-folding-bike/

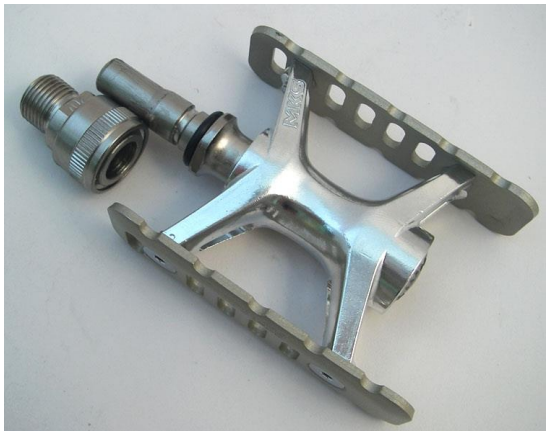


Fig.72

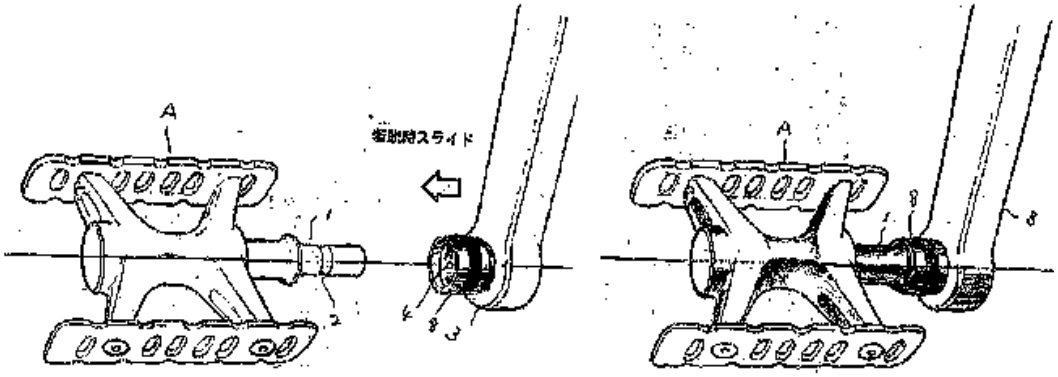


Fig.73
MKS

Fig.74
Wellgo□

Fig.75

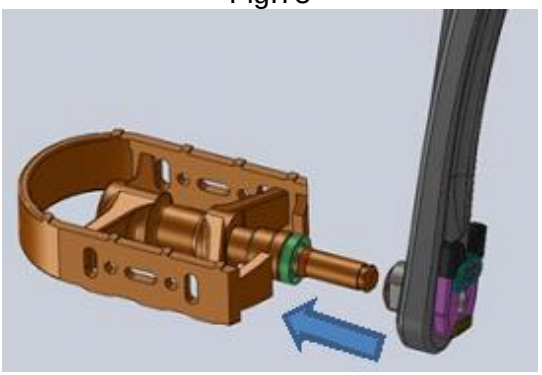


Fig.76

DAHON's detachable, quick-release pedal

4. Instead of the pedal, the crank can also be folded or detached at various places to greater achieve compactness and/or strength/stiffness. The first models of Dahon in the 80s used a foldable crank. Oyama, among others, attempted again in the 2000's. All did not have the needed stiffness/strength or durability to succeed commercially so far. But some inventors are still enamored by the idea, especially in view of the relatively poor performance of many foldable pedals..

Fig.77

Dahon 1980's with foldable crank

Fig.78
Oyama COMPACT PRO L700 with foldable crank
http://www.oyama.hk/product_show.asp?id=343

d). <u>Hinges and latches</u>

1. These are needed for folding actions, especially for the frame and the handlebar post. The most popular design involves two opposing and matching plates connected on one lateral side by a vertical hinge, and, on the opposite side, latched or clamped together by a quick-release latch. There are many quick-release latch designs on the market, but those involving various cam and over-center actions can offer the best combination of strength/weight, ease of operation and cost. Proper design and workmanship are found on some products.

ii. Clamps on wedges, such as those found on Brompton 1990s, Birdy 1990s, Dahon1990s, bike Friday Tikit and others, may be among the most reliable principles currently.

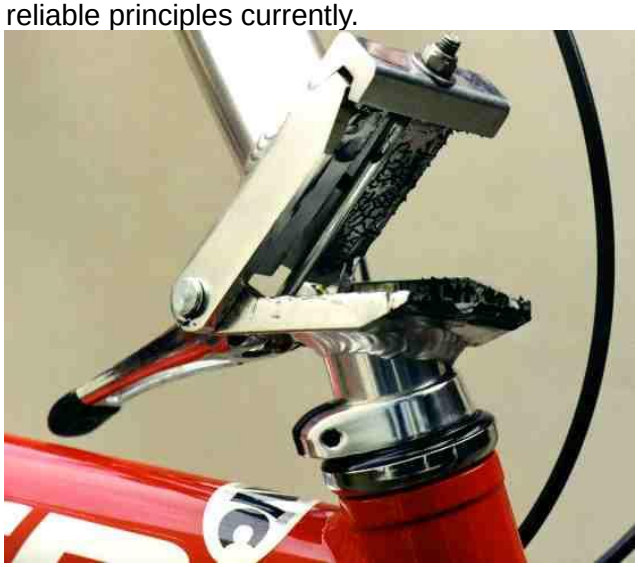


Fig.79

Fig.80
 Birdy joint

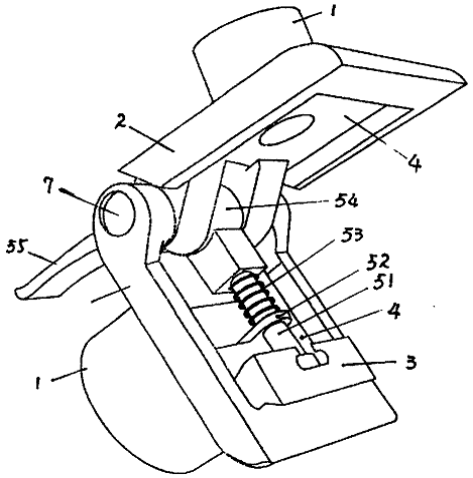


Fig.81

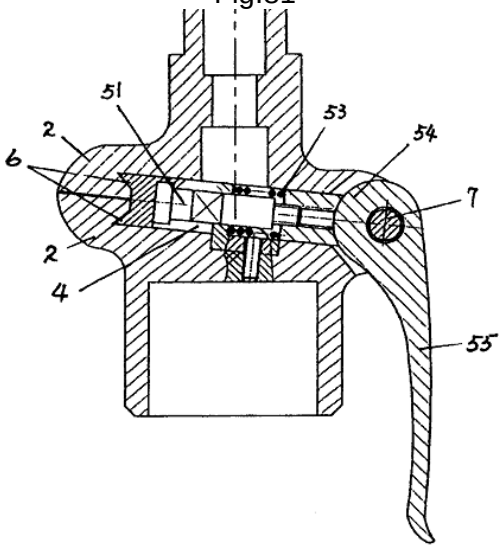


Fig.82
Dahon 2,000s

iii. A simple online search on images of “latches” and “Folding Bicycle latches” can be very rewarding for inventors/engineers. Any weakness or looseness in this area can cause unwanted flexibility of the frame. These can be aggravated under the repeated punishment in use, eventually becoming a safety issue. Overall, hinges and latches are where many cheap products fail safety requirements.

e. **Single-sided fork**

This can significantly reduce the width of a folded Folding Bicycle by 2 or 3 cm. This has been used by a number of manufacturers (Giant Halfway 2000s, Strida 2000s and Pacific IF Mode 2000s). The technology is long ripe from regular bicycles, if cost is no issue.

Fig.83

Strida
Source: BlessThisStuff. 2016. Strida Foldable Bike. [ONLINE] Available at:http://www.blessthisstuff.com/stuff/vehicles/cycles/strida-foldable-bike/. [Accessed 25 November 2015]

Fig.84

Pacific IF Mold
Source: Fudges Cycle Store. 2016. Pacific IF Mode Folding Bike Only £2,199.99. [ONLINE] Available at:http://fudgescyclesonline.com/index.php?p=166201. [Accessed 25 November 2015].

f. Fatter tires,

With fairly high pressures, these are a safe bet for small wheeled Folding Bicycles, especially if the road and whether conditions are not ideal. They provide a better suspension and road grab that most riders would appreciate. However, if you are racing on an Folding Bicycle, (like they do in London and New York, etc. YouTube. 2016. Final of the London Nocturne Folding Bike Race 2015 - YouTube. [ONLINE] Available at:https://www.youtube.com/watch?v=RPYSJP1wBQ8. [Accessed 25 November 2015]) then skinny tires with high-pressure will give you an edge in rolling efficiency but not traction or comfort.

6.Quality Problems

In some manufacturing countries, the samples prepared for testing by the customs office are often much better than the container average. Not ethical really, but very common. Folding Bicycles (and E-Folding Bicycles) are legally treated as bicycles

(and E-bicycles) everywhere. Unfortunately, many products sold today still do not comply with safety standards for bicycles (and E-Folding Bicycles) as they should – mostly in attempts to save costs and/or weight. Inventors and engineers must pay attention right from the start. Likewise for everyone in the supply chain (manufacturers, marketers, regulators) all the way through to the consumers. Common problems nowadays include:

a) Strength and stiffness - legitimate concerns, as they involve safety (as well as riding efficiency). Folding Bicycles generally requires more welding. The greatest concerns are with areas around the frame hinges halfway between the wheels where the greatest punishment is received during riding. Here, thin-walled tubes are welded to thick hinge plates, resulting in stress concentration. Intense welding heat also tends to weaken the material. Failures occur most often here. Special attention is needed in design and production.

b) Most Folding Bicycles with 20 inch or smaller wheels have a single front tube. Unless this is oversized (or thicker-walled), especially vertically, strength and stiffness can be compromised. Front triangles, with both top and down tubes, however, are found with some Folding Bicycle's.

Fig.85

Moulton
MOULTON Bicycle Company. 2016. MOULTON Bicycle Company. [ONLINE] Available at:http://www.moultonbicycles.co.uk/models.html. [Accessed 25 November 2015].

Fig.86

Jango
Jango Flik folding bikes introduction. 2016. Jango Flik folding bikes introduction. [ONLINE] Available at:http://www.foldingcyclist.com/Jango-Flik-folding-bikes-Interbike.html. [Accessed 25 November 2015]

Fig.87

Helix

Helix unveils “world’s best folding bike” that folds down to the size of its wheels | Inhabitat - Green Design, Innovation, Architecture, Green Building. 2016. Helix unveils “world’s best folding bike” that folds down to the size of its wheels | Inhabitat - Green Design, Innovation, Architecture, Green Building. [ONLINE] Available at: http://inhabitat.com/helix-to-launch-worlds-best-folding-bike-that-folds-down-to-the-size-of-its-wheels/. [Accessed 25 November 2015].

Fig.88

Dahon Folding Bicycle OCA673 2010s

Fig.89

Dahon Clinch Folding Bicycle 2015

Uber Apparatus. 2016. Clinch Folding Bike from DAHON - Uber Apparatus. [ONLINE] Available at:http://uberapparatus.com/clinch-folding-bike-dahon/. [Accessed 25 November 2015].

c) Seat and handlebar posts for small wheel Folding Bicycle are inherently long. Unless oversized or robustly built, they will contribute to notorious overall flexibility, or even bending.

d) Latches must be adjustable and strongly built to withstand the punishment of constant vibration under load –hopefully without frequent inspection and readjustment, which can be a problem among some products.

e) Foldable Pedals. The vast majority of pedals on less expensive Folding Bicycles on the market today do not pass any safety test. In most cases, this can be improved by merely replacing cheap bearings with better ones.

7.Alignment

1. During riding. Due to the many additional joints involving welding which invariably causes heat distortions, a foldable bicycle requires a lot more care to attain multiple alignment essential to bicycles, namely: among the wheels, the handlebar and the bottom bracket. Otherwise, parts would wear out prematurely and ride performance will suffer, just like any bicycle. (As described above)
2. Furthermore, the Folding Bicycle, when folded, must be in the intended configuration for proper storage or portage. For example, it should stand stably instead of falling over unaided; the wheels should be parallel for pushing. The folded bike should roll freely for easier portage.

G. The Future of Folding Bicycle

1. Growing international support. Bicycles and E-bicycles in different forms are widely recognized as an important part of the health industry as well as green urban mobility for the 21st century. In 2011, a Commission on Sustainable Development by the UN made an agreement "BICYCLE-SHARING SCHEMES: ENHANCING SUSTAINABLE MOBILITY IN URBAN AREAS". Many nations have signed this and other agreements to promote the use of the bicycle. Bike lanes and other friendly facilities are being built all around the world. More and more people are using the bicycle for transport and recreation, and the market is expected to expand as people and governments become more aware or affluent.
2. The Folding Bicycle (including E-Folding Bicycle) has many practical and conceivable uses in recreation and daily lives. New investment and technology are being channeled continually. It is a fast-growing category in the bicycle industry. Today, of all the bicycles produced, ~10%, or about 10 million units, is already folding bicycles. The growth trend is expected to continue in most markets.

In conclusion, the Folding Bicycle market is bound to grow. But opportunity implies challenge. As reviewed above, much remains to be done.
A list of folding bike forums and magazines:
http://www.foldingcyclist.com/
http://www.foldingforum.com/
http://www.foldsoc.co.uk/
http://www.bikeforums.net/folding-bikes/
http://www.cyclechat.net/forums/folding-bikes.51/
http://www.pinoymtbiker.org/forum/forumdisplay.php?f=114
http://www.atob.org.uk/folding-bikes/
http://www.nycewheels.com/articles-folding-bikes.html

OTHER REFERENCES

g. Tony Hadland, 2014. Bicycle Design: An Illustrated History (MIT Press). 1 Edition. The MIT Press.

Appendix A

List of Folding Pedal Manufacturers and manufacturing statistics

Manufacturer	Address	Employees	Monthly output in sets	Folding	Standard
Ningbo Jialong Industrial Co. Ltd.	Shezhen, China	**600+**	**3,340,000**	**25%**	**75%**
Shenzhen Fengming Industrial Co., Ltd.	Shenzhen, China	**200**	**410,000**	**2%**	**98%**
Shenzhen Longguan Co,.Ltd	Shenzhen, China	**170**	**570,000**	**12%**	**88%**
Shezhen Sanyun Factory	Shenzhen, China	**73**	**111,000**	**29%**	**71%**
Kunshan wellgo Co,.Ltd	Jiangsu, China	**200**	**630,000**	**5%**	**95%**
Foshan Qisheng Co,.Ltd	Foshan, China	**30**	**70,000**	**30%**	**70%**
Yonghua Bicycle Co,.Ltd	Jiande, China	**200-300**	**1,200,000**	**30%**	**70%**
Ningbo Hengfeng Co,.Ltd	Ningbo, China	**100+**	**1,300,000**	**30%**	**70%**
Hebei Liye Co,.Ltd	Guangzong, China	**20**	**30,000**	**0%**	**100%**
Baokang Co,.Ltd	Xingtai, China	**40**	**100,000**	**30%**	**70%**
Jiangmen Desenjian Co,.Ltd	Jiangmen, China	**10**	**1000**	**0%**	**100%**
Shenzhen Huarongxinye Technology Co,.Ltd	Shenzhen, China	**33**	**2,500**	**0%**	**100%**
Qirui Co,.Ltd	Cixi, China	**30-40**	**130,000**	**25%**	**75%**
Ningbo Baolifeng Bicycle accessories Co,.Ltd	Ningbo, China	**50**	**10,000**	**0%**	**100%**
Jiajian Co,.Ltd	Yongkang, China	**14**	**120,000**	**90%**	**10%**
Qite Co,.Ltd	Jinhua, China	**500+**	**1,000,000**	**8%**	**92%**
Shenzhen YKLBike Co., Ltd	Shenzhen, China	**208**	**30,000**	**30%**	**70%**

Appendix B

List of DAHON Patents and Their Use

Number	Name	Chinese Name	Number	Types	Date	Authorization day	Status	In use by DAHON	Third party users	Name of Third party	Any improvement by others
1	bicycle frame	自行车车架	CN92301442.X	surface	1992.04.15	1993.03.17	Expired				
2	bicycle fork	自行车前叉	CN91226644.9	new	1991.10.18	1992.06.10	Expired				
3	frame safety latch	折叠式自行车车架安全锁架	CN92207531.X	new	1992.04.15	1992.10.07	Expired				
4	bicycle handlepost	自行车竖管总成	CN92207532.8	new	1992.04.15	1992.11.25	Expired				
5	bicycle seat tube	多槽中管	CN97240689.1	new	1997.09.12	1999.01.06	Expired	√			
6	bicycle frame hinge	多邊管接头	CN97240688.3	new	1997.09.12	1999.03.10	Expired				
7	handlepost clamp	豎管倒扣	CN97240696.4	new	1997.09.15	1999.03.17	Expired				
8	folding bicycle with strengthened folding latch	NH接頭補強	CN97245800.X	new	1997.10.22	1999.04.21	Expired				
9	Traction cable	分段線	CN98233800.7	new	1998.03.13	1999.07.07	Expired				
10	clamp	反束環	CN98233799.X	new	1998.03.13	1999.07.07	Expired	√			
11	retention pin	CT安全銷	CN98234400.7	new	1998.06.10	1999.09.08	Expired				
12	quick folding latch	雙邊壓接頭	CN98233833.3	new	1998.03.18	1999.09.08	Expired				
13	quick draw device	I型锁紧接头/JJ快鎖	CN99235561.3	new	1999.03.15	2000.02.16	Expired	√	√		giant
14	locking bolt	MTB立管快拆	CN98234405.8	new	1998.06.10	2000.04.26	Expired				
15	drive-pined quick draw device	有传动销的快速夹紧装置	CN99240631.5	new	1999.10.28	2000.08.23	Expired	√	√	XDS、Aleoca、Dillenger、Columba、FITO	
16	quick draw device	T锁（带弹簧）	CN99240632.3	new	1999.10.28	2000.08.23	Expired	√	√	giant	
17	2-bar connection and locking device	BK快鎖(貝殼接头）	CN99238733.7	new	1999.09.17	2000.09.27	Expired				

18	bicycle frame	K-BIKE	CN98318400.3	surface	1998.06.10	1999.03.17	Expired				
19	bicycle frame	自行车架	CN98333757.8	surface	1998.12.18	1999.09.15	Expired				
20	strengthened folding latch	接头上下扣	CN96237086.X	new	1996.06.19	1997.09.10	Expired				
21	acclivitous connection bar folding latch	斜快鎖柄	CN96237462.8	new	1996.09.13	1997.12.03	Expired				
22	connection structure between handlebar and fork	短前管偶接	CN96236904.7	new	1996.05.08	1997.12.03	Expired				
23	improved front-triangle of folding bicycle frame	上下管干涉	CN96236894.6	new	1996.05.06	1997.12.03	Expired	√	√	CRONUS、Bbtang,PHOENIX、FOREVER…	
24	rigid bar quick folding latch	4連桿接頭	CN96236902.0	new	1996.05.08	1998.02.18	Expired				
25	adjustable tube	有洞管	CN96237463.6	new	1996.09.13	1998.02.25	Expired				
26	connection structure between handlepost and fork	豎管接頭肋	CN96236893.8	new	1996.05.06	1998.03.11	Expired				
27	quick released pedal	快卸踏板（珠子）	CN96237430.X	new	1996.09.06	1998.05.27	Expired				
28	connection structure between central axis and frame	BB補強板	CN96236903.9	new	1996.05.08	1998.06.03	Expired	√			
29	foldable rear rack	可折貨架	CN96237461.X	new	1996.09.13	1998.09.02	Expired				
30	front-triangle of folding bicycle frame	小三角	CN96316307.8	surface	1996.05.06	1997.06.18	Expired				
31	bicycle central axis structure	小鏈盤2	CN200620062245.8	new	2006.07.28	2008.03.26	Expired				
32	E-bike's power control device	电动助力车的助力控制装置	CN200720057189.3	new	2007.09.19	2008.10.22	Expired				
33	folding bicycle handlebar	彎把	CN01214909.8	new	2001.01.12	2001.11.21	Expired	√			
34	folding bicycle frame	打凹	CN01215299.4	new	2001.02.23	2002.03.06	Expired				
35	resilient swaying device	VAX	CN00227772.7	new	2000.04.05	2002.03.06	Expired				
36	front wheelset suspension mechanism	三點彈性片	CN01255487.1	new	2001.09.02	2002.05.08	Expired				
37	folding bicycle frame	打扁	CN01255381.6	new	2001.08.29	2002.12.25	Expired	√			

38	suspension fork	一种自行车的减震前叉	CN02226766.2	new	2002.04.11	2003.01.29	Expired				
39	swaying device	彈性片絞鏈	CN02225591.5	new	2002.02.04	2003.12.03	Expired				
40	connection structure between bar and bottom bracket	點焊連接	CN03224090.2	new	2003.03.10	2004.03.03	Expired	√			
41	chain	沒滾子鏈條	CN200320118674.9	new	2003.11.28	2004.12.15	Expired				
42	Inner variable speed bicycle freewheel device	內變速小飛輪	CN200420093633.3	new	2004.09.30	2005.11.16	Expired				
43	combined rear hub device	小飛輪	CN200420095759.4	new	2004.11.29	2005.12.07	Expired				
44	weight of fitness equipment	水筒砝码	CN200520119843.X	new	2005.12.06	2007.03.28	Expired				
45	a trailer wheel fixing device	拖車輪固定	CN200620057661.9	new	2006.04.13	2007.05.09	Expired				
46	bicycle bottom bracket mechanism	小鏈盤1	CN200620061652.7	new	2006.07.14	2007.07.11	Expired				
47	snowplane frame	雪撬架	CN200520119845.9	new	2005.12.06	2007.07.11	Expired				
48	taillight connection mechanism	拖車尾燈	CN200620055860.6	new	2006.03.08	2007.08.15	Expired				
49	folding latch lever	手柄凸块	CN200620060401.7	new	2006.06.16	2007.05.30	Expired	√	√	TIANXS	
50	folding latch	接頭手柄	CN01255435.9	new	2001.08.31	2002.05.08	Expired	√	√	LANGTU、CRIUS…	
51	folding pedal	打凹折疊腳踏	CN200620061687.0	new	2006.07.17	2007.12.05	Expired				
52	locking mechanism of folding latch	拉鎖	CN00260169.9	new	2000.12.27	2001.11.28	Expired				
53	industrial oven	一种工业烘炉	CN01107561.9	invention	2001.02.23	2004.10.06	Expired				
54	dislocation-preventing folding latch	接头凹凸	CN02225417.X	new	2002.01.25	2002.11.20	Expired	√			
55	quick folding latch	A鎖	CN02248160.5	new	2002.09.19	2003.10.29	Expired				
56	power-adjustable electric bike	一种可调助力的电动助力车	CN200720057145.0	new	2007.09.18	2008.07.30	Expired				
57	folding latch	斜面驱动接头	CN200420093886.0	new	2004.10.12	2005.11.02	Expired	√			
58	bottom bracket for electric bike motor	松下电机座	CN200620066620.6	new	2006.10.26	2007.11.07	Expired	√			

59	folding latch	内藏式弧形接头 (包边)	CN200420094521.X	new	2004.11.01	2006.03.08	Expired	√	√	FNHON、Banian	
60	fixing mechanism of folding latch lever	自动安全勾	CN200620154753.9	new	2006.12.14	2007.12.19	Expired	√	√	FNHON、KOUAN、LANGTU、TIANXS、TWITTER、TERN…	
61	folding bicycle seatpost	双节座管	CN200520119847.8	new	2005.12.06	2007.03.28	Expired	√			
62	bicycle handlebar fixing mechanism	无牙碗组固定套	CN200720048325.2	new	2007.02.06	2008.02.27	Expired	√			
63	reinforced mechanism for single tube folding bicycle latch	上补强	CN00260163.X	new	2000.12.27	2001.10.31	Expired	√	√	FNHON、KOUAN、TIANXS、LANGTU…	
64	locking device of folding bicycle	磁扣	CN01214908.X	new	2001.01.12	2001.12.26	Expired	√	√	OYAMA，DAHON	
65	folding bicycle	拉輪	CN200420043200.7	new	2004.03.05	2005.03.23	Expired	√			
66	handlebar adjustment mechanism	吴头	CN200920055838.5	new	2009.5.4	2010.8.4	Expired				
67	chain	不對稱鏈條	CN200320118716.9	new	2003.12.01	2004.12.15	Expired				
68	streamlined battery case	電池盒	CN200620057769.8	new	2006.04.14	2007.05.09	Expired				
69	four-bar linkage folding frame latch	手柄	CN02225922.8	new	2002.02.25	2004.06.02	Expired	√	√	CRIUS、TIANXS、KOUAN、LANGTU、FNHON、TERN、JOE	
70	seatpost clamp	07座管束環	CN200630066915.9	surface	2006.07.28	2007.08.15	Expired	√	√	mi.xim、QUARRY、YASITE	
71	Kickstand	中支撑	CN200420093885.6	new	2004.10.12	2005.11.02	Expired				
72	folding pedal	沖壓折疊腳踏	CN200420093884.1	new	2004.10.12	2005.11.16	Expired				
73	a connecting device	拖车连接	CN200620066367.4	new	2006.10.24	2007.12.12	Expired				
74	bicycle	无声齿形链	CN200420103330.5	new	2004.12.31	2006.02.15	Expired				
75	folding latch (A)	无牙头（精铸）	CN200430085532.7	surface	2004.10.08	2005.07.20	Expired		√	CRONUS	

76	folding latch (B)	无牙头（锻压）	CN200430085534.6	surface	2004.10.08	2006.02.22	Expired		√	TIANXS、KOUAN	
77	folding bicycle	异形管	CN200420043198.3	new	2004.03.05	2005.03.23	Expired	√	√	FNHON、Banian	
78	seatpost	不等壁座管	CN200420043823.4	new	2004.03.23	2005.03.23	Expired				
79	a manufacturing method of a folding bicycle frame and the fixture	切焊	CN98113243.X	invention	1998.06.10	2000.11.29	Expired	√			
80	frame	PA410、412車架	CN200430085533.1	surface	2004.10.08	2005.05.11	Expired	√			
81	fork	直焊腿前叉	CN200420094454.1	new	2004.10.29	2005.11.02	Active	√			
82	lever connecting device of a trolley	拖車把連接	CN200620055857.4	new	2006.03.08	2007.08.15	Expired				
83	suspension device	卷型車後避震	CN200620055862.5	new	2006.03.08	2007.03.28	Expired				
84	handlebar fixing device	無牙接頭	CN200420043199.8	new	2004.03.05	2005.03.23	Expired	√	√	FNHON	
85	double bar linkage folding latch	双压紧接头	CN200520120408.9	new	2005.12.15	2007.02.07	Active				
86	power-supplying control device of E-BIKE	电动助力车的助力控制装置	CN200710030300.4	invention	2007.09.18	2009.08.19	Active				
87	resilient oscillation device	VAX	CN00114185.6	invention	2000.04.05	2003.11.05	Active				
88	Innerlocking folding latch	V型接頭	CN01127832.3	invention	2001.09.07	2005.10.26	Active	√	√	Specialized	
89	manufacturing method of a hollow crank	空心曲柄	CN200510034627.X	invention	2005.05.17	2008.02.20	Active				
90	component transfering system between assembly lines	傳輸線	CN200410096447.X	invention	2004.12.01	2010.6.16	Active				
91	foldable bike	一种便携式小车	CN200610034126.6	invention	2006.03.08	2010.5.26	Active				
92	folding bicycle	卷型車	CN200610034125.1	invention	2006.03.08	2010.5.12	Active				
93	four-bar linkage suspension fork	轴承外移前叉	CN200620154754.3	new	2006.12.14	2008.02.27	Active				
94	electric bicycle	五通前置，电池空间	CN200720051028.3	new	2007.04.29	2008.03.26	Active				
95	folding saddle	折叠鞍座	CN200720050753.9	new	2007.04.25	2008.04.02	Active				
96	folding seatpost	切斜座管	CN200620153712.8	new	2006.11.27	2008.04.30	Active	√	√	TIANXS…	

97	climing-sensiable E-BIKE	可检测爬坡的电动助力车	CN200720057143.1	new	2007.09.18	2008.07.30	Active				
98	suspension fork	一种避震前叉	CN200720056868.9	new	2007.09.11	2008.07.30	Active				
99	foldable Handlepost	自行车车把的折叠竖管	CN200720055349.0	new	2007.08.10	2008.08.20	Active				
100	Soft starting E-BIKE	可软起动的电动助力车	CN200720057144.6	new	2007.09.18	2008.09.10	Active				
101	hinge	外V	CN200720055880.8	new	2007.08.22	2008.10.22	Active	√	√		FNHON、LANGTU
102	hinge	双手柄	CN200720058656.4	new	2007.10.24	2008.10.22	Active	√			
103	Inclined folding folding latch	倾斜接头	CN200720055862.X	new	2007.08.21	2008.10.22	Active	√	√	KOUAN、TIANXS、Yingqi	
104	frame hinge	U型接头（新）	CN200420093887.5	new	2004.10.12	2005.11.02	Active	√			
105	chain guide device	防掉链档	CN200520120406.X	new	2005.12.15	2007.02.07	Active	√			
106	seatpost pump	座管气筒	CN200520119954.0	new	2005.12.07	2007.02.07	Active	√			
107	telescopic pipes locking mechanism	长管槽束紧法	CN200520119846.3	new	2005.12.06	2007.02.07	Active	√			
108	tubing coupling	分离接头	CN200520120407.4	new	2005.12.15	2007.02.21	Active				
109	suspension mechanism	橡膠避震	CN200620057768.3	new	2006.04.14	2007.03.28	Active				
110	Frame Structure of E-BIKE	後置五通	CN200620057767.9	new	2006.04.14	2007.03.28	Active				
111	folding bicycle	狗腿前叉	CN200520119844.4	new	2005.12.06	2007.03.28	Active	√			
112	headset	竖管接头套	CN200520119953.6	new	2005.12.07	2007.03.28	Active				
113	a machinery and electric derailleur device of E-bike	雙變速電動車	CN200620057660.4	new	2006.04.13	2007.05.09	Active				
114	connecting device between handlebar and fork	平易接頭(束環)	CN200620057357.4	new	2006.04.04	2007.05.30	Active	√			
115	Bottom bracket of a rear Motor E-bike	五通偏移	CN200620057662.3	new	2006.04.13	2007.05.30	Active	√			
116	suspension seatpost	避震打氣筒	CN200620061689.X	new	2006.07.17	2007.07.11	Active				
117	four-bar linkage suspension fork	軸承外移四連杆避震器	CN200620062246.2	new	2006.07.28	2007.08.15	Active				

118	three dimensional baking oven	立体烤炉	CN200520057028.5	new	2005.04.14	2007.08.15	Active				
119	a punch formed folding device	防掉漆盖板	CN200620062022.1	new	2006.07.24	2007.08.15	Active	√	√	TIANXS、KOUAN	
120	Freewheel mechanism of Motor hub E-BIKE	輪轂式小飛輪	CN200620062058.X	new	2006.07.25	2007.09.05	Active				
121	reinforced folding latch	UPA接頭	CN200620062021.7	new	2006.07.24	2007.10.31	Active				
122	folding bicycle frame	KA	CN200530155830.3	surface	2005.12.02	2006.10.18	Active	√	√	KOUAN、TIANXS、LANGTU、FNHON	
123	folding bicycle frame	HA	CN200530155833.7	surface	2005.12.02	2006.10.18	Active	√	√	KOUAN、TIANXS、LANGTU	
124	suspension fork	四连杆前叉	CN200630076566.9	surface	2006.10.24	2007.08.08	Active				
125	frame	BYA車架	CN200630178097.1	surface	2006.12.26	2007.12.19	Active	√	√	TIANXS、FNHON、KOUAN、LANGTU、monster、missle、JAVA、SAVA、ALIENWARE	
126	folding bicycle frame (PA083-00)	折叠自行车车架(PA083-00)	CN200730333707.5	surface	2007.12.20	2009.01.21	Active	√	√	TIANXS、KOUAN、LANGTU、trinx、maruishi、EMMELLE、SEEFAR、Saisatu	
127	folding bicycle frame (YVA060)	YVT010	CN200730333759.2	surface	2007.12.21	2009.04.22	Active	√			
128	folding bicycle frame (JA20-24S-07Y1)	FA073	CN200730333708.X	surface	2007.12.20	2009.04.08	Active	√	√		TIANXS、KOUAN、CRIUS
129	folding bicycle frame （RAO72-00）	RA060、RA072	CN200730333758.8	surface	2007.12.21	2009.05.06	Active	√	√	TIANXS、ENDA、SPECIALIZED	
130	swaying device	彈性片絞鏈	CN02114811.2	invention	2002.02.04	2004.09.15	Active				
131	bar folding latch	螺絲上下夹緊	CN200620055858.9	new	2006.03.08	2007.05.30	Active	√			
132	bar folding latch	偏心上下夹緊	CN200620055859.3	new	2006.03.08	2007.05.30	Active				

133	folding bicycle frame （NA)	折叠自行车车架（NA)	CN200530155835.6	surface	2005.12.02	2006.12.06	Active	√			
134	folding bicycle frame （LA）	折叠自行车车架（LA）	CN200530156151.8	surface	2005.12.06	2007.06.06	Active	√	√	KOUAN、TIANXS	
135	bicycle bottom bracket speed up device	自行车中轴增速装置	CN200820020149.4	new	2008.9.5	2009.8.26	Active				
136	rollover prevention structure of tricycle	三轮车	CN200810026720.X	invention	2008.03.10	2011.5.18	Active				
137	a handlebar positioning mechanism	吴头	CN200910039137.7	invention	2009.5.4	2011.5.18	Active				
138	electric bicycle frame	踏杆	CN200920062785.X	new	2009.8.21	2010.8.4	Active				
139	fender stay	一种挡泥板支撑杆	CN200920062531.8	new	2009.8.18	2010.5.26	Active	√			
140	electric bicycle (Star of City)	仿雅马哈	CN200930086652.1	surface	2009.8.21	2010.5.12	Active				
141	a scooter structure	双直管梁	CN200920204359.5	new	2009.9.7	2010.8.18	Active				
142	a folding latch	韩头	CN200920204360.8	new	2009.9.7	2010.8.4	Active				
143	a continuous casting and forging equipment and method	一种连铸连锻装置及方法	CN201010161407.4	invention	2010.4.13	2013.10.2	Active				
144	an auger-type building	一种螺旋厂房建筑	CN201020174762.0	new	2010.4.13	2011.4.6	Active				
145	bicycle shifer	变速手柄	CN201020136031.7	new	2010.3.18	2011.1.26	Active				
146	a bicycle latch	C型铰链	CN201020136037.4	new	2010.3.18	2010.11.24	Active				
147	folding latch	L连杆	CN201020136040.6	new	2010.3.18	2011.1.26	Active				
148	bicycle pedal axle structure	脚蹬引导快装	CN201020153433.8	new	2010.4.2	2010.11.24	Active				
149	a tool-free quick draw pedal	快拆脚蹬(优先权3.5)	CN201010161406.X	invention	2010.4.13	2013.4.10	Active	√			
150	handlebar adjustment device	吴头下弹垫	CN201010160174.6	invention	2010.4.27	2012.10.3	Active				
151	a bicycle pedal bracket	脚蹬插座	CN201020175183.8	new	2010.4.27	2011.2.16	Active	√			
152	folding pedal stand	滑板车脚踏	CN201020175170.0	new	2010.4.27	2011.1.5	Active				
153	bicycle front wheel fixing device	前轮防偏转	CN201020175165.X	new	2010.4.27	2011.5.18	Active				

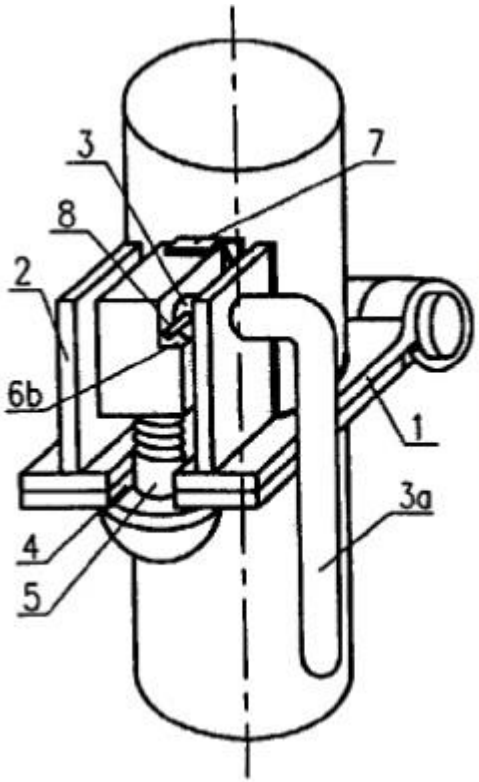
154	Vehicle umbrella fixing device	伸缩伞	CN201020175145.2	new	2010.4.27	2011.5.18	Active				
155	folding scooter	整体折叠	CN201020175154.1	new	2010.4.27	2011.1.5	Active				
156	folding saddle of bicycle	鞍座侧翻	CN201020175141.4	new	2010.4.27	2011.4.6	Active				
157	frame reinforced mechanism	三角内补强	CN201020246212.5	new	2010.6.28	2011.5.18	Active	√			
158	quick-draw pedals	红色警示带	CN201020246213.X	new	2010.6.28	2011.1.26	Active	√			
159	automatic balance control device	三轮车	CN201020275910.8	new	2010.7.28	2011.5.18	Active				
160	bicycle folding latch	郑氏车	CN201020515064.2	new	2010.8.27	2011.4.6	Active				
161	back triangle structure of a bicycle	郑氏车	CN201020515061.9	new	2010.8.27	2011.4.6	Active	√			
162	folding positioning device	郑氏车	CN201020515073.1	new	2010.8.27	2011.4.6	Active	√			
163	vertical folding bicycle	郑氏车	CN201020515083.5	new	2010.8.27	2011.4.6	Active	√			
164	frame reinforcing and locking device	上补强锁	CN201010280472.9	invention	2010.9.8	2012.12.26	Active				
165	folding hinged mechanism	不对称铰轴	CN201020529428.2	new	2010.9.8	2011.5.18	Active	√			
166	folding bicycle	三折车	CN201020544040.X	new	2010.9.25	2011.5.18	Active				
167	folding latch	平价接头	CN201020691660.6	new	2010.12.30	2011.12.14	Active				
168	folding bicycle	五通定位	CN201020691656.X	new	2010.12.30	2011.9.7	Active				
169	folding magnet device	磁扣	CN201120002829.7	new	2011.1.6	2011.9.7	Active	√			
170	spanner tool	转动工具	CN201110041714.3	invention	2011.2.22	2014.8.6	Active	√			
171	folding latch	I型接头	CN201120086481.4	new	2011.3.22	2011.11.9	Active				
172	quick release crank system	童车五通组	CN201120179307.4	new	2011.5.24	2012.1.4	Active				
173	folding frame	I型接头(侧扳)	CN201120228813.8	new	2011.6.23	2012.2.8	Active	√			
174	improved folding latch	E型接头	CN201120179322.9	new	2011.5.24	2012.2.15	Active				

175	a E-BIKE battery installation structure	电池装配	CN201110204315.4	invention	2011.7.20	2013.7.10	Active				
176	bicycle handlebar	握把（避ergon）	CN201110212644.3	invention	2011.7.25	2013.6.5	Active				
177	frame	JIFO变体	CN201130254713.8	surface	2011.8.1	2011.12.21	Active	√			
178	quick folding bicycle	JIFO变体	CN201120278542.7	new	2011.8.1	2012.3.7	Active	√			
179	folding frame	内藏接头(I型)	CN201120278544.6	new	2011.8.1	2012.3.14	Active	√			
180	rotating structure	折叠曲柄	CN201110262043.3	invention	2011.8.31	2013.10.23	Active				
181	handlebar clip device	车把夹持	CN201120332381.5	new	2011.8.31	2012.5.30	Active				
182	bike handlebar	工具内藏把手	CN201120332383.4	new	2011.8.31	2012.5.30	Active	√			
183	pump	气筒	CN201110266186.1	invention	2011.9.7	2014.4.16	Active	√			
184	bike handlebar	握把外观（避ergon）	CN201130315069.0	surface	2011.9.7	2012.3.14	Active				
185	bike frame (IGA)	液压管	CN201130395196.6	surface	2011.10.28	2012.12.12	Active	√			
186	a strengthened Single Armed frame	液压管	CN201120424081.X	new	2011.10.28	2012.7.4	Active	√			
187	installable pump	简易	CN201120467433.X	new	2011.11.18	2012.10.3	Active				
188	vertical folding bicycle	双后杆jifo	CN201120559429.6	new	2011.12.20	2012.10.3	Active	√			
189	quicke clipping device for folding bike	前后轮锁扣	CN201120559409.9	new	2011.12.27	2012.10.3	Active				
190	quicke release crank set	五通组合件	CN201220056696.6	new	2012.2.16	2013.2.20	Active				
191	latch of quick release for folding bike frame	手柄尾端加垫片	CN201220056660.8	new	2012.2.16	2012.10.10	Active				
192	rear rack for e-bike	电池侧置	CN201220106988.6	new	2012.3.20	2012.10.10	Active				
193	folding bike	後扁平-不对称后叉	CN201220145794.7	new	2012.4.5	2013.2.20	Active	√			
194	folding bike	後扁平二-花鼓	CN201220145833.3	new	2012.4.5	2013.2.20	Active	√			
195	middle settled support device for folding bikes	第三轮	CN201220185057.X	new	2012.4.25	2012.12.12	Active	√			

196	locking device for snap joint	卡扣锁紧装置	CN201220185047.6	new	2012.4.25		Active				
197	handlebar installing structure	手柄安装结构	CN201220229284.8	new	2012.5.21	2012.12.26	Active	√			
198	bicycle handlebar	内藏工具	CN201220413603.0	new	2012.8.20	2013.6.5	Active	√			
199	folding bike frame	扁平上补强	CN201220473203.9	new	2012.9.17	2013.4.10	Active				
200		插花装置	CN201220593743.0	new	2012.11.8	2013.6.5	Active				
201	wrench tool	简易Z型工具	CN201320053067.2	new	2013.1.30	2013.8.7	Active				
202	bike sprocket set	小外三速	CN201320053082.7	new	2013.1.30	2013.8.7	Active				
203	bike sprocket set	阶梯轴方案（N+2)	CN201320053084.6	new	2013.1.30	2013.8.7	Active				
204	bike frame(IOS)	IOS	CN201330055266.2	surface	2013.3.4	2013.8.7	Active	√			
205	bike frame (VECTOR)	VECTOR	CN201330055267.7	surface	2013.3.4	2013.8.7	Active	√	√	Banian、FNHON	
206	cable system for folding bike	前加强管穿线	CN201320111888.7	new	2013.3.9	2013.10.23	Active				
207	cable system for folding bike	走线卡止一	CN201320111919.9	new	2013.3.9	2013.10.2	Active	√			
208	handlble assembly	休息把	CN201320111899.5	new	2013.3.9	2013.10.2	Active				
209	cable system for folding bike	内走线之二	CN201320466879.X	new	2013.8.1	2014.2.26	Active	√			
210	rod piece folding joint	防松车架接头	CN201320466896.3	new	2013.8.1	2014.2.26	Active				
211	rod piece folding joint	Greg	CN201320466887.4	new	2013.8.1	2014.2.26	Active	√			
212	handlebard adjusting device	不对称夹持	CN201310692360.8	invention	2013.12.13						
213	headset for frame	三角头管	CN201430046569.2	surface	2014.3.5		Active	√			
214	a bike frame	三角头管	CN201420107271.2	new	2014.3.5	2014.8.6	Active	√			
215	handlebar adjusting device	弯折（前后两瓣、中部单锁）	CN201420107199.3	new	2014.3.5						
216	handlebar adjusting device	弯折、双拉杆	CN201420107275.0	new	2014.3.5			√			

218	folding pedal for bike	自行车折叠脚踏	CN201430046596.X	surface	2014.3.5		Active	√			
219	folding saddle	车辆折叠鞍座（发、实	201410444206.3	invention	2014.8.28						
220	a bike front fork	方形前叉	201420502577.8	new	2014.8.28		Active	√			
221	a folding bike frame	方形管	201420502539.2	new	2014.8.28	2015.1.7	Active	√			
222	a folding bike frame	两下管	201420502538.8	new	2014.8.28		Active	√			
223	a folding bike	异形中管		new	3.18						
224	a folding bike	单拖轮		new	3.18		Active	√			
225	a locking device	卷型车后车架锁紧		new	3.18			√			
226	a cable bunching device	可转动束线座		new	3.18		Active	√			
227	a bike handlepost	方形竖管		new	3.18			√			
228	a folding saddle	鞍座侧翻		new	3.18			√			
229	a bike handlebar	T把		new	3.18		Active				

Illustrations labelled by Number (Column 1)



No. 13

No. 15

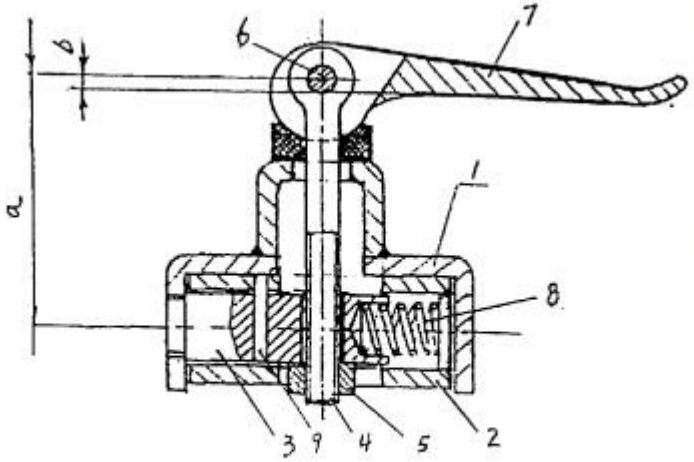


图 1

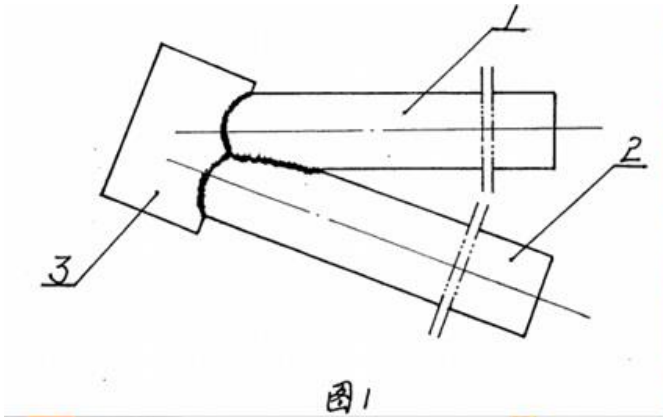


图1

No. 23

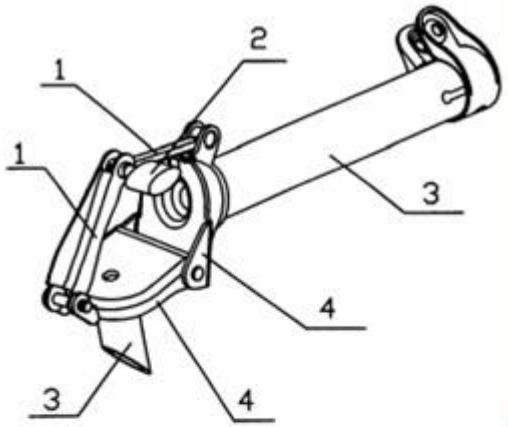
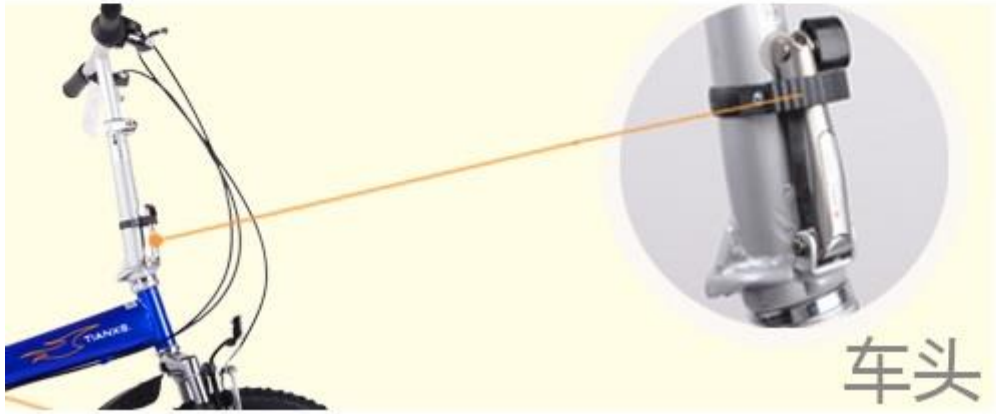


图2

No. 49



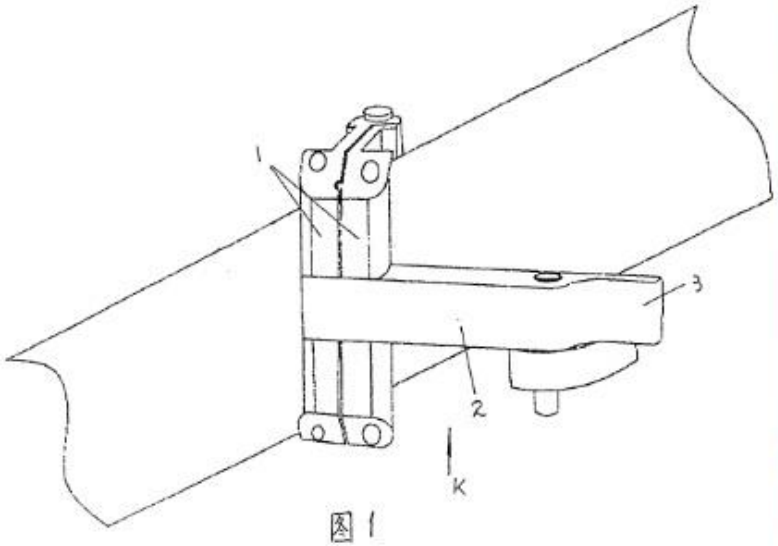
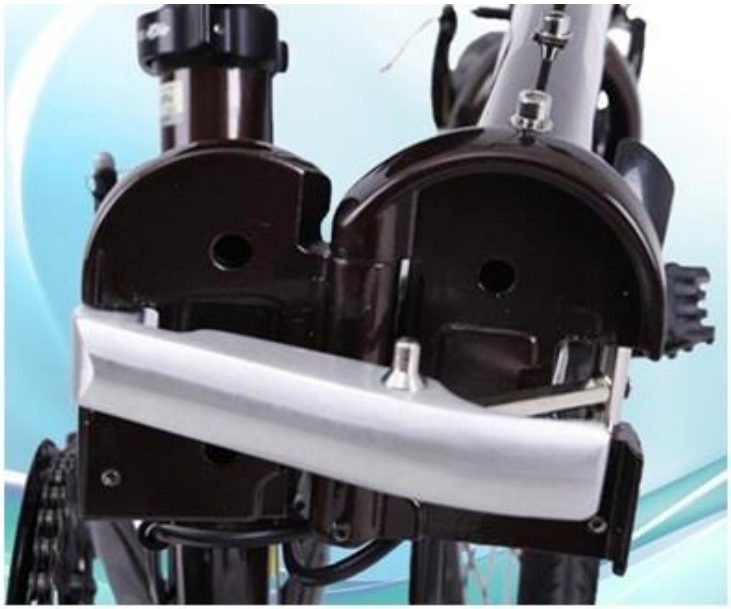
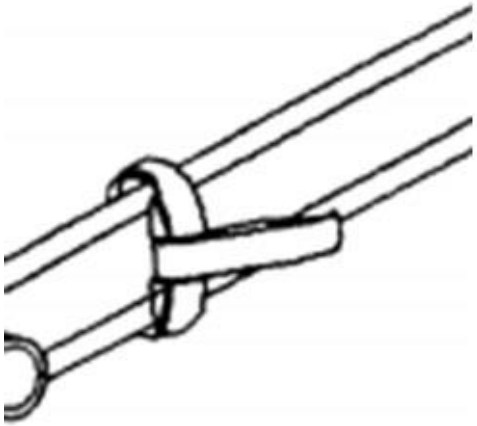


图 1



LANGTU 狼途

No. 50



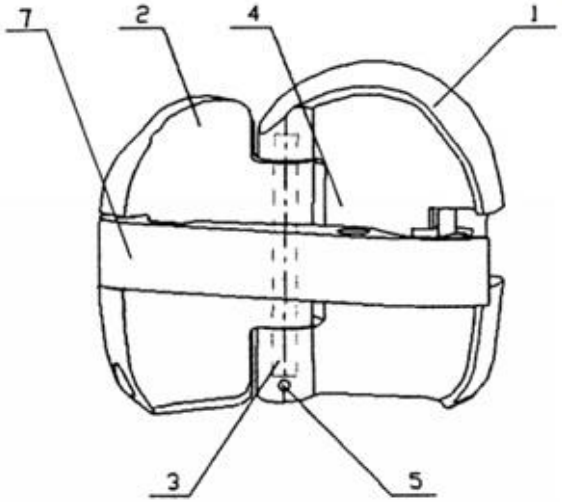
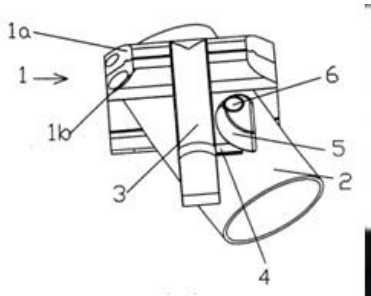


图 2

No. 59


1a
1
1b
6
5
2
3
4

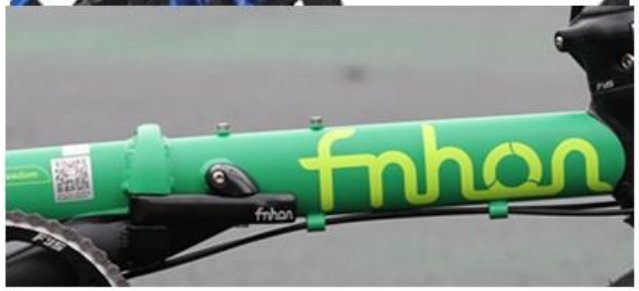

KT060
加长车架锁


KOUAN

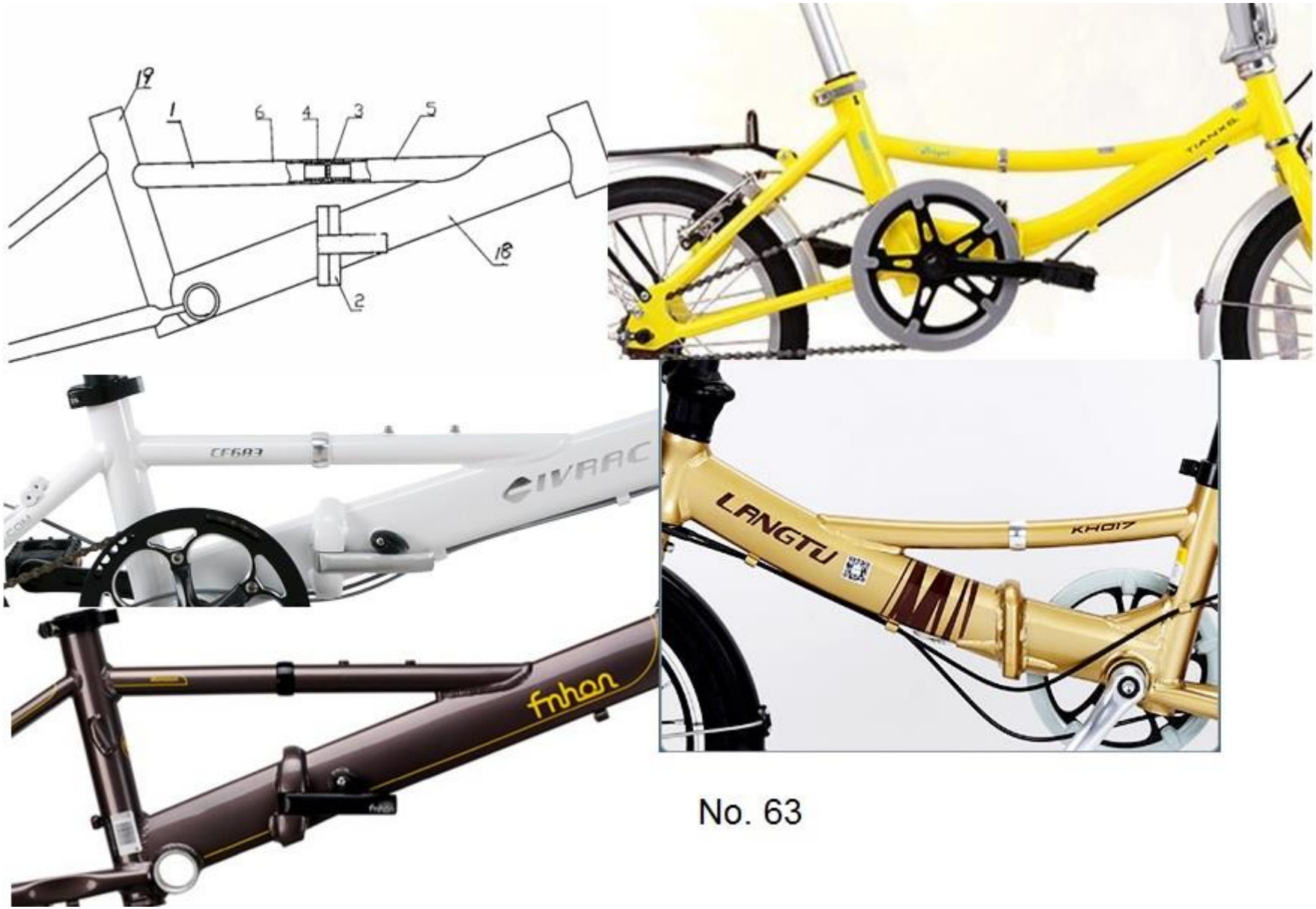

FKT021D


JAVA

No. 60


fnhon
fnhon


TW
TW 2088



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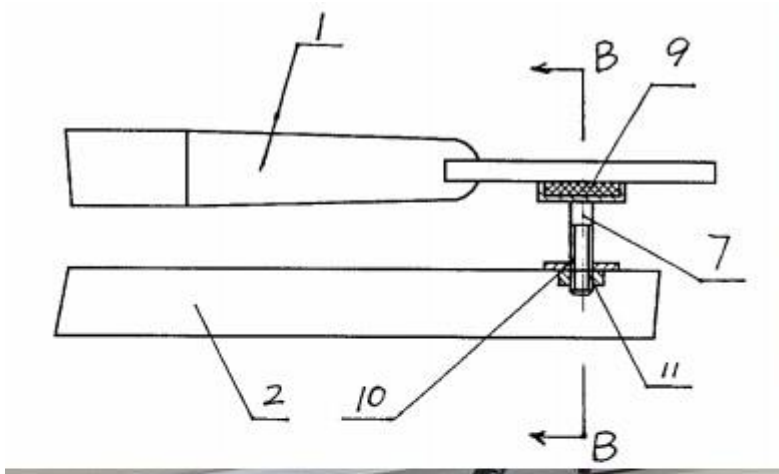

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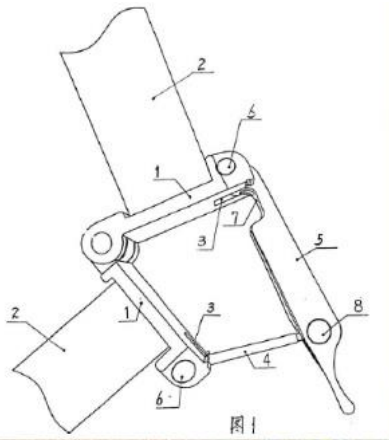
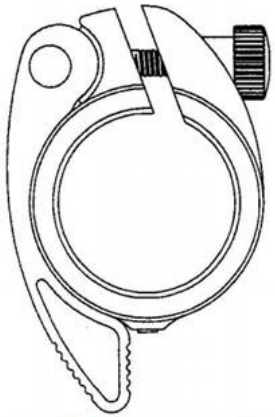


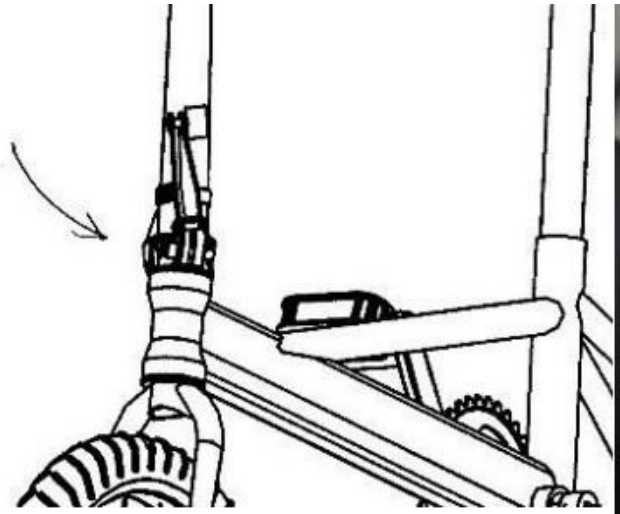
图1

No. 69

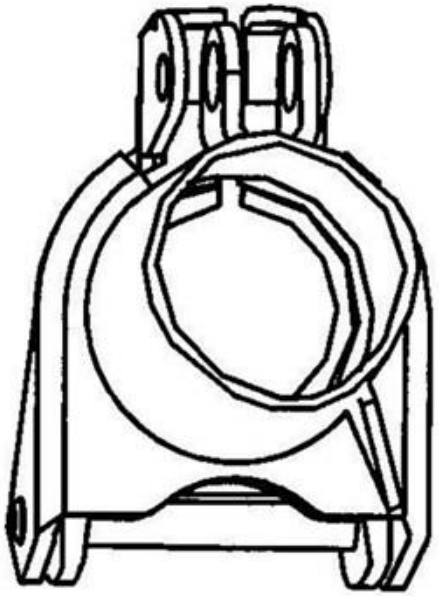


No. 70


立体图1
No. 75



俯视图



No. 76

图 2

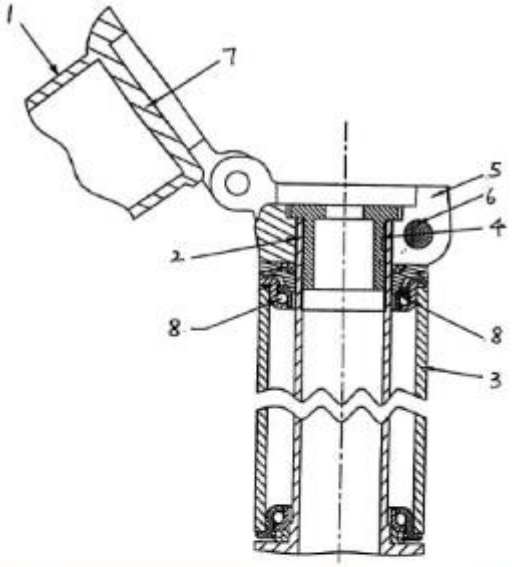
图 3

图 4

图 5

No. 77

叠车(碟刹)



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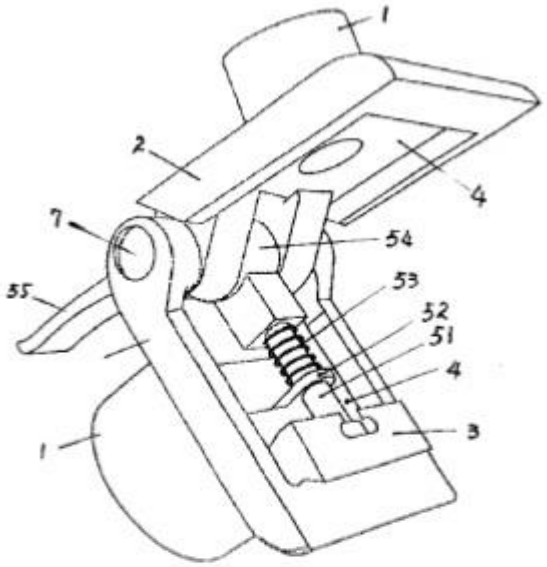
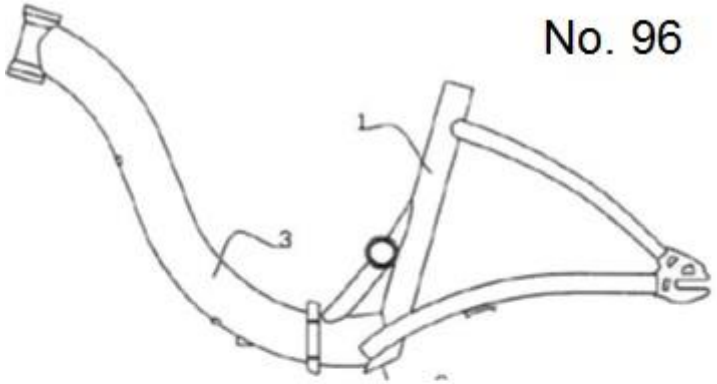
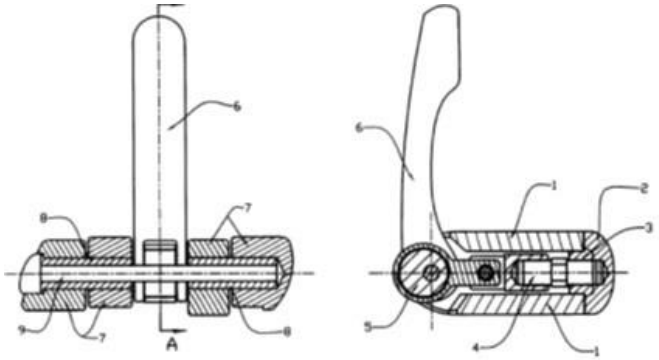


No. 88

No. 96

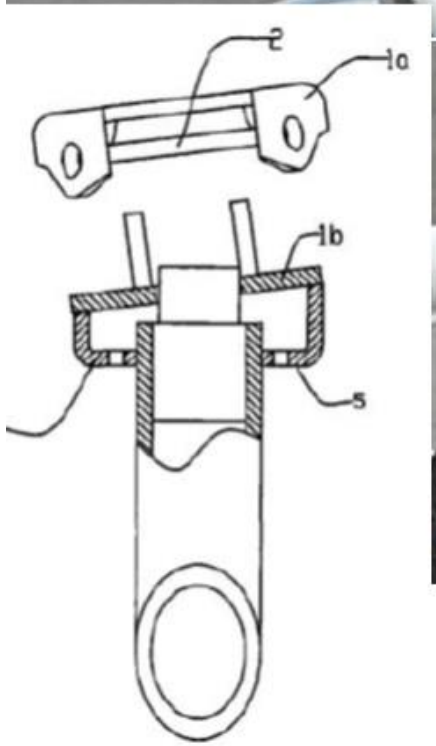




No. 101


YINGQI
FOLDING BIKE

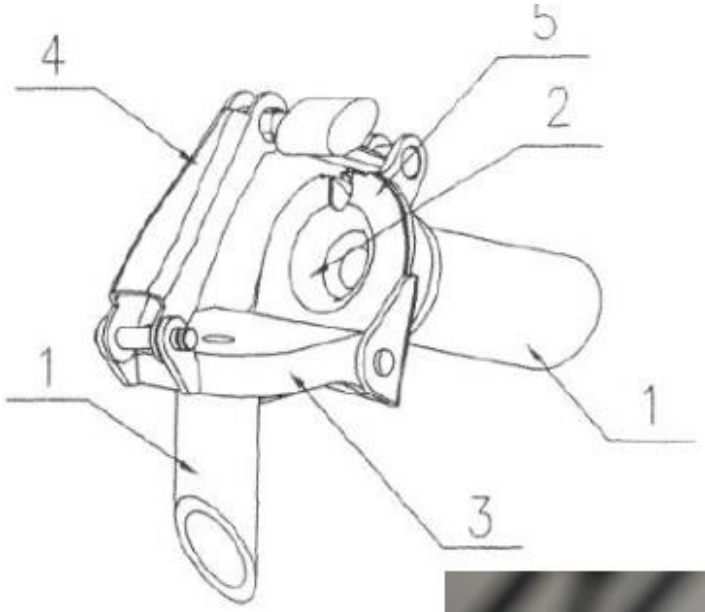

KOUAN


2
1a
1b
5


YINGQI
FOLDING BIKE


TIANXS.

No. 103



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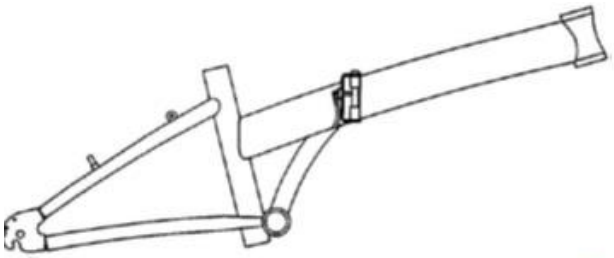
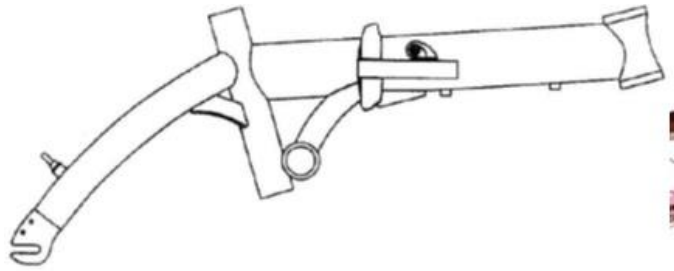




No. 122


No. 123



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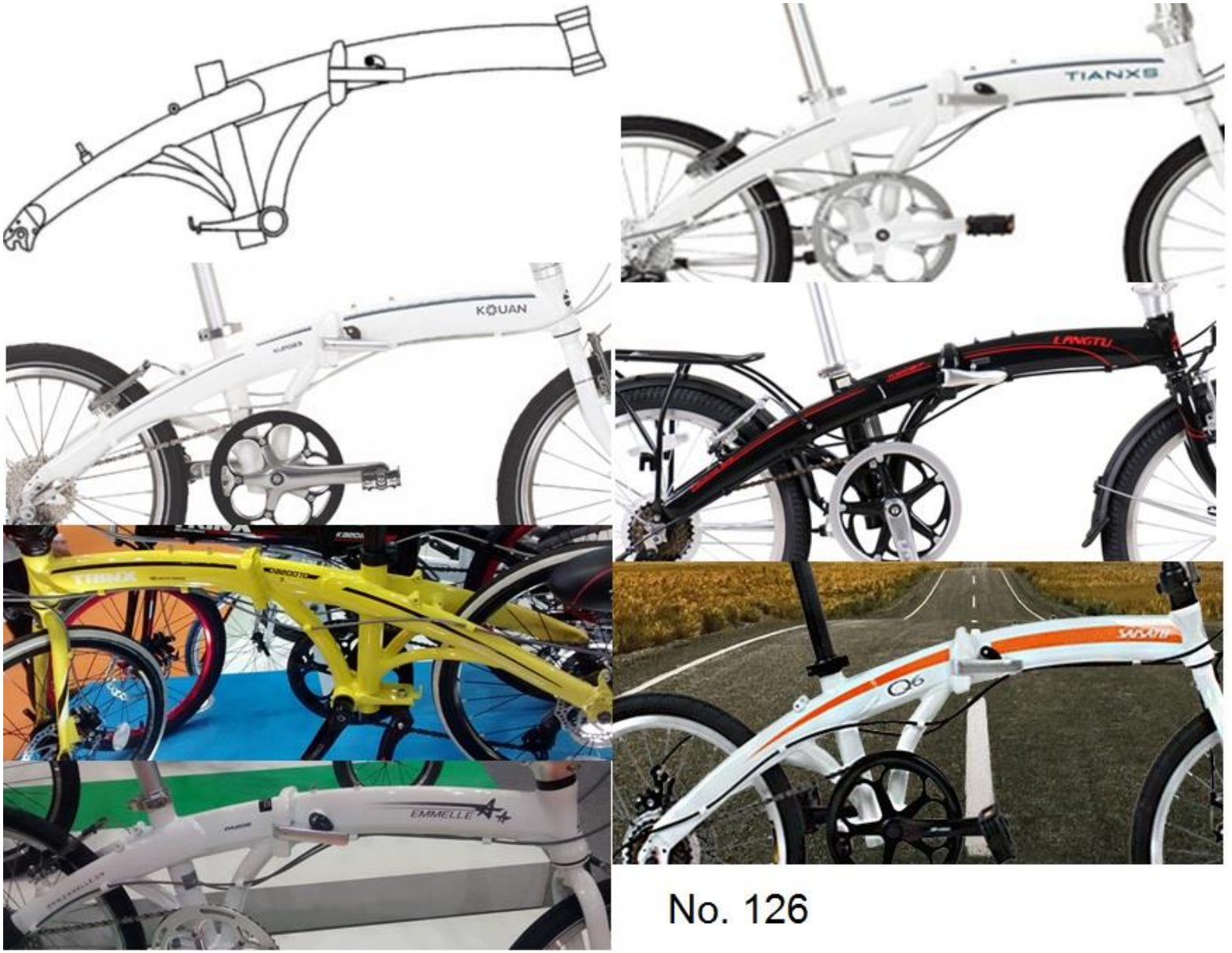

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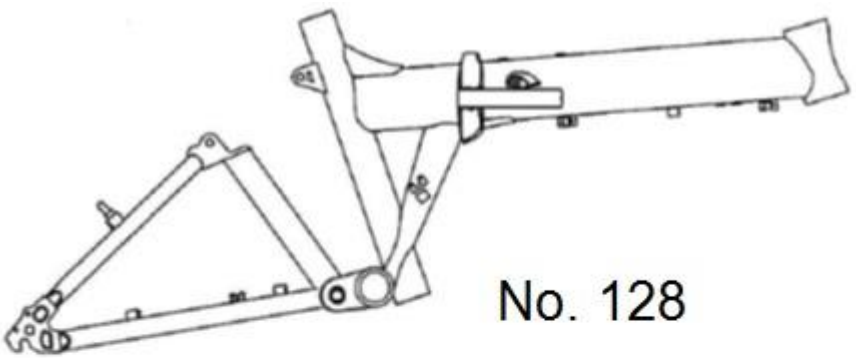

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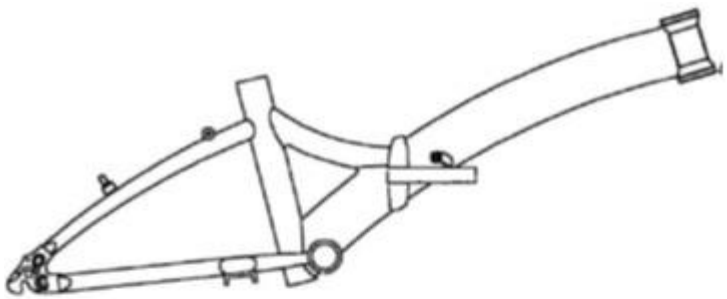

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