The Origin of the Reverse Umbrella

Jyhjeng Deng

Industrial Engineering and Management Department, DaYeh University, Taiwan

E-mail: jdeng@mail.dyu.edu.tw

Abstract

There has been much online controversy and discussion among members of the Taiwan umbrella industry regarding who was the original inventor of the reverse umbrella, since Kazbrella, a British brand, was successfully launched. The purpose of the reverse umbrella is to keep the wet side of the umbrella away from the user on rainy days. Some people argue that the Taiwanese inventor Li Sheng Chun, the owner of Taiwanese patent I254619, was the originator of the reverse umbrella, although he did not put his patent into commercial practice. This paper traces the origin of the reverse umbrella and surveys patent databases in Taiwan, the USA and Europe. Based on the timeline of the application dates of patents, the trend of evolution in the Creax innovation suite is used to indicate the status of trends of dynamization of patents. It is discovered that the dynamic structure of the Kazbrella based on US8893736 is far more advanced than that of I254619. I254619 includes a sliding ring feature, which is connected with two honeycombs, sliding along the central spine of the umbrella. The honeycombs trigger the umbrella to fold inside out. Note that the umbrella is not foldable. The US8893736 umbrella, in contrast, is foldable with three moveable parts, including the upper crown, outermost section, and inner section, which are connected to the central spine and a pulley system to control the relative movement of the upper crown and inner section. Obviously the patent US8893736 has a higher status, approaching ideality in terms of the trend of object segmentation.

1. Introduction

Umbrellas are used on rainy days to partially cover the body and have been in use for thousands of years of human history (Umbrella History, 2017). As human society evolves, people have started to find out that more functions should be added to the umbrella. For example, when someone gets into a car outdoors during rainy weather, it is desirable to keep the umbrella dry in order to avoid spoiling the carpet or important papers inside the car. But how can a wet umbrella be kept dry? It seems like an impossible mission. From the perspective of the TRIZ physical contradiction, the umbrella must be wet because the weather is rainy; however, it must also be dry because we do not want it to spoil the things we like. This contradiction is solved by the principle of space separation (Altschuller, 1984; Bukhman, 2012). Due to the rainy weather, the outer surface of the outer canopy of the umbrella must be wet; with regard to the things we like, the inner surface of the inner canopy of the umbrella must be kept dry. Principle number one, segmentation, of the 40 inventive principles is applied to solve the contradiction. The original canopy is segmented into two: an outer canopy and an inner canopy. In this way, raindrops are kept in the pocket formed by the outer canopy (which is collapsible) when the umbrella is closed by pulling the spine towards to the user. This procedure of closing the umbrella is just the reverse of the ordinary method. In this paper, we will discuss the origin of the reverse umbrella to settle the issue raised on the Internet regarding who was the originator of the reverse umbrella (Who Invented the Reverse Umbrella, 2017). Through the analysis of the patents for reverse umbrellas, the trend of dynamization is shown (Yoon and Kim, 2011).

The rest of the paper is organized as follows: Section 2 provides a literature review on the reverse umbrella and trend of evolution. Section 3 gives adetailed description of the technology used in reverse umbrellas. Section 4 concludes the paper.

2. Literature review

There is hardly any literature concerning the reverse umbrella in research literature databases in either English or Chinese. However, some patents exist in the patent database. There are three kinds of reverse umbrellas shown on the Internet, and their brand names and inventors can be obtained; they are 李盛群 (Li Sheng-Chiun) (Who Invent Reverse Umbrella, 2017), 神美傘 (Shen-Mei umbrella, 2017), and Jenan Kazim (Reverse Folding Umbrella, 2017). The corresponding patents are TWI254619 (Li, 2006), TWM522603 (Wu, 2016), GB2346556 (Kazim, 2001), US8893736 (Kazim, 2014), and US20150265013 (Kazim, 2015). Using the backward and forward citations of those patents in the European patent database (Espacenet Patent Search, 2017), it is easy to derive the cited and citing documents, as shown in Tables 1–3. Note that there are no citations for TWI254619 and TWM522603, no forward citations for US8893736, and no backward citations for US20150265013. Each patent states the filing date and whether the published patent (kind code A) is followed by an approved patent (kind code B); the approved patent is stated beside the published patent. Tables 1–3 show the technology history of the reverse umbrella. It is clear that the earliest attempt to solve the problem was made in 1968 with the patent GB1233564. The patents show that nations like the UK, Italy, Japan, the USA, Taiwan, and China are involved in tackling the reverse umbrella problem. Due to the limited paper length, those patents will not be further pursued.

After discussing the patent search for the reverse umbrella, the paper turns to the trend of evolution. One of the main tools in the TRIZ is the ideality concept, where ideality = conceived benefit/(cost + harm) (Mann, 2002). The general TRIZ trend on ideality is that most systems increase their ideality by changing during each phase of the trend, from low ideality to high ideality. There are 35 trends in the trend of evolution (Mann, 2002). For example, in the trend of dynamization, the phases of the technological system could be immobile, single joint, multiple joints, completely flexible, liquid/gas, and field. In the trend of object segmentation, the phases of the technological system could be monolithic solid, segmented solid, highly segmented solid, solid granules, solid powder, monolithic liquid, segmented liquid, aerosol, gas, plasma, field, and sparse field (Creax Innovation Suite, 2001). By identifying the current status of the technological system, a possible jump forward can be sought.

Lastly, the product architecture (Pahl and Beitz, 1999; Fiorineschia, Frillicia, Rissonea, and Cascinib, 2015) can be useful in analyzing the product (in our case, the reverse umbrella) and grouping its components into different modules. The product architecture of a product is composed of two layers, one for components and the other for their functions, and the components and functions are linked together so that module can be easily identified through functions. A sample product architecture is shown in Figure 1.

Table 1 Citation of GB2346556

Kazbrella patent	Backward citation (cited documents)	Forward citation (citing documents)
GB2346556 filing date: 2000-02-14	GB1233564 (GB2019210) filing date: 1968-02-14	US20150265013 (GB2507649) filing date: 2013-09-27
	GB1581103 filing date: 1978-05-12	US2013092206 (US8733378) filing date: 2012-03-22
	GB2239173 filing date: 1989-12-19	US2012240969 (US8893736) filing

		date: 2010-09-20
	GB2320893 filing date: 1997-01-06	US2010031984 (US8011379) filing date: 2008-02-01
	GB2329123 filing date: 1997-09-10	US2006016465 (US7523759) filing date: 2005-07-26
	EP0596180 filing date: 1992-11-02	
	US3935874 filing date: 1975-12-18	
	US4456023 filing date: 1981-07-25	
	WO8703460 filing date: 1985-12-12	
	WO9748303 filing date: 1996-06-17	

Table 2 Citation of US8893736

Kazbrella patent	Backward citation (cited documents)	Forward citation (citing documents)
US8893736 filing date: 2010-09-20	US3435836 filing date: 1967-06-20	
	US3534752 filing date: 1969-02-03	
	US3709238 filing date: 1971-03-26	
	US4007753 filing date: 1976-01-22	
	US2004211451 filing date: 2004-04-27	
	US2007089768 (US8733378) filing date: 2005-10-22	
	US2007169801 (US7484518) filing date: 2007-01-22	
	JPH0467803 (JPH088882) filing date: 1990-07-06	
	JPH0856725 filing date: 1994-08-19	
	JP2007181657 (JP4108720) filing date: 2005-12-09	
	JP2013141462 (JP5912535) filing date: 2012-01-06	

Table 3 Citation of US20150265013

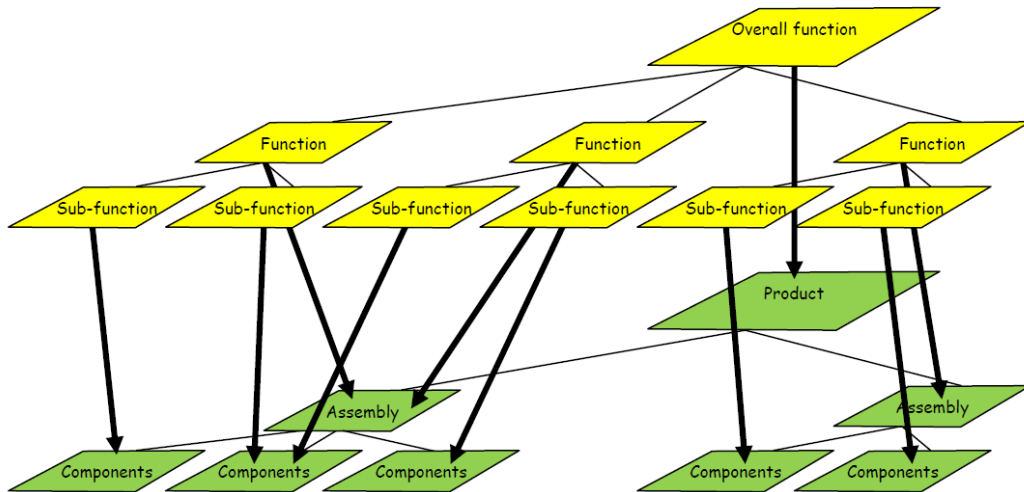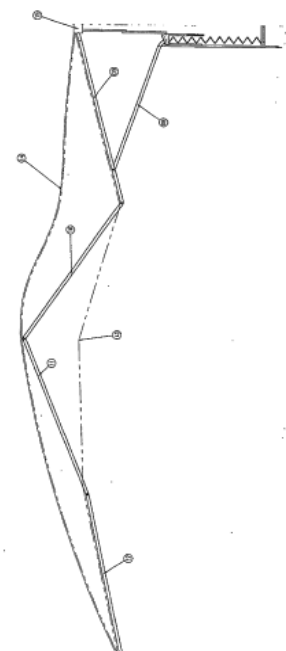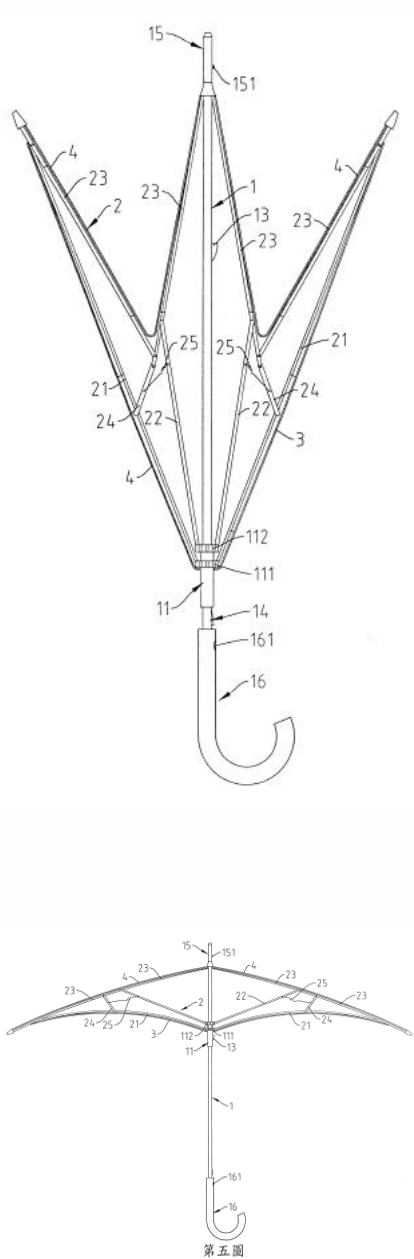| Kazbrella patent	Backward citation (cited documents)	Forward citation (citing documents)
US20150265013 (GB2507649) filing date: 2013-09-27		US9629426 filing date: 2016-05-04
		US9538819 filing date: 2016-04-19

Figure 1. Product architecture in terms of functional elements and physical elements.
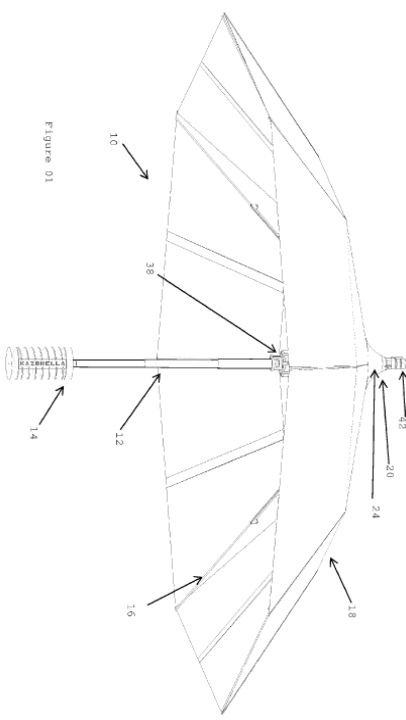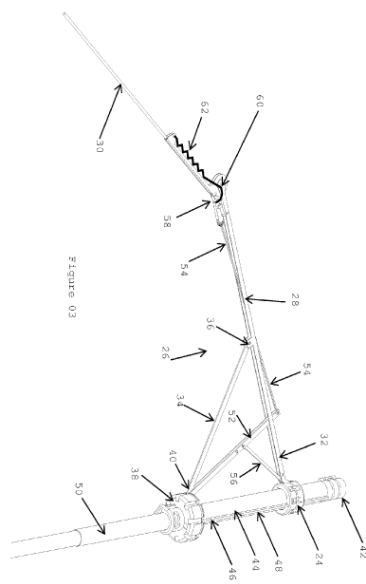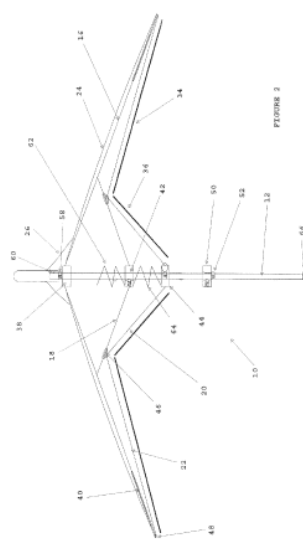
3. Technology of Reverse Umbrella

Due to the limit on the paper length, descriptions of the five patents listed in the previous section will be given in detail and are shown in Table 4.

Table 4 Technological descriptions of the patents.

Patent	filing date	Technological description	Figures	Status in the trend of dynamization
GB2346 556	2000-02-14	The compact umbrella has one canopy fabric and uses several sets of four studs, 9–12, a spoke, 08, and air tubes, 13 and 14, to make the canopy fold in such a way that its dry region is on the outside. The air tube is activated by a plunger to right itself when blown inside out.		The stud has multiple joints.

TWI254 619	2004-09-01	There are two canopies, the inner canopy, 3, and the outer one, 4, where the outer canopy, 4, is foldable so that the outside of the outer canopy, 4, can form a cavity to collect raindrops. The extension of the two canopies is operated by a sliding ring, 11, with two honeycomb structures attached therein.		In the structure with the sliding rim, 11, the sliding rim is immobile.

US8893 736	2010-09-20	The compact umbrella has a main canopy, 18, and a collapsible canopy framework, 16, including a pulley system housing, 42, upper crown, 24, and lower crown, 38. The pulley systems trigger the relative movement of the upper crown and lower crown. An inner strut, 28, is connected to the upper crown, whereas the outer strut, 30, is remotely connected to the lower crown with an actuation system, 52.		There are two crowns, an upper crown and a lower crown, sliding on the central spine. This makes the collapsible canopy framework run smoothly.

Figure 01

Figure 03

US2015 0265013	2013-09-27	There is one main canopy, 24, and optional internal canopies, 34 and 36. There are also four sliding supports, a first, 38, a second, 42, a third, 44, and a fourth, 50, which are connected to the central spine, 12. The fourth sliding support, 50, contains a pulley system which controls the movement of the first and second sliding supports. In addition, a sliding strut, 40, and a sliding pivot, 46, are provided to allow the umbrella to open and close more smoothly.		There are four sliding supports on the central spine, where the fourth sliding support contains the pulley system.
TWM52 2603	2015-11-03	This compact umbrella uses only one canopy. However, the outside of the canopy can be folded three times such that it forms a cavity to retain raindrops. Beside the main rib, 23, there are three supporting ribs, a first, 24, a second, 25, and a third, 26, respectively.		The rib structure has multiple joints.

Looking at the Table 4, several key findings can be observed. First, only patent TWI254619 tackles the raindrop problem using a regular size umbrella, while the other four patents, GB2346556, US8893736, US20150265013, and TWM522603, are for compact umbrellas. Second, the patent TWI254619 does not provide rigid proof that its linkage of the struts can work properly in opening and closing the umbrella. Besides, there is no prototype to demonstrate its functionality. Third, although there are three patents for compact umbrellas from Kazbrella, GB2346556, US20150265013, and US8893736, there is no commercial product yet. Kazbrella has only presented a reverse umbrella for a regular size umbrella, not a foldable umbrella. This makes us curious about why there is no commercial foldable reverse umbrella from Kazbrella, even though it has three patents on it. Perhaps the technology presented in the patent is difficult or expensive to make. On the contrary, patent TWM522603 has been put on market as a commercial product, the compact reverse umbrella. Investigating the patent GB2346556 shows that using an air tube to self-right the umbrella seems implausible. Fourth, two canopies are used in the regular size umbrella, whereas only one canopy can be used in the compact umbrella. Fifth, there are two types of evolutionary trend in the case of the umbrella: one is the trend of dynamization and the other is the trend of object segmentation. In the dynamization trend, the stud connected to the central spine evolves from immobile (TWI254619) to single joint to multiple joints (US20150265013). In the trend of object segmentation, the sliding support evolves from monolithic solid (TWM522603) to segmented solid (US8893736).

To further assist the understanding of patents TWI254619 and US8893736, their function attribute models (Mann, 2002) from the first independent claims are stated. Meanwhile, their working principles and product architectures will be stated in sequence. The function attribute model is augmented from the function model with attributes of parts specified on the boundaries of the parts. The function attribute model of the first independent claim of TWI254619 is shown in Figure 2. The attribute of the object is depicted in the

corner of the box of the object. For example, two attributes, namely the upper and preset positions, are attached to the main support, 2, in the top left of Figure 2. The first independent claim is stated in the format of a function attribute model as follows, and it can be read together with the umbrella structure in Figures 3 and 4.

A main pole, 1, is set up with a sliding ring, 11, where the sliding ring, 11, is set up with the first honeycomb, 111, and second honeycomb, 112. The main pole, 1, is set up with the shaft, 14, and end pole, 15, at either end. Thereby, both the shaft, 14, and the end pole, 15, are set up with buckles, 141, respectively, to set up with a handle, 16, for practical situations. The umbrella framework is composed of an inner brace, 21, and an inner framework, 22, where the inner brace, 21, is set up with the first honeycomb, 111, and the inner framework, 22, is set up with the second honeycomb, 112, in a radial state. A folding brace, 23, is set up at the bottom end of the end pole, 15. A moving brace, 24, pivots on the middle part of the folding brace, 23. An inner canopy, 3, is combined with the inner brace, 21. An outer canopy is combined with the folding brace, 23. Due to the interchangeable position of the handle, 16, between the shaft, 14, and the end pole, 15, through the buckles, 141, the handle, 16, can be placed at the shaft, 14, during normal weather whereas the handle, 16, can be placed at the end pole, 15, to collect raindrops during rainy days.

In Figure 3, the umbrella is in normal mode, where it is expanded to protect the user. In this case, the handle, 16, is placed at the shaft, 14. On the other hand, in raindrop-collection mode, the handle, 16, is switched to the end pole, 15, so that the outer canopy can hold the raindrops as shown in Figure 4. In practice, it is not necessary to install two buckles, 141, at both the shaft, 14, and the end pole, 15. Only one buckle, 141, is needed at the shaft, 14. When the user wants to collect the raindrops, he or she just pulls the sliding ring, 11, towards the handle, 16, so that the outer canopy, 4, can collect them. In this way, the operation of switching the handle, 16, from the shaft, 14, to the end pole, 15, can be avoided. Indeed, Kazbrella uses this method to collect the raindrops.

Figure 5 shows the function attribute model based on the first independent claim of US8893736. It can be read together with the umbrella structure shown in Figures 6–8. Figure 6 shows the open position of the umbrella. Figure 7 shows that the outer strut, 30, is pivoted clockwise at the hinge, 60, when the upper crown, 24, is pulled close to the lower crown, 38, to close the umbrella. In this way, the outer strut, 30, is bent inward and is surrounded by the inner strut, 28, so that only the dry side of the canopy is shown outside, as shown in Figure 6. The independent claim 1 is stated below.

This is a foldaway umbrella that is moveable between an open configuration and a closed configuration. Said umbrella comprises: a) a central spine, 12; b) an upper crown, 24, that is moveable with respect to the central spine, 12; c) a lower crown, 38, that is fixed with respect to the central spine, 12; d) a canopy framework, 16, connected to the upper crown, 24, and the lower crown, 38; and e) a main canopy, 18, covering the canopy framework, 16; this main canopy, 18, has its inside face closest to the canopy framework and its outside face furthest from the canopy framework, so that movement of the upper crown, 24, from a position far from the lower crown, 38, to a position close to the lower crown causes the canopy framework and thus the main canopy to move from the open configuration to the closed configuration, wherein the main canopy, 18, is folded inside out such that only the inside face of the main canopy is exposed and movement of the upper crown from a position close to the lower crown to a position far from the lower crown causes the canopy framework and thus the main canopy to move from the closed configuration, where the main canopy is folded inside out such that only the inside face of the main canopy is exposed, to the open configuration, where the central spine, 12, comprises an outermost section, 44, and an inner section, 50; the inner section, 50, is movable inside the outermost section, 44; the lower crown, 38, is fixed to the outermost section of the central spine, and the upper crown, 24, is moveable with respect to the outermost section, 44, of the central spine 12, and movement of the inner section, 50, of the central spine, 12, out of the outermost section, 44, of the central spine results in the movement of the upper crown from a position close to the lower crown, 38, to a position far from the lower crown, 38, and the inner section, 50, of the central spine, 12, is connected to the upper crown, 24, by a string and pulley system, 42.
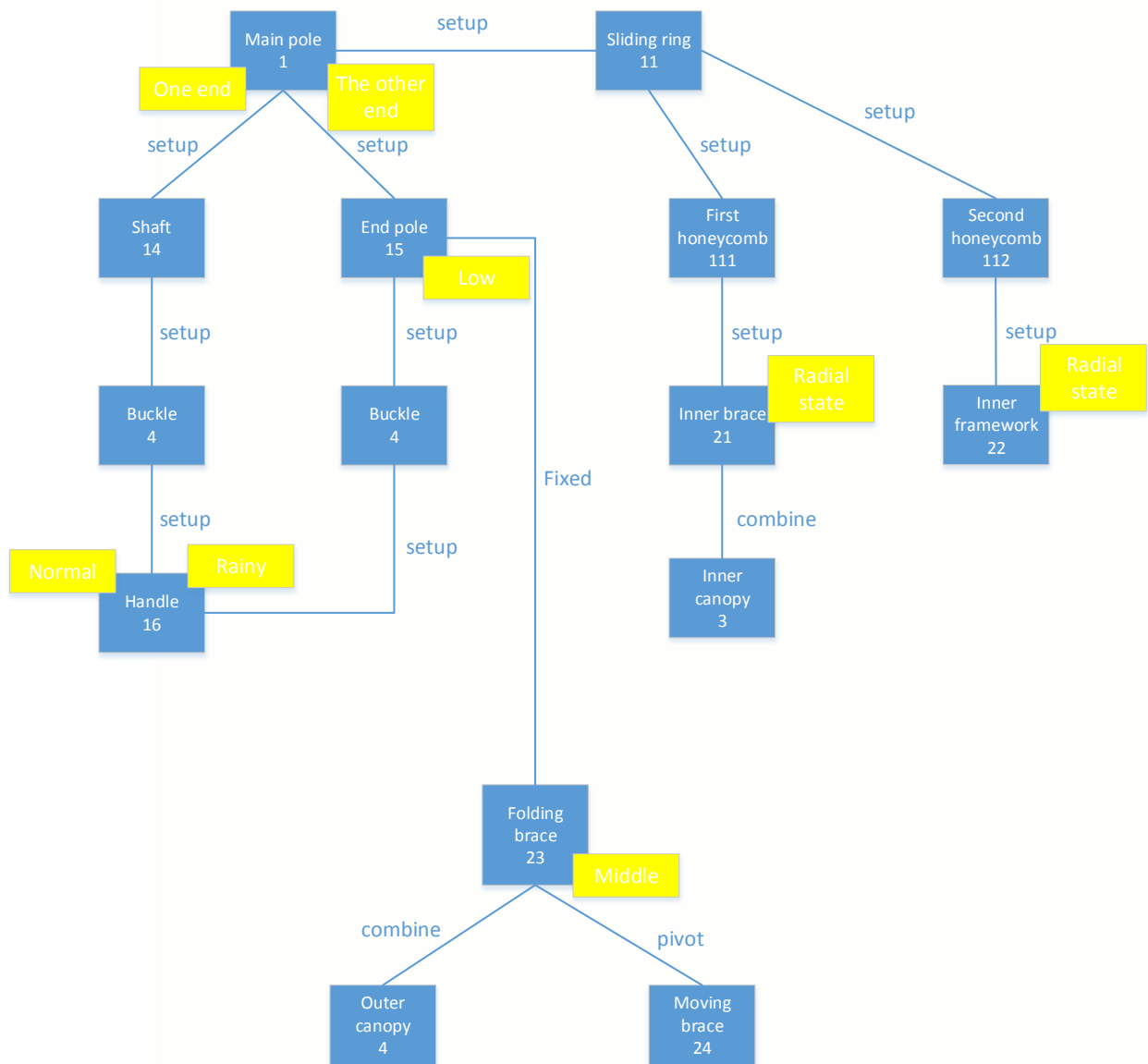
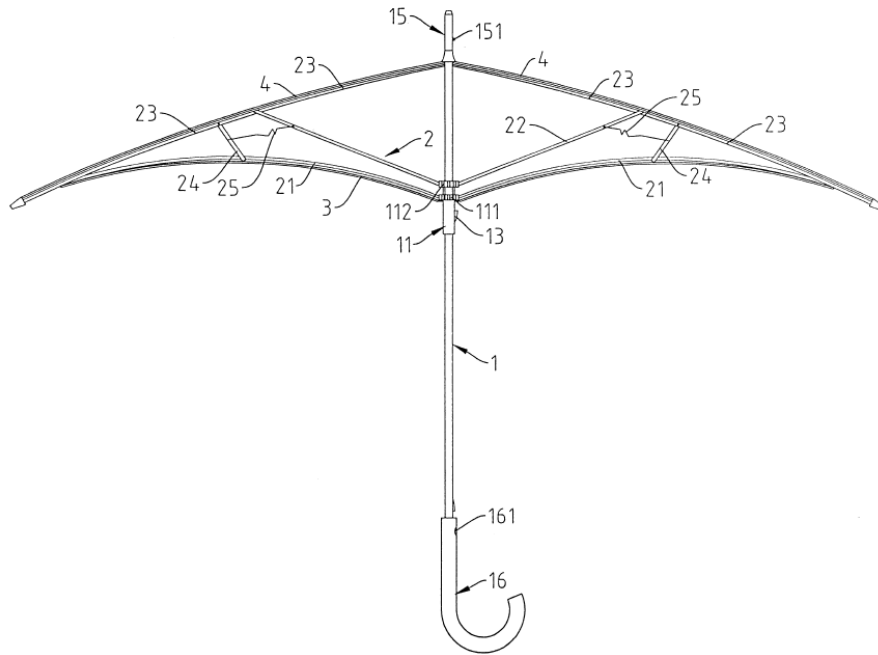**Fig. 2** Function attribute model of the first independent claim of TWI254619

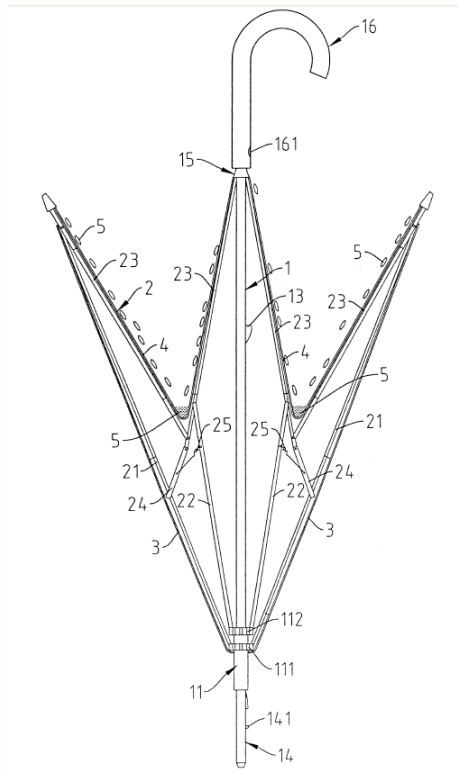**Fig. 3** An umbrella in normal usage

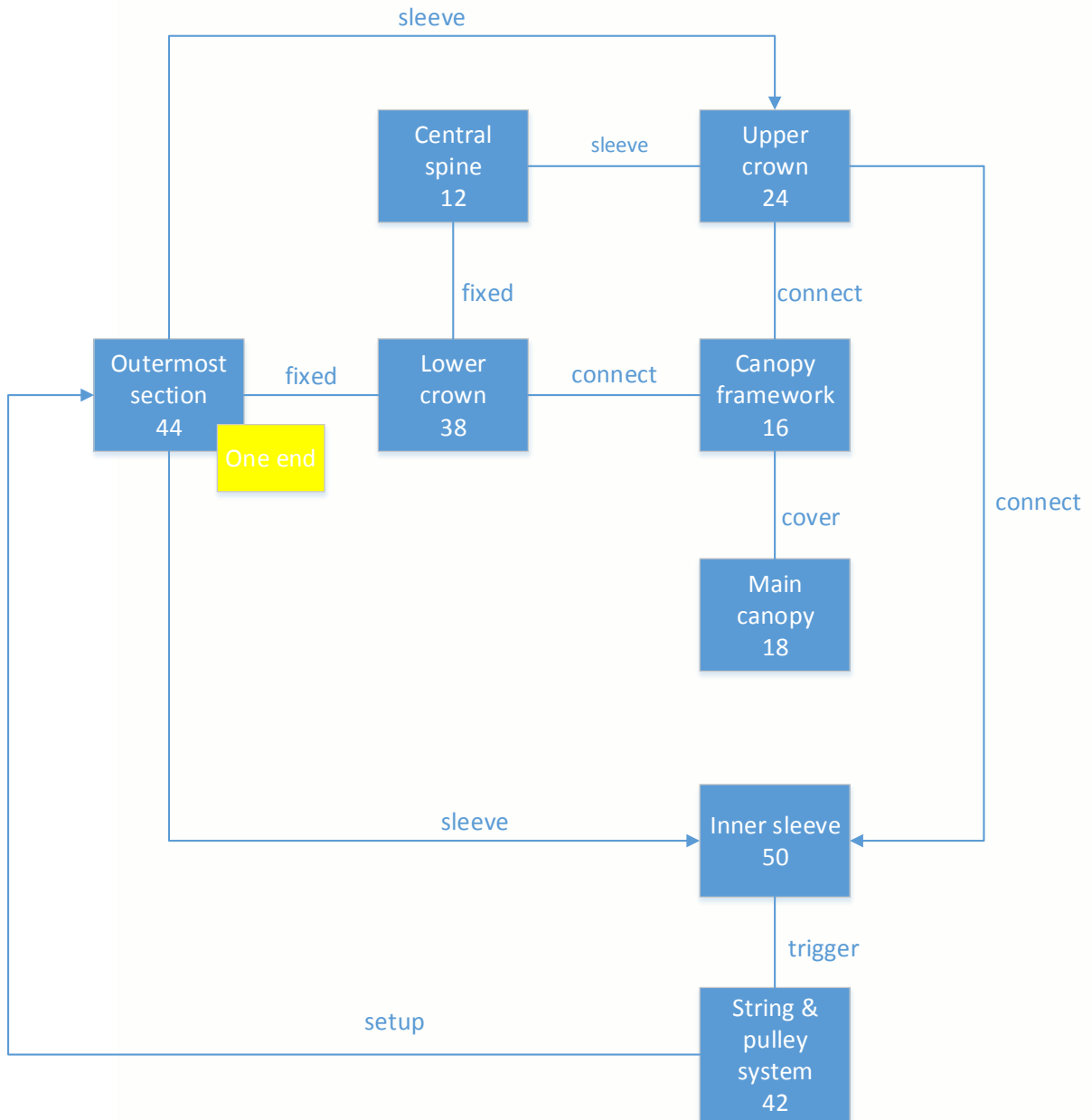**Fig.4** An umbrella in raindrop-collection mode

Fig. 5 Function attribute model of the first independent claim of US8893736
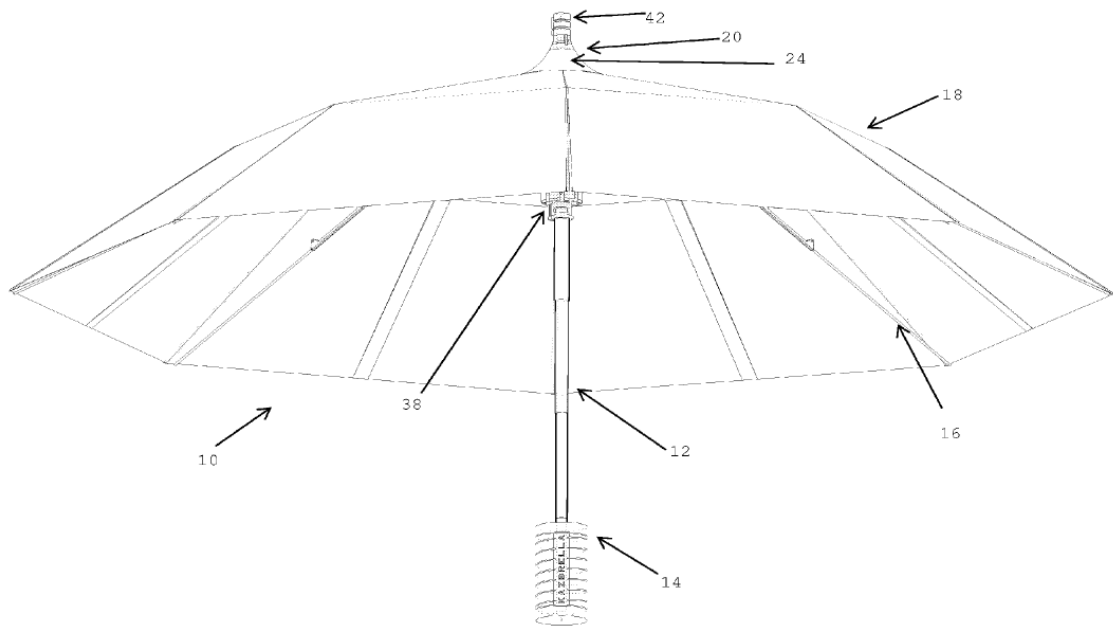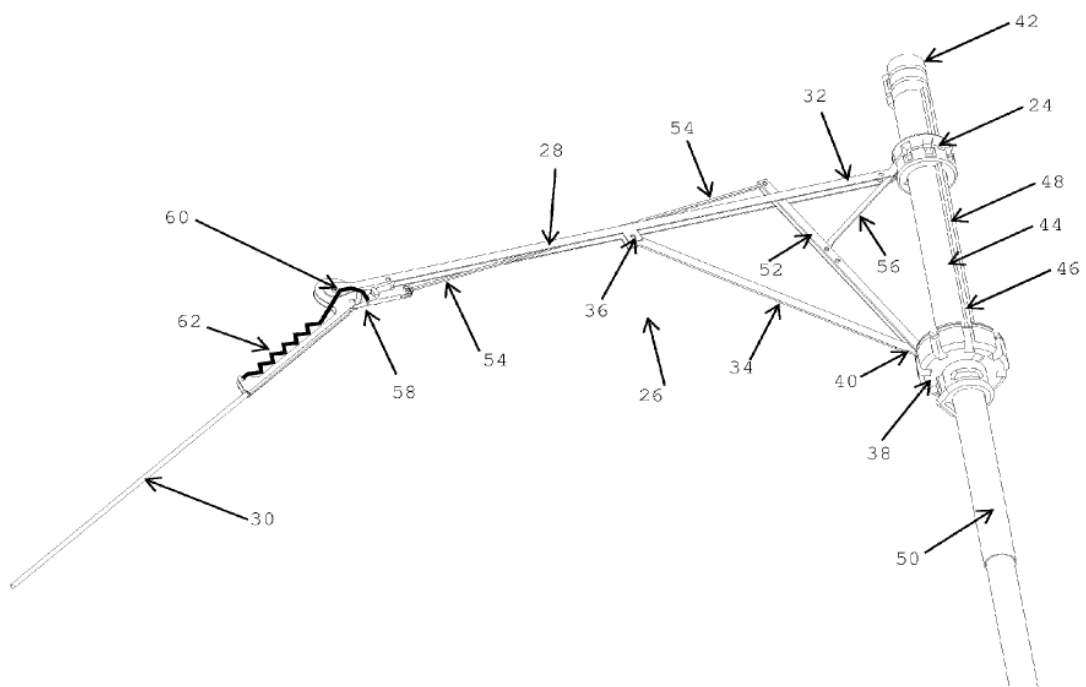
Fig. 6 Umbrella in open position
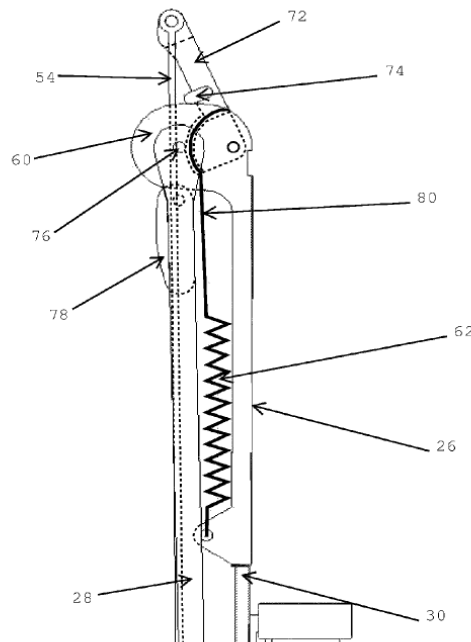

Fig. 7 Umbrella framework

Fig. 8 Umbrella in closed position

The working principle of TWI254619 is stated as follows. A folding brace, 23, is pulled by the inner brace, 21, and inner framework, 22, which are radially spread out from the first and second honeycombs, 111 and 112, when the sliding ring, 11, slides down the handle, 16. In this way, a V-shape is formed in the outer canopy, 4, so that pockets are formed to collect the raindrops.

Pahl and Beitz (1999) define the product architecture as a scheme showing the relationship between the function structure of a product and its physical configuration; a graphical representation of this definition is shown in Figure 1. As seen in Figure 1, there are two layers in the graph: one concerns the components and the other concerns their corresponding functions. It is possible to associate two functions with a sub-assembly. When the components become larger, the graph will become messy. In cases where each component and sub-assembly has only one corresponding function, then it may be better to separate the two layers into two separate graphs. Thus for the sake of clarity of presentation, we will separate the components and functions into two different graphs. They are presented in Figures 9 and 10 for the product architecture of TWI254619. It can be clearly seen in Figures 9 and 10 that the shaft and the end pole have identical functions. Thus one of them, namely the end pole, and its associated buckle can be trimmed.
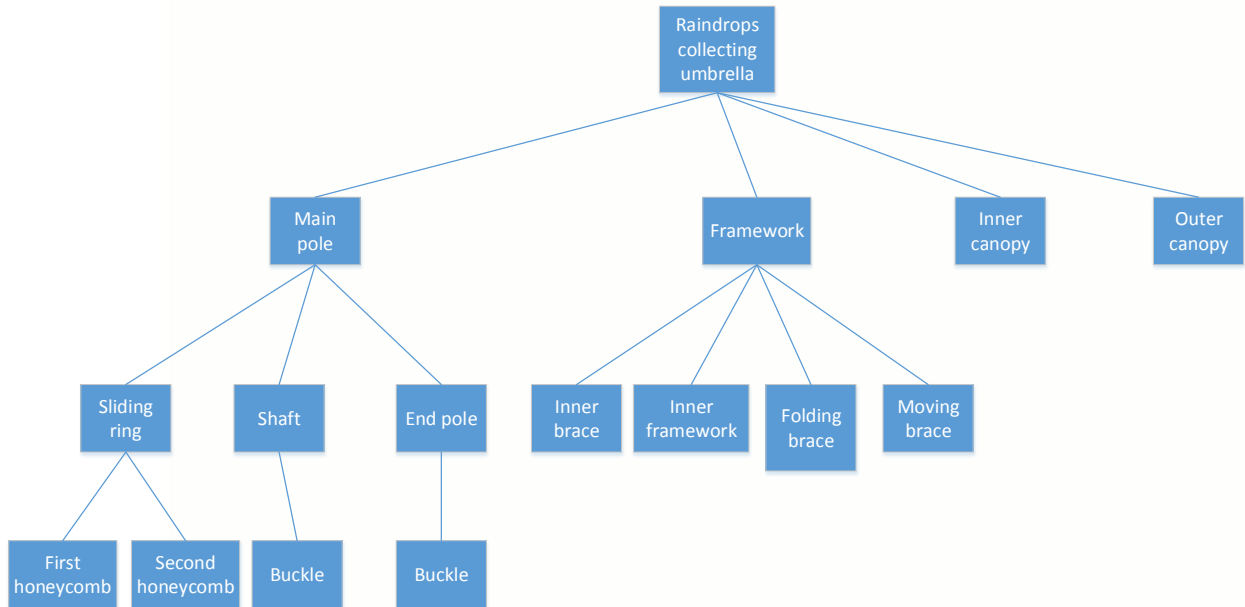
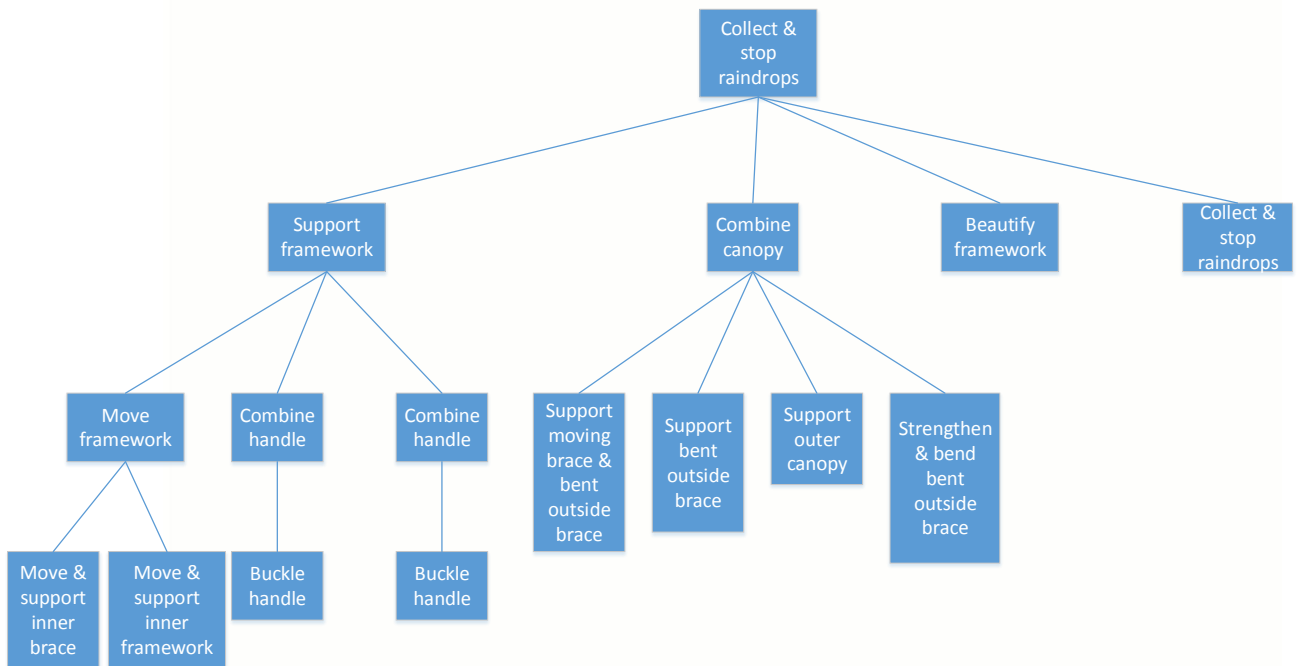**Fig. 9** Product architecture of TWI254619 – components

Fig 10 Product architecture of TWI254619 – functions

The working principle of US8893736 is that the upper crown, 24, is pulled close to the lower crown, 38, so that the push and pull rod, 54, will be drawn near to the central spine, 12. Then, the outer strut, 30, rotates around the hinge, 60, clockwise so that the inner strut, 28, surrounds the outer strut, 30. In this way, the dry side of the canopy will always be on the outside, so that raindrops will be kept within the foldaway umbrella. The component and function graphs of the product architecture of US8893736 are shown in Figures 11 and 12, respectively.
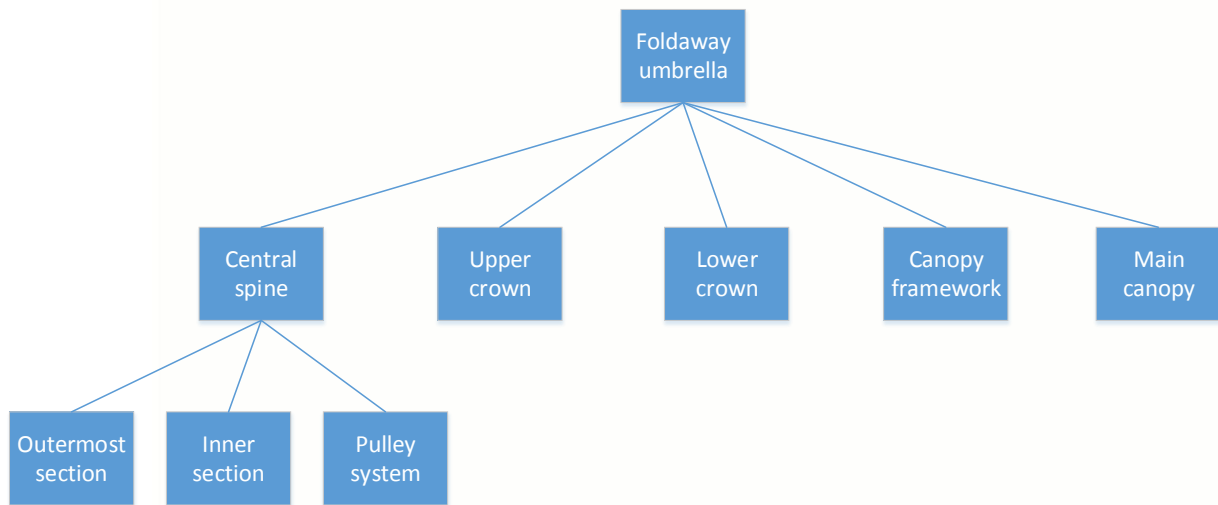
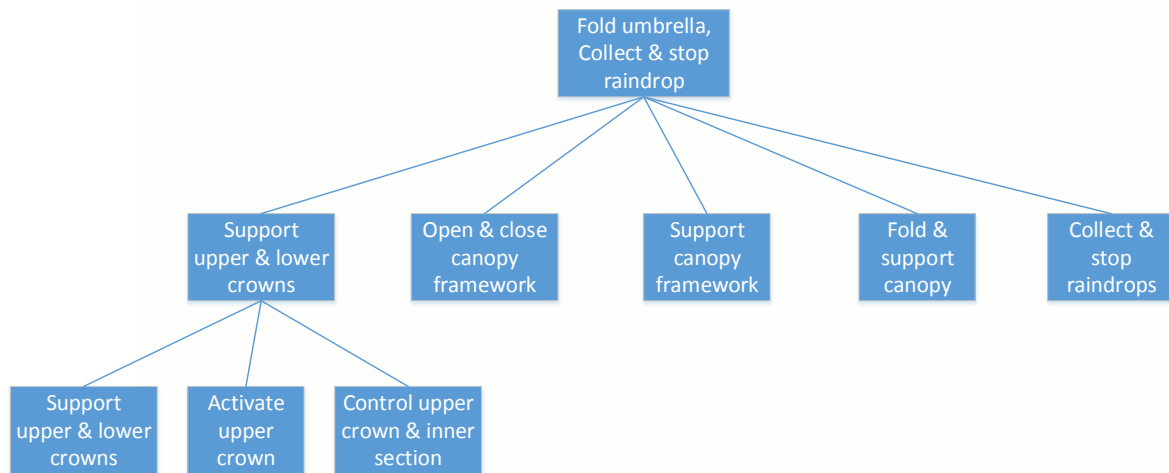**Fig. 11** Product architecture of US8893736 – components

Figure 12. Product architecture of US8893736 – functions

A comparison of the function attribute models of the first independent claims between TWI254619 and US8893736 shows that although the structure of TWI254619 looks clumsier than that of US8893736, it is indeed simpler. This is because the canopy framework, 16, of US8893736 contains many components that are shown in the model. In terms of technological complexity, that of TWI254619 is simpler; however, in terms of operating efficiency, that of US8893736 is better. Of course, these two patents belong to two different categories, namely the conventional umbrella and the compact umbrella.

Comparing the working principles of these two patents, that of TWI254619 uses inventive principle (IP) 1, segmentation, to convert one canopy into two canopies, namely the inner canopy and the outer canopy. However, that of US8893736 uses three inventive principles: 12, equipotentiality, 15, dynamization, and 17, another dimension. The use of the pulley is related to IP 12, because the user does not need to stretch out his or her hand to reach the upper crown. The use of the canopy framework is related to IP 15 because the canopy framework can change its structure between open and closed positions. The folding of the outer strut in the canopy framework applies IP 17 so that the dry side can be erected in the closed position.

Comparing the product architectures of these two patents, their main functions are slightly different. The structure of TWI254619 collects and stops raindrops, while that of US8893736 has, beside the previous two functions, an additional function of being a folding umbrella. In order to perform folding, the canopy structure applies IP 15 to change its structure between the open and closed positions.

In sum, Table 5 lists the similarities and differences between TWI254619 and US8893736. There are two points in common between these two patents. One is that they both fold canopies to collect rain drops. The other is that they use a spring and brace to fold the canopy. There are four differences between them. First, one uses a double canopy and the other uses only a single canopy. Second, one is a conventional umbrella and the other is compact. Third, one uses an inner canopy to cover the folding mechanism and the other uses a sleeve to cover it. Fourth, one has a pulley and the other has not.

By now, we are able to answer our original question: who was the original inventor of the reverse umbrella? It seems that Mr Jenan Kazim (GB2346556, filing date 2000-02-14), was the first to tackle the foldable reverse umbrella problem. Note that GB2346556 uses only one canopy. His first patent, GB2346556, was proposed much earlier than that of TWI254619 (filing date 2004-09-01). However, the concept of the double canopy used in the conventional reverse umbrella was first proposed by Mr Li Sheng-Chiun, the inventor of patent TWI254619.

In patent TWI254619, only one sliding support is connected to the central spine, whereas in patent US8893736, three moveable parts, namely the upper crown, outermost section, and inner section, are connected to the central spine and a pulley system to control the relative movement of the upper crown and inner section. Obviously the patent US8893736 has a higher status, approaching ideality in terms of the trend of object segmentation.

Table 5 Similarities and differences between TWI254619 and US8893736.

	TWI254619	US8893736
Similarity	1. Fold the canopy to collect rain drops 2. Use spring and brace to assist folding canopy	
Difference	1a Double canopy 2a Conventional 3a Use inner canopy to cover the folding mechanism. 4a Without pulley	1b Single canopy 2b Compact 3b Use sleeve to cover the folding mechanism 4b With pulley

44

4. Conclusion

A study of the originality on the reverse umbrella was conducted to solve the dispute on the Internet regarding who was the original inventor of the reverse umbrella. Five patents were investigated in detail with regard to their technological aspects: GB2346556, TWI254619, US8893736, US20150265013, and

much earlier than TWI254619 (filing date 2004-09-01), but has never been put on the market as a commercial product. However, the concept of the double canopy used in the reverse umbrella was first proposed by Mr Li Sheng-Chiun, the inventor of patent TWI254619. Mr Li and Mr Kazim used different mechanisms to solve the reverse umbrella problem, which can be best demonstrated by patents TWI254619 and US8893736. In patent TWI254619, only one sliding support is connected to the central spine, whereas in patent US8893736, three moveable parts, namely the upper crown, outermost section, and inner section, are connected to the central spine and a pulley system to control the relative movement of the upper crown and inner section. Obviously the patent US8893736 has a higher status, approaching ideality in terms of the trend of object segmentation.

Further comparison of the function attribute models, working principles, and product architectures between the first independent claims of TWI254619 and US8893736 reveals several technology insights. The comparison of the function attribute models of the first independent claims between TWI254619 and US8893736 shows that although the structure of TWI254619 looks clumsier than that of US8893736, it is indeed simpler. This is because the canopy framework, 16, of US8893736 contains many components which are shown in the model. In terms of

TWM522603. Only patent TWI254619 tackles the raindrop problem with a regular size umbrella, whereas the other four patents, GB2346556, US8893736, US20150265013, and TWM522603, are compact umbrellas. As for the foldable reverse umbrella, it seems that Mr Jenan Kazim (GB2346556, filing date 2000-02-14) was the first to tackle the reverse umbrella problem. His first patent, GB2346556, was proposed

technological complexity, that of TWI254619 is simpler, but in terms of operational efficiency, that of US8893736 is better. Of course, these two patents belong to two different categories: the conventional umbrella and the compact umbrella.

Comparing the working principles of these two patents, those of TWI254619 use IP 1, segmentation, to convert one canopy into two canopies, namely the inner and outer canopies. However, the working principles of US8893736 use three inventive principles: 12, equipotentiality, 15, dynamization, and 17, another dimension. The use of the pulley is related to IP 12 because the user does not need to stretch out his or her hand to reach the upper crown. The use of the canopy framework is related to IP 15, because the canopy framework can change its structure between open and closed positions. The folding of the outer strut in the canopy framework applies IP 17 so that the dry side can be erected in the closed position.

Comparing the product architectures of these two patents, their main functions are slightly different. The functions of TWI254619 are to collect and stop raindrops, whereas US8893736 has, beside the previous two functions, the additional function of being a folding umbrella. In order to perform the folding, the canopy structure applies IP 15 to change its structure between the open and closed positions.

5. References

Altschuller, G., Creativity as an Exact Science: the Theory of the Solution of Inventive Problems, 1984 (Gordon and Breach).

Bukhman, I., TRIZ Technology for Innovation, 2012 (Cubic Creativity Company).

Creax Innovation Suite, Computer software, 2001.

Espacenet Patent Search – Advanced Search (2017, May 19). Retrieved from https://worldwide.espacenet.com/advancedSearch?locale=en_EP.

Fiorineschia, L., Frillicia, F. S., Rissonea, P. and Cascinib, G., Product Architecture definition: evaluating the potentiality of TRIZ tools, *Procedia Engineering*, 2015, 131, 359–371.

Kazim, J., Improved foldaway umbrella, British patent, GB2346556, 2001.

Kazim, J., Umbrella folding upward and inside out, US patent, US8936736, 2014.

Kazim, J., Umbrella, US patent, US20150265013, 2015.

Li, S. C., Umbrella with rainwater collector, Taiwanese patent, TW I254619, 2006.

Mann, D., Hands-on systematic innovation, 2002 (Creax Press).

Pahl, G. and Beitz, W., Engineering Design. 2nd ed., 1999 (Springer-Verlag, London)

Reverse folding umbrella (2017, May 19). Retrieved from https://kazbrella.com/.

Shen-Mei umbrella (2017, May 19). Retrieved from http://www.jojogo168.com/3g_news_content.php?id=385.

Umbrella history (2017, May 19). Retrieved from http://www.umbrellahistory.net/.

Who invented the reverse umbrella (in Chinese) (2017, May 19). Retrieved from http://crowdwatch.tw/reports/126.

Wu, C. X., Multi-fold automatic reverse folding umbrella, Taiwanese patent, TWM522603, 2016.

Yoon, J. and Kim, K., An automated method for identifying TRIZ evolution trends from patents, Expert Systems with Applications, 2011, 38, 15540–15548.

AUTHOR BIOGRAPHIES

Jyhjeng Deng has been a Professor at DaYeh University in Taiwan since 1994. He received his Ph.D. degree in Industrial Engineering from Iowa State University. He is currently the Chair of the Industrial Engineering and Management Department at DaYeh University and a board member of the Society of Systematic Innovation. His areas of interests include systematic innovation, including TRIZ and patent analysis and circumvention, and computer graphics in product desig