US012135071B2

(12) **United States Patent**
Jia

(10) **Patent No.: US 12,135,071 B2**
(45) **Date of Patent: Nov. 5, 2024**

(54) **FOLDABLE APPARATUS AND ELECTRONIC DEVICE**

(71) Applicant: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Guangdong (CN)

(72) Inventor: **Yuhu Jia**, Guangdong (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 229 days.

(21) Appl. No.: **17/843,126**

(22) Filed: **Jun. 17, 2022**

(65) **Prior Publication Data**

US 2022/0316559 A1 Oct. 6, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2020/134997, filed on Dec. 9, 2020.

(30) **Foreign Application Priority Data**

Dec. 18, 2019 (CN) 201911310488.7

(51) **Int. Cl.**
G06F 1/16 (2006.01)
F16H 1/22 (2006.01)

(52) **U.S. Cl.**
CPC ***F16H 1/222*** (2013.01); ***G06F 1/1616*** (2013.01); ***G06F 1/1652*** (2013.01); ***G06F 1/1681*** (2013.01)

(58) **Field of Classification Search**
CPC F16H 1/222; G06F 1/1616; G06F 1/1652; G06F 1/1681; H04M 1/0268; H04M 1/022; H04M 1/0249; H04M 1/0214
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,258,914 B2 * 2/2016 Koser G06F 1/1633
10,037,058 B2 * 7/2018 Kato E05D 3/06
(Continued)

FOREIGN PATENT DOCUMENTS

CN 103398093 11/2013
CN 205847339 12/2016
(Continued)

OTHER PUBLICATIONS

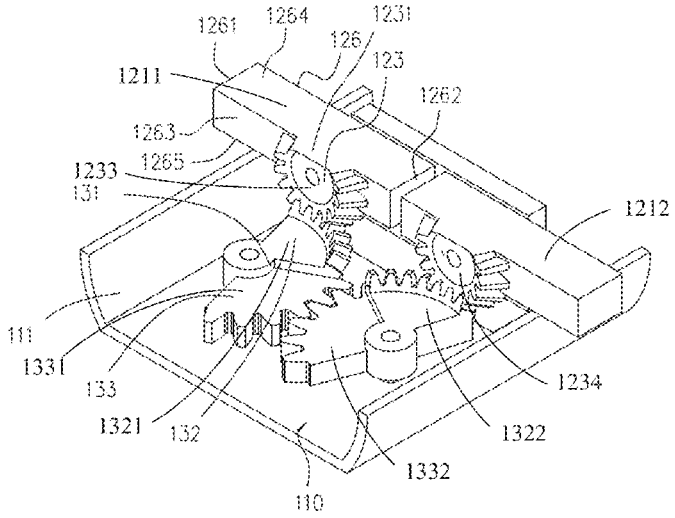
EPO, Extended European Search Report for EP Application No. 20903594.8, Jan. 16, 2023.
(Continued)

Primary Examiner — Anthony M Haughton
Assistant Examiner — Theron S Milliser
(74) *Attorney, Agent, or Firm* — Hodgson Russ LLP

(57) **ABSTRACT**

A foldable apparatus and an electronic device are provided. The foldable apparatus includes a rotating shaft base, two main bodies disposed at two opposite sides of the rotating shaft base, and a synchronous transmission assembly connected with the two main bodies. Each main body is provided with a rotating member rotatably connected with the rotating shaft base and a housing fixedly connected with the rotating member. Each rotating member is provided with a first bevel gear at an end. The synchronous transmission assembly includes two combined-gears rotatably connected with the rotating shaft base, each combined-gear includes a second bevel gear and a spur gear coaxial with the second bevel gear, two second bevel gears engage with two first bevel gears respectively, and two spur gears engage with each other.

20 Claims, 4 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

10,563,438	B1 *	2/2020	Chen	E05D 5/10
11,093,008	B2 *	8/2021	Hallar	E05D 11/1028
11,599,155	B2 *	3/2023	Siddiqui	G06F 1/1618
2008/0109995	A1	5/2008	Kuwajima et al.	
2012/0096678	A1 *	4/2012	Zhang	G06F 1/1681 16/302
2015/0293562	A1	10/2015	Nakamura et al.	
2015/0305185	A1 *	10/2015	Koser	G06F 1/1633 361/679.58
2016/0010374	A1	1/2016	Asu et al.	
2018/0059740	A1 *	3/2018	Kato	G06F 1/1681
2021/0096607	A1 *	4/2021	Hallar	G06F 1/1681
2021/0325937	A1 *	10/2021	Siddiqui	G06F 1/1679

FOREIGN PATENT DOCUMENTS

CN	207504926	6/2018
CN	208686793	4/2019
CN	109872630	6/2019
CN	209029007	6/2019
CN	110417964	11/2019
CN	209731298	12/2019
KR	100549915	2/2006
KR	20150000916	3/2015

OTHER PUBLICATIONS

WIPO, International Search Report and Written Opinion for PCT/CN2020/134997, Mar. 10, 2021.

CNIPA, First Office Action for CN Application No. 201911310488.7, Aug. 21, 2020.

CNIPA, Notification to Grant Patent Right for Invention for CN Application No. 201911310488.7, Jan. 15, 2021.

* cited by examiner

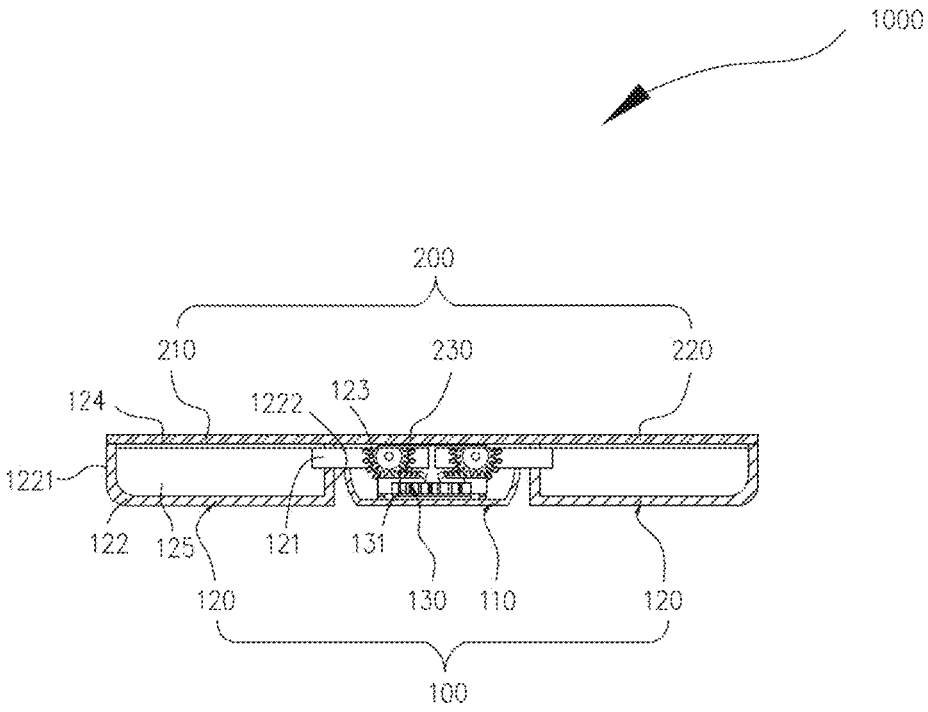

1000
200
210
230
220
124
1222
123
1221
122
125
121
131
120
130
110
120
100

FIG. 1

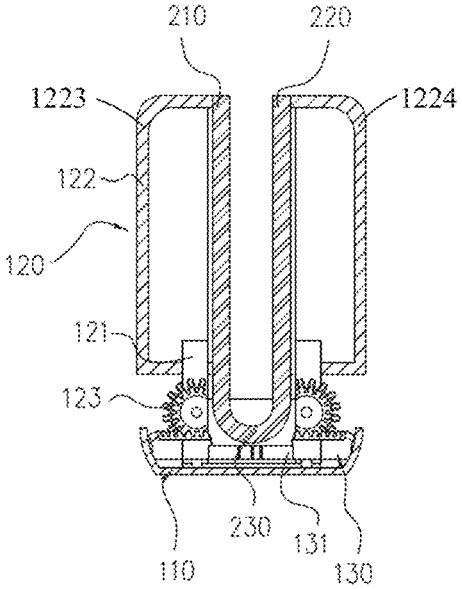

210
220
1223
1224
122
120
121
123
230
131
110
130

FIG. 2

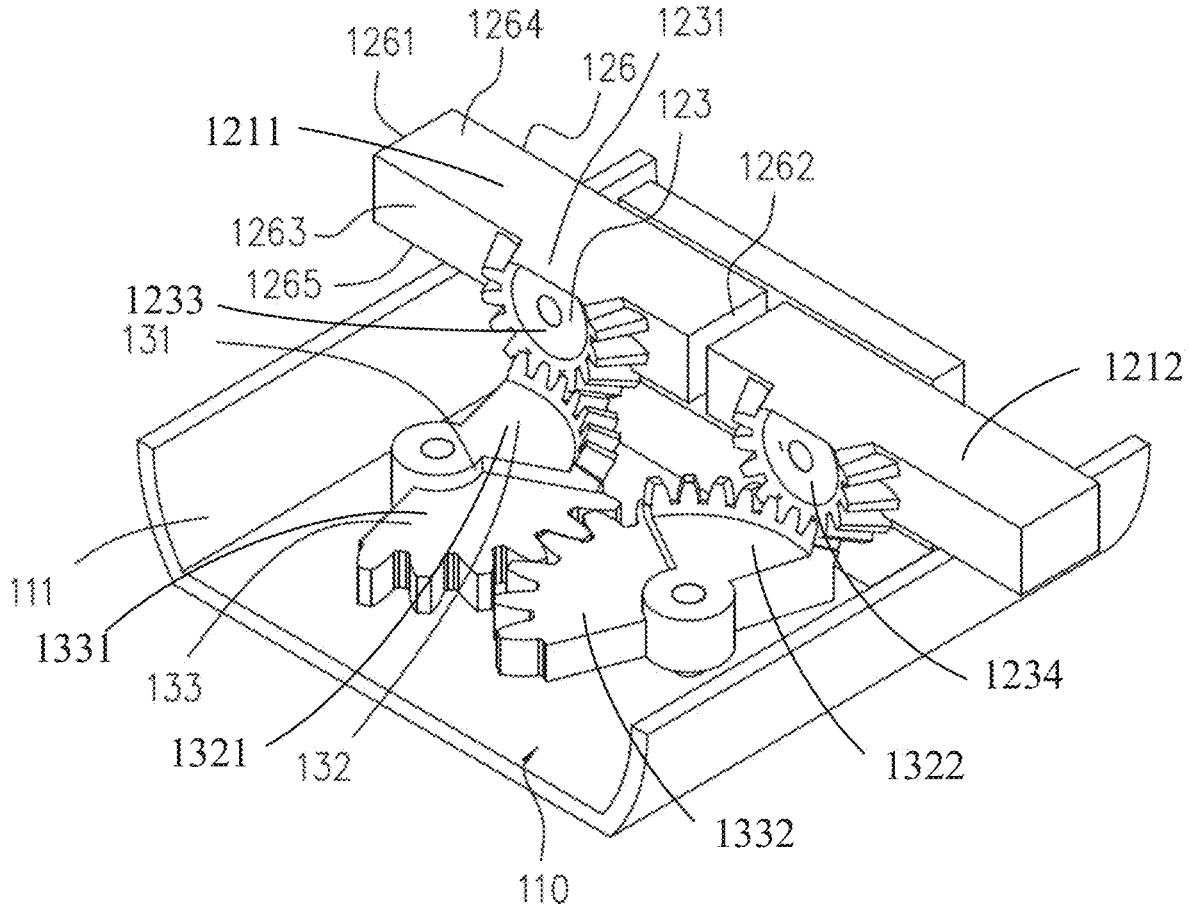

1261
1264
1231
126
123
1211
1262
1263
1265
1233
131
1212
111
1331
133
1321
132
1234
1322
1332
110

FIG. 3

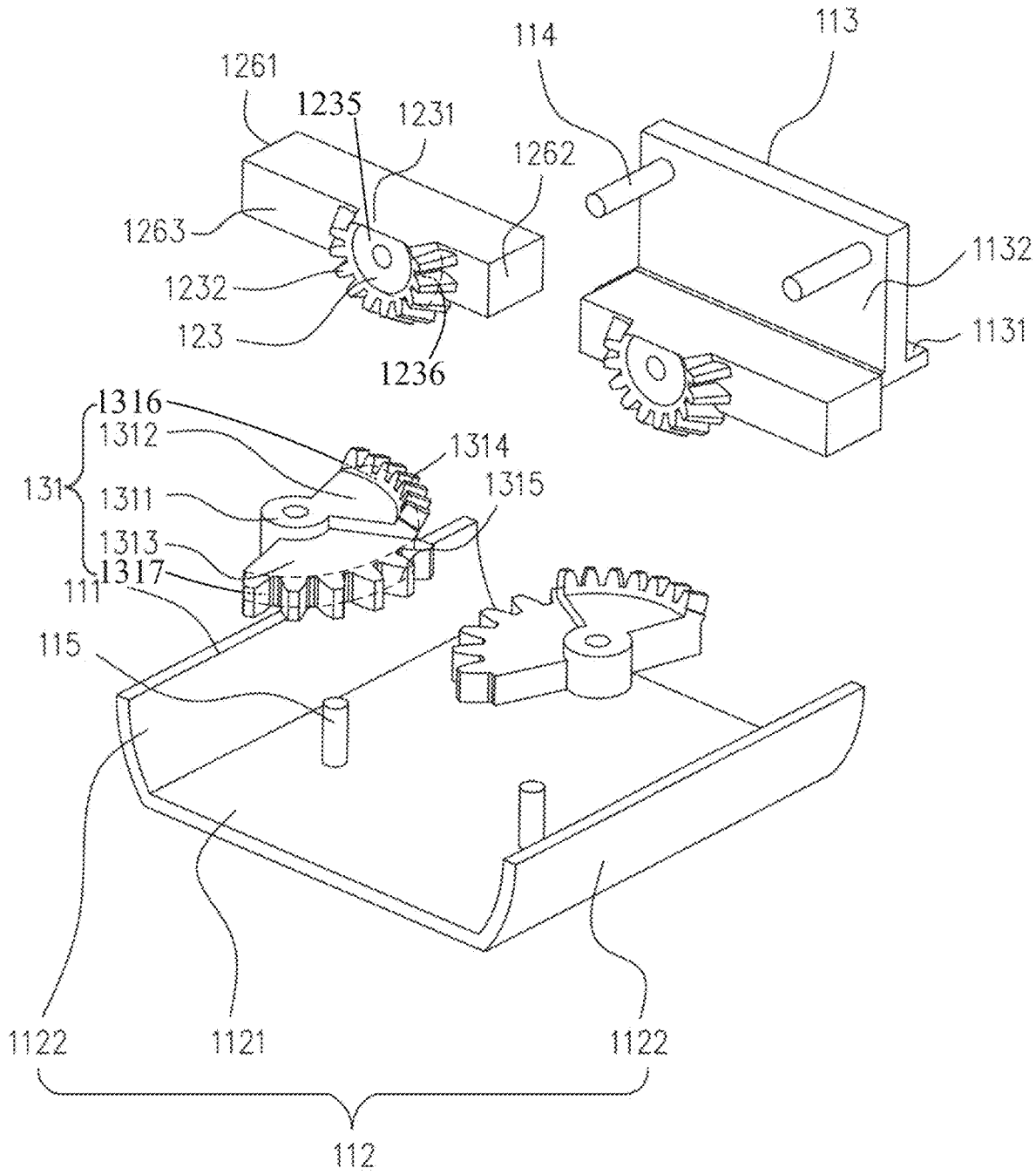

114
113
1261
1235
1231
1262
1263
1132
1232
1131
123
1236
1316
1312
1314
131
1315
1311
1313
1317
111
115
1122
1121
1122
112

FIG. 4

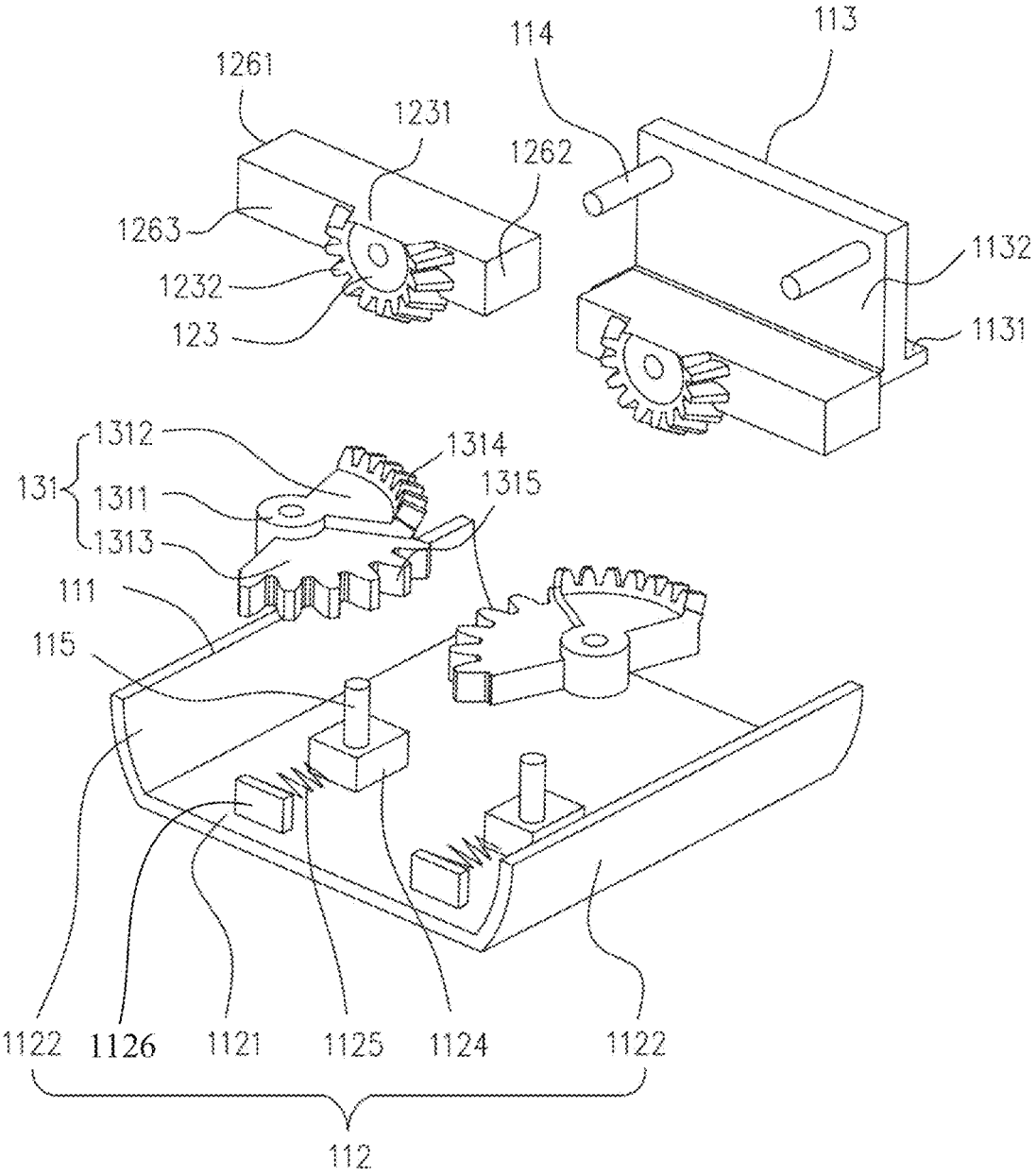

1261
1231
1262
1263
1232
123
114
113
1132
1131
131
1312
1311
1313
1314
1315
111
115
1122
1126
1121
1125
1124
1122
112

FIG. 5

FOLDABLE APPARATUS AND ELECTRONIC DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation application of International Application No. PCT/CN2020/134997, filed on Dec. 9, 2020, which claims priority to Chinese Patent Application No. 201911310488.7 filed on Dec. 18, 2019, the entire disclosure of which are incorporated herein by reference.

TECHNICAL FIELD

This disclosure relates to the field of communication devices, and in particular to a foldable apparatus and an electronic device.

BACKGROUND

At present, in a foldable mobile phone, a synchronous transmission gearset is used to drive main-body parts at two sides of the foldable mobile phone to rotate relative to each other, and then drive two opposite parts of a flexible display screen to fold or unfold relative to each other. However, multiple gears of the synchronous transmission gearset are in the same rotation plane and gear moment tolerances of multiple gears are relatively large, which will lead to a phenomenon of gear rotation lag, thus affecting synchronous rotation effect of the main-body parts at two sides of the foldable mobile phone.

SUMMARY

A foldable apparatus is provided in implementations of the present disclosure, where the foldable apparatus includes a rotating shaft base, two main bodies disposed at two opposite sides of the rotating shaft base, and a synchronous transmission assembly connected with the two main bodies. Each main body is provided with a rotating member rotatably connected with the rotating shaft base and a housing fixedly connected with the rotating member, and two rotating members drive two housings to unfold or fold relative to each other respectively. Each rotating member is provided with a first bevel gear at an end, the first bevel gear is rotatably connected with the rotating shaft base. A rotating shaft of the first bevel gear is coaxial with a rotating shaft through which the rotating member is rotatably connected with the rotating shaft base. The synchronous transmission assembly includes two combined-gears rotatably connected with the rotating shaft base, each combined-gear includes a second bevel gear and a spur gear coaxial with the second bevel gear, two second bevel gears engage with two first bevel gears respectively, and two spur gears engage with each other.

An electronic device is provided in implementations of the present disclosure, where the electronic device includes a foldable apparatus and a flexible display screen. The foldable apparatus includes a rotating shaft base, two main bodies disposed at two opposite sides of the rotating shaft base, and a synchronous transmission assembly connected with the two main bodies. Each main body is provided with a rotating member rotatably connected with the rotating shaft base and a housing fixedly connected with the rotating member, and two rotating members drive two housings to unfold or fold relative to each other respectively. Each rotating member is provided with a first bevel gear at an end, the first bevel gear is rotatably connected with the rotating shaft base. A rotating shaft of the first bevel gear is coaxial with a rotating shaft through which the rotating member is rotatably connected with the rotating shaft base. The synchronous transmission assembly includes two combined-gears rotatably connected with the rotating shaft base, each combined-gear includes a second bevel gear and a spur gear coaxial with the second bevel gear, two second bevel gears engage with two first bevel gears respectively, and two spur gears engage with each other. The flexible display screen includes two parts which are able to be folded or unfolded relative to each other, and the two parts are respectively fixed to the two housings and able to be folded or unfolded along with mutual rotation of the two housings.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to describe technical solutions of the present disclosure more clearly, the following will give a brief introduction to the accompanying drawings used for describing the implementations. Apparently, the accompanying drawings hereinafter described are merely some implementations of the present disclosure. Based on these drawings, those of ordinary skill in the art can also obtain other drawings without creative effort.

FIG. **1** is a schematic cross-sectional view of an electronic device in an unfolded state provided by implementations of the present disclosure.

FIG. **2** is a schematic cross-sectional view of an electronic device in a folded state provided by implementations of the present disclosure.

FIG. **3** is a partial three-dimensional schematic view of an electronic device provided by implementations of the present disclosure.

FIG. **4** is a partial three-dimensional exploded schematic view of an electronic device provided by implementations of the present disclosure.

FIG. **5** is a partial three-dimensional exploded schematic view of an electronic device provided by other implementations of the present disclosure.

DETAILED DESCRIPTION

Technical solutions of implementations of the present disclosure will be described clearly and completely, with reference to accompanying drawings in the implementations of the present disclosure.

Reference can be made to FIG. **1**, FIG. **2**, and FIG. **3**, an electronic device **1000** is provided in the present disclosure, and the electronic device **1000** includes a foldable apparatus **100** and a flexible display screen **200**. The flexible display screen **200** includes a first part **210**, a second part **220** which is folded or unfolded relative to the first part **210**, and a bendable part **230** connected between the first part **210** and the second part **220**. The foldable apparatus **100** includes a rotating shaft base **110**, two main bodies **120** disposed at two opposite sides of the rotating shaft base **110**, and a synchronous transmission assembly **130** connected with the two main bodies **120**. Each main body **120** includes a rotating member **121** rotatably connected with the rotating shaft base **110** and a housing **122** fixedly connected with the rotating member **121**, and two rotating members **121** drive two housings **122** to unfold or fold relative to each other respectively. The two housings **122** are fixedly connected with the first part **210** and the second part **220** respectively. Each rotating member **121** is provided with a first bevel gear **123** at an end, and the first bevel gear **123** is rotatably connected

with the rotating shaft base **110**. A rotating shaft of the first bevel gear **123** is coaxial with a rotating shaft through which the rotating member **121** is rotatably connected with the rotating shaft base **110**. The synchronous transmission assembly **130** includes two combined-gears **131** rotatably connected with the rotating shaft base **110**, each combined-gear **131** includes a second bevel gear **132** and a spur gear **133** coaxial with the second bevel gear **132**, two second bevel gears **132** engage with two first bevel gears **123** respectively, and two spur gears **133** engage with each other.

It can be understood that the two main bodies **120** can carry the first part **210** and the second part **220** respectively. The two main bodies **120** rotate relative to the rotating shaft base **110**, to drive the first part **210** and the second part **220** to rotate relative to the rotating shaft base **110**, thus realizing that the first part **210** and the second part **220** are folded or unfolded relative to each other, such that the electronic device **1000** presents a folded state or an unfolded state. The electronic device **1000** may be a mobile phone, a tablet computer, a laptop, or other devices.

The rotating member **121** includes the first bevel gear **123**, the synchronous assembly **130** includes combined-gears **131**, each combined-gear **131** includes the second bevel gear **132** and the spur gear **133** coaxial with the second bevel gear **132**, the two second bevel gears **132** engage with the two first bevel gears **123** respectively, and the two spur gears **133** engage with each other, such that the rotating member **121** drives a rotating member **121** at another side to synchronously rotate through the synchronous transmission assembly **130**, thus the two main bodies **120** can synchronously rotate around the rotating shaft base **110**, that is, the rotating member **121** and the rotating member **121** at the another side can rotate relative to the rotating shaft base **110** at the same time.

In the implementations, the housing **122** has a first edge **1221** and a second edge **1222** opposite to the first edge **1221**. First edges **1221** of the two housings **122** are fixedly connected with end portions of the first part **210** and the second part **220** respectively. The second edge **1222** is adjacent to the rotating shaft base **110**. The rotating member **121** is fixed to the second edge **1222** and extends perpendicular to the second edge **1222**. The rotating member **121** partially protrudes relative to the housing **122**. A part of the rotating member **121** protruding relative to the housing **122** extends into the rotating shaft base **110** and is rotatably connected with a combined-gear **131**. The rotating member **121** of each main body **120** can be implemented as multiple rotating members **121**, and the multiple rotating members **121** are arranged at regular intervals in a length direction of the second edge **1222**. Each main body **120** may further include a cover plate **124** covering the housing **122**. An accommodating cavity **125** is defined between the housing **122** and the cover plate **124**, and a part of the rotating member **121** is accommodated in the accommodating cavity **125**. The accommodating cavity **125** can also be configured to accommodate a functional component. The functional component may be a battery, a circuit board, a connector, a memory, a processor, a camera, a fingerprint module, a speaker, a receiver, etc. A surface of the cover plate **124** away from the housing **122** is smooth, such that cover plates **124** of the two main bodies **120** can support the first part **210** and the second part **220** respectively. Of course, in other implementations, the cover plates **124** of the two main bodies **120** may also be slidably connected with the first part **210** and the second part **220** respectively, to compensate for a length change of the flexible display screen **200**.

In the implementations, the rotating shaft base **110** has two side plates **1122**. The rotating shaft base **110** substantially forms a rotating shaft structure for the two main bodies **120**, such that the two main bodies **120** can rotate relative to each other through the rotating shaft base **110**. The rotating shaft base **110** is in a rectangular rod shape. A length direction of the rotating shaft base **110** is parallel to a direction of a rotating shaft of the rotating member **121**. The rotating shaft base **110** defines a rotating shaft cavity **111** and the synchronous transmission assembly **130** is partially disposed in the rotating shaft cavity **111**, to reduce a volume of the rotating shaft base **110**. A part of the rotating member **121** away from the housing **122** can rotate into the rotating shaft cavity **111**. When the two main bodies **120** drive the first part **210** and the second part **220** respectively to be in an unfolded state, the bendable part **230** is located outside the rotating shaft cavity **111**, and the two rotating members **121** are located outside the rotating shaft cavity **111**. When the two main bodies **120** drive the first part **210** and the second part **220** respectively to be in a folded state, an end of the rotating member **121** away from the housing **122** rotates into the rotating shaft cavity **111**.

In the implementations, the rotating member **121** includes a rotating link **126**, the rotating link **126** is fixedly connected with the housing **122** at one end of the rotating link **126**, and the first bevel gear **123** is disposed at another end of the rotating link **126** and is rotatably connected with the first rotating shaft **114**. The rotating link **126** extends perpendicular to the second edge **1222** to facilitate the rotating link **126** to rotate around the rotating shaft base **110**. The rotating link **126** includes a first end **1261** fixedly connected with the housing **122** and a second end **1262** opposite to the first end **1261**. The rotating link **126** is provided with the first bevel gear **123** at the second end **1262**, and the first bevel gear **123** is rotatably connected with the rotating shaft base **110**. The first bevel gear **123** is disposed at the second end **1262**. The rotating link **126** has a side surface **1263** which is substantially perpendicular to the cover plate **124**. The first bevel gear **123** is disposed at the side surface **1263**. The rotating link **126** further has a top surface **1264** which is substantially parallel to the cover plate **124** and connected with the side surface **1263**, and the rotating link **126** further has a bottom surface **1265** which is opposite to the top surface **1264** and connected with the side surface **1263**. When the flexible display screen **200** is in an unfolded state, the top surface **1264** can support the bendable part **230**. The first bevel gear **123** has a cross section **1231** flush with the top surface **1264**, such that a volume of the first bevel gear **123** is reduced, thus reducing the whole volume of the rotating shaft base **110**. The combined-gears **131** are completely accommodated in the rotating shaft cavity **111**. The first bevel gear **123** partially protrudes relative to the bottom surface **1265**, such that when the bottom surface **1265** of the rotating member **121** is substantially flush with an opening of the rotating shaft cavity **111**, a part of the first bevel gear **123** can also extend into the rotating shaft cavity **111** and keep engaging with a combined-gear **131**. Of course, in other implementations, the first bevel gear **123** may also be detachably connected with the rotating link **126**, which facilitates detachment and maintenance of the first bevel gear **123**.

In the implementations, the combined-gear **131** is rotatably connected with the rotating shaft cavity **111** at a bottom of the rotating shaft cavity **111**. A second rotating shaft **115** of the combined-gear **131** is perpendicular to the first rotating shaft **114** of the first bevel gear **123**. In other words, the second rotating shaft **115** of second bevel gear **132** is perpendicular to the first rotating shaft **114** of the first bevel

gear **123**. A rotation plane of the second bevel gear **132** is perpendicular to a rotation plane of the first bevel gear **123**, and when the first bevel gear **123** engages with the second bevel gear **132**, a distance between the first bevel gear **123** and the bottom of the rotating shaft cavity **111** is reduced, such that a center distance tolerance between the first bevel gear **123** and the second bevel gear **132** can be eliminated, thus avoiding idling of the first bevel gear **123** and the second bevel gear **132**, and ensuring effectiveness of synchronous rotation of the two main bodies **120**.

Specially, rotating members **121** include a first rotating member **1211** and a second rotating member **1212** which is opposite to the first rotating member **1211**. Housings **122** include a first housing **1223** and a second housing **1224** which is opposite to the first housing **1223**. First bevel gears **123** include a first first-bevel gear **1233** and a second first-bevel gear **1234** which is opposite to the first first-bevel gear **1233**. Second bevel gears **132** include a first second-bevel gear **1321** and a second second-bevel gear **1322** which is opposite to the first second-bevel gear **1321**. Spur gears **133** include a first spur gear **1331** and a second spur gear **1332** which is opposite to the first spur gear **1331**. The first housing **1223** drives the first rotating member **1211** to rotate around the rotating shaft base **110** and drives the first part **210** of the flexible display screen **200** to rotate around the rotating shaft base **110**, the first rotating member **1211** drives the first first-bevel gear **1233** to rotate, the first first-bevel gear **1233** drives the first second-bevel gear **1321** to rotate, the first second-bevel gear **1321** drives the first spur gear **1331** to rotate, the first spur gear **1331** drives the second spur gear **1332** to rotate, the second spur gear **1332** drives the second second-bevel gear **1322** to rotate, the second second-bevel gear **1322** drives the second first-bevel gear **1234** at to rotate, the second first-bevel gear **1234** drives the second rotating member **1212** to rotate, and the second rotating member **1212** drives the second housing **1224** and the second part **220** to rotate around the rotating shaft base **110**, such that the first part **210** and the second part **220** synchronously rotate around the rotating shaft base **110** to be folded.

Furthermore, reference can be made to FIG. **4**, the rotating shaft base **110** includes a base **112** and a rotating shaft bracket **113** fixed to the base **112**, the rotating shaft bracket **113** is provided with first rotating shafts **114** rotatably connected with rotating members **121**, the base **112** is provided with second rotating shafts **115** rotatably connected with the combined-gears **131**, and each first rotating shaft **114** is perpendicular to each second rotating shaft **115**.

In the implementations, the base **112** defines the rotating shaft cavity **111**. A bottom of the rotating shaft bracket **113** is fixed in the rotating shaft cavity **111**. The first rotating shafts **114** are disposed at a part of the rotating shaft bracket **113** exposed beyond the rotating shaft cavity **111**. The rotating shaft bracket **113** is provided with two first rotating shafts **114**. Rotating members **121** of the two main bodies **120** are rotatably connected with the two first rotating shafts **114** respectively. The first bevel gear **123** is sleeved on the first rotating shaft **114**. A rotation torque of the housing **122** rotating around the rotating shaft base **110** is transmitted to the first bevel gear **123** through the rotating link **126**, such that the first bevel gear **123** rotates around the first rotating shaft **114**. The second rotating shafts **115** extend from the bottom of the rotating shaft cavity **111** towards the opening of the rotating shaft cavity **111**. The combined-gear **131** is sleeved on a second rotating shaft **115**. A distance between the two second rotating shafts **115** is substantially equal to a sum of pitch diameters of the two spur gears **133**. The first rotating shaft **114** is perpendicular to the second rotating shaft **115**, such that the center distance tolerance between the first bevel gear **123** and the second bevel gear **132** is avoided. Since the second rotating shaft **115** is perpendicular to the first rotating shaft **114**, a height of the synchronous transmission assembly **130** is substantially equal to a thickness of the combined-gear **131**, in other words, the height of the synchronous transmission assembly **130** can be effectively reduced, and a volume of the rotating shaft base **110** can be effectively reduced.

Furthermore, the first bevel gear **123** includes a conical boss **1235** which extends parallel to the first rotating shaft **114**, and the conical boss **1235** is provided with multiple first sawteeth **1232** at a first inclined side wall **1236** of the conical boss **1235**.

In the implementations, the conical boss **1235** is disposed at the side surface **1263** of the rotating link **126**, which is close to the second end **1262** and away from the rotating shaft bracket **113**. The conical boss **1235** has the first inclined side wall **1236**. The multiple first sawteeth **1232** are arranged at regular intervals at the first inclined side wall **1236**. The multiple first sawteeth **1232** form sawteeth of the first bevel gear **123**. The multiple first sawteeth **1232** are arranged at the first inclined side wall **1236** at a radian greater than 90°, such that the rotating member **121** can rotate at least 90° around the rotating shaft base **110**, and synchronous rotation of the two main bodies **120** can be ensured. The first bevel gear **123** is formed at the side surface **1263** of the rotating link **126**, such that the first bevel gear **123** is integrally disposed with the rotating link **126**, an assembly tolerance between the first bevel gear **123** and the rotating link **126** is eliminated, and lag rotation of the first bevel gear **123** relative to the rotating link **126** is prevented.

Furthermore, the combined-gear **131** includes a bushing **1311**, the second bevel gear **132**, and the spur gear **133**. The second bevel gear **132** includes a first sector **1312** fixed to a circumferential side of the bushing **1311**, and the spur gear **133** includes a second sector **1313** fixed to a circumferential side of the bushing **1311**. The bushing **1311** is rotatably connected with the second rotating shaft **115**. The first sector **1312** has a second inclined side wall **1316** at a periphery of the first sector **1312** away from the bushing **1311** and multiple second sawteeth **1314** arranged at the second inclined side wall **1316**. The second sector **1313** has a vertical wall **1317** at a periphery of the second sector **1313** away from the bushing **1311** and multiple third sawteeth **1315** arranged at the vertical wall **1317**.

In the implementations, the bushing **1311** is sleeved on the second rotating shaft **115**. The first sector **1312** and the second sector **1313** each extend in a direction perpendicular to the second rotating shaft **115**, and the first sector **1312** and the second sector **1313** are arranged side by side in the direction perpendicular to the second rotating shaft **115**. A radian of the second inclined side wall **1316** is substantially 90°. A radian of the vertical wall **1317** is substantially 90°. When the rotating member **121** rotates 90° around the rotating shaft base **110**, the second bevel gear **132** can rotate 90° relative to the base **112**, and the spur gear **133** can rotate 90° relative to the base **112**. The first sector **1312**, the second sector **1313**, and the bushing **1311** are integrally disposed, such that the second bevel gear **132** and the spur gear **133** synchronously rotate relative to the base **112**.

Furthermore, the base **112** has a bottom plate **1121** and two side plates **1122** fixed to two sides of the bottom plate **1121**, the two side plates **1122** are adjacent to the two housings **122** respectively, the rotating shaft bracket **113** is fixed between the bottom plate **1121** and the two side plates **1122**, and the second rotating shafts **115** are disposed on the

bottom plate **1121**. The first sector **1312** and the second sector **1313** are arranged in a direction parallel to the bottom plate **1121** side by side.

In the implementations, the rotating shaft cavity **111** is defined between the bottom plate **1121** and the two side plates **1122**. The rotating shaft bracket **113** is fixed to the bottom plate **1121** at the bottom of the rotating shaft bracket **113**. The rotating shaft bracket **113** includes a bearing bottom plate **1131** and a bearing vertical plate **1132** perpendicularly fixed to the bearing bottom plate **1131**. The first rotating shafts **114** are disposed on the bearing vertical plate **1132** and extend perpendicular to the bearing vertical plate **1132**, that is, extend parallel to the bearing bottom plate **1131**. The bearing bottom plate **1131** is attached to the bottom plate **1121**. The second rotating shafts **115** extend perpendicular to the bottom plate **1121**. The combined-gears **131** each are spaced apart from the bearing bottom plate **1131** on the bottom plate **1121**. The bearing vertical **1132** is spaced apart from side plates **1122** to ensure a parallelism between a plane where a connection line between the two first rotating shafts **114** is located and the bottom plate **1121**, that is, to ensure that distances between the two first rotating shafts **114** each and the bottom plate **1121** are the same, thus ensuring synchronous transmission efficiency of the synchronous transmission assembly **130**. The side plates **1122** and the bottom plate **1121** can protect the synchronous transmission assembly **130** and the rotating shaft bracket **113**.

In the implementations, the first rotating shafts **114** are substantially located at places of the bearing vertical plate **1132** flush with the opening of the rotating shaft cavity **111**, such that edges of the side plates **1122** away from the bottom plate **1121** can limit rotation of the rotating members **121**. Specifically, when rotating links **126** rotate to a state where the rotating links **126** are in contact with the edges of the side plates **1122** away from the bottom plate **1121**, two rotating links **126** are substantially flush and drive the two housings **122** to unfold relative to each other, such that the first part **210** and the second part **220** are unfolded, that is, the flexible display screen **200** is in an unfolded state, the side plates **1122** limit the rotating members **121** to continually rotate away from the bottom plate **1121**, that is, limit continuous rotation of the two housings **122**, thus prevent the flexible display screen **200** from being pulled apart. The rotating shaft cavity **111** can accommodate ends of the rotating links **126** away from the housings **122**. When the flexible display screen **200** is in an unfolded state, second ends **1262** of the two rotating links **126** are spliced with each other. When the flexible display screen **200** is in a folded state, the two housings **122** are folded relative to each other, the second ends **1262** of the two rotating links **126** each are accommodated in the rotating shaft cavity **111** and close to the bottom plate **1121**, thus ensuring that the rotating shaft cavity **111** can accommodate a part of the bendable part **230**.

In other implementations, reference can be made to FIG. **5**, which is substantially the same as the implementations illustrated in FIG. **4**, except that the second rotating shafts **115** may also be slidably disposed at the bottom plate **1121**. Specifically, the base **112** further includes sliding blocks **1124**, elastic members **1125**, and vertical plates **1126**. Each vertical plate **1126** is perpendicularly fixed to the bottom plate **1121**, each sliding block **1124** is slidably connected with the bottom plate **1121**, and each elastic member **1125** is elastically compressed between each sliding block **1124** and each vertical plate **1126**. A sliding direction of a sliding block **1124** is parallel to the length direction of the rotating shaft base **110**. An elastic member **1125** is configured to provide an elastic restoring force of the sliding block **1124** sliding towards the rotating shaft bracket **113**. The second rotating shaft **115** is disposed on the sliding block **1124**. The second rotating shaft **115** extends perpendicular to the bottom plate **1121**. The sliding block **1124** can drive the second bevel gear **132** of the combined-gear **131** to move closer towards the rotating shaft bracket **113**, such that the second bevel gear **132** abuts against the first bevel gear **123** in a direction parallel to the first rotating shaft **114**. In other words, fit tightness of the first bevel gear **123** and the second bevel gear **132** is improved, fit clearance of the first bevel gear **123** and the second bevel gear is reduced, and synchronous rotation efficiency of the first bevel gear **123** and the second bevel gear **132** is improved.

In the foldable apparatus **100** and the electronic device **1000** provided in the implementations of the present disclosure, the rotating member **121** includes the first bevel gear **123**, the synchronous transmission assembly **130** includes the combined-gears **131**, each combined-gear **131** includes the second bevel gear **132** and the spur gear **133** coaxial with the second bevel gear **132**, the two second bevel gears **132** engage with the two first bevel gears **123** respectively, and the two spur gears **133** engage with each other, such that the rotating member **121** drive drives a rotating member **121** at another side to synchronously rotate through the synchronous transmission assembly **130**, thus the two main bodies **120** can synchronously rotate around the rotating shaft base **110**.

The above are the preferable implementations of the present disclosure. It should be noted that, for those of ordinary skill in the art, without departing from a concept of the present disclosure, several modifications and improvements can be made, and these modifications and improvements are also regard as the protection scope of the present disclosure.

What is claimed is:

1. A foldable apparatus, comprising:

a rotating shaft base;

two main bodies disposed at two opposite sides of the rotating shaft base; and

a synchronous transmission assembly connected with the two main bodies, wherein each main body is provided with a rotating member rotatably connected with the rotating shaft base and a housing fixedly connected with the rotating member, two rotating members drive two housings to unfold or fold relative to each other respectively, each rotating member is provided with a first bevel gear at an end, the first bevel gear is rotatably connected with the rotating shaft base, a rotating shaft of the first bevel gear is coaxial with a rotating shaft through which the rotating member is rotatably connected with the rotating shaft base, the synchronous transmission assembly comprises two combined-gears rotatably connected with the rotating shaft base, each combined-gear comprises a second bevel gear and a spur gear coaxial with the second bevel gear, two second bevel gears engage with two first bevel gears respectively, and two spur gears engage with each other.

2. The foldable apparatus of claim **1**, wherein the housing has a first edge and a second edge opposite to the first edge, first edges of the two housings are configured to be fixedly connected with two end portions of a flexible display screen respectively, and the second edge is adjacent to the rotating shaft base.

3. The foldable apparatus of claim **2**, wherein the rotating member is fixed to the second edge and extends perpen-

dicular to the second edge, the rotating member partially protrudes relative to the housing, and a part of the rotating member protruding relative to the housing extends into the rotating shaft base and is rotatably connected with a combined-gear.

4. The foldable apparatus of claim **2**, wherein the rotating member of each main body is implemented as a plurality of rotating members, and the plurality of rotating members are arranged at intervals in a length direction of the second edge.

5. The foldable apparatus of claim **2**, wherein each main body further comprises a cover plate covering the housing, the cover plate is configured to support the flexible display screen, an accommodating cavity is defined between the housing and the cover plate, and a part of the rotating member is accommodated in the accommodating cavity.

6. The foldable apparatus of claim **1**, wherein the rotating shaft base comprises a base and a rotating shaft bracket fixed to the base, the rotating shaft bracket is provided with first rotating shafts rotatably connected with rotating members, the base is provided with second rotating shafts rotatably connected with combined-gears, and each first rotating shaft is perpendicular to each second rotating shaft.

7. The foldable apparatus of claim **6**, wherein the base defines a rotating shaft cavity, a bottom of the rotating shaft bracket is fixed in the rotating shaft cavity, and the first rotating shafts are disposed at a part of the rotating shaft bracket exposed beyond the rotating shaft cavity.

8. The foldable apparatus of claim **6**, wherein the rotating shaft bracket is provided with two first rotating shafts, rotating members of the two main bodies are rotatably connected with the two first rotating shafts respectively.

9. The foldable apparatus of claim **6**, wherein the first bevel gear is sleeved on the first rotating shaft.

10. The foldable apparatus of claim **7**, wherein the second rotating shafts extend from a bottom of the rotating shaft cavity towards an opening of the rotating shaft cavity, and each combined-gear is sleeved on each second rotating shaft.

11. The foldable apparatus of claim **6**, wherein the rotating member comprises a rotating link, the rotating link is fixedly connected with the housing at one end of the rotating link, and the first bevel gear is disposed at another end of the rotating link and is rotatably connected with the first rotating shaft.

12. The foldable apparatus of claim **11**, wherein the first bevel gear comprises a conical boss which extends parallel to the first rotating shaft, and the conical boss is provided with a plurality of first sawteeth at a first inclined side wall of the conical boss.

13. The foldable apparatus of claim **12**, wherein the plurality of first sawteeth are arranged at the first inclined side wall of the conical boss at a radian greater than 90°.

14. The foldable apparatus of claim **6**, wherein a combined-gear comprises a bushing, the second bevel gear, and the spur gear, the second bevel gear comprises a first sector fixed to a circumferential side of the bushing, and the spur gear comprises a second sector fixed to a circumferential side of the bushing;

wherein the bushing is rotatably connected with the second rotating shaft;

wherein the first sector has a second inclined side wall at a periphery of the first sector away from the bushing and a plurality of second sawteeth arranged at the second inclined side wall; and

wherein the second sector has a vertical wall at a periphery of the second sector away from the bushing and a plurality of third sawteeth arranged at the vertical wall.

15. The foldable apparatus of claim **14**, wherein a radian of the second inclined side wall is substantially 90° and a radian of the vertical wall is substantially 90°.

16. The foldable apparatus of claim **6**, wherein the base has a bottom plate and two side plates fixed to two sides of the bottom plate, the two side plates are adjacent to the two housings respectively, the rotating shaft bracket is fixed between the bottom plate and the two side plates, and the second rotating shafts are disposed on the bottom plate.

17. The foldable apparatus of claim **16**, wherein the rotating shaft bracket comprises a bearing bottom plate and a bearing vertical plate perpendicularly fixed to the bearing bottom plate, the first rotating shafts are disposed on the bearing vertical plate and extend perpendicular to the bearing vertical plate, and the bearing bottom plate is attached to the bottom plate.

18. The foldable apparatus of claim **16**, wherein the two housings are unfolded relative to each other, when the two rotating members rotate to a state where the two rotating members are in contact with edges of side plates away from the bottom plate.

19. The foldable apparatus of claim **16**, wherein the two housings are folded relative to each other, when ends of the two rotating members away from housings rotates to be close to the bottom plate.

20. An electronic device, comprising:

a foldable apparatus, comprising:

a rotating shaft base;

two main bodies disposed at two opposite sides of the rotating shaft base; and

a synchronous transmission assembly connected with the two main bodies, wherein each main body is provided with a rotating member rotatably connected with the rotating shaft base and a housing fixedly connected with the rotating member, two rotating members drive two housings to unfold or fold relative to each other respectively, each rotating member is provided with a first bevel gear at an end, the first bevel gear is rotatably connected with the rotating shaft base, a rotating shaft of the first bevel gear is coaxial with a rotating shaft through which the rotating member is rotatably connected with the rotating shaft base, the synchronous transmission assembly comprises two combined-gears rotatably connected with the rotating shaft base, each combined-gear comprises a second bevel gear and a spur gear coaxial with the second bevel gear, two second bevel gears engage with two first bevel gears respectively, and two spur gears engage with each other; and

a flexible display screen, wherein the flexible display screen comprises two parts which are able to be folded or unfolded relative to each other, and the two parts are respectively fixed to the two housings and able to be folded or unfolded along with mutual rotation of the two housings.

* * * * *