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ELECTRICAL APPARATUS, DOOR OPENING AND CLOSING DEVICE AND CONTROL METHOD FOR CLUTCH THEREOF

Abstract

The disclosure relates to a field of electrical technology, and particularly discloses an electrical apparatus, a door opening and closing device and a control method of a clutch thereof. The door opening and closing device includes: a drive mechanism, a door ejection mechanism, a door rotation mechanism and an angle acquisition unit. a drive mechanism including a driver, a first transmission assembly, a second transmission assembly connected to the driver and simultaneously separably connected to the first transmission assembly, and a clutch-ejection-push assembly pushing the second transmission assembly to separate from or connect to the first transmission assembly; and a linkage gear connected to the first transmission assembly and simultaneously connected to the door ejection mechanism **00**) and the door rotation mechanism. The angle acquisition unit is configured to acquire a rotation angle of the linkage gear.

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Background/Summary

CROSS-REFERENCES TO RELATED APPLICATIONS [0001] The present disclosure is a national phase application of International Application No. PCT/CN2022/101710, filed on Jun. 28, 2022, which claims priority to the Chinese patent application No. 202210135501.5, filed on Feb. 14, 2022, which is incorporated herein by reference in its entirety.

FIELD

[0002] The disclosure relates to a field of electrical technology, and particularly to an electrical apparatus, a door opening and closing device and a control method for a clutch of a door opening and closing device.

BACKGROUND

[0003] With an improvement of living standards, electrical apparatuses such as refrigerators, dishwashers, and disinfection cabinets have become widely used in lives of people. In order to maintain a sealing performance of the above electrical apparatuses, an adsorption structure is usually disposed between a box body and a door body of the electrical apparatuses, or a negative pressure is maintained inside relative to outside of the electrical apparatuses to stably fix the door body onto the box body. Although the electrical apparatuses have an improved sealing performance, a difficulty of opening a door body has also been increased to an extent. It usually requires a greater force to open the door body, which is inconvenient to use. Especially for the elderly, children, patients and so on, it is not only difficult to operate, but also has certain safety risks.

SUMMARY

[0004] A door opening and closing device and an electrical apparatus are provided according to the disclosure, aiming to achieve an effect of improving a convenience and safety of opening a door body of an electrical apparatus to an extent.

[0005] A door opening and closing device is provided according to one embodiment of the disclosure, including: a drive mechanism, a door ejection mechanism, a door rotation mechanism and an angle acquisition unit, and the drive mechanism includes: a driver; a first transmission assembly; a second transmission assembly, connected to the driver and simultaneously separably connected to the first transmission assembly; a clutch-ejection-push assembly, pushing the second transmission assembly to separate from or connect to the first transmission assembly; a linkage gear, connected to the first transmission assembly and simultaneously connected to the door ejection mechanism and the door rotation mechanism; and the angle acquisition unit is configured to acquire a rotation angle of the linkage gear.

[0006] An electrical apparatus is provided according to another embodiment of the disclosure, including a box body, a door body rotatably disposed on the box body, and the door opening and closing device, and the door opening and closing device is disposed between the box body and the door body.
[0007] A door opening and closing control method applied to the electrical apparatus is provided according to another embodiment of the disclosure, including: obtaining an angle information collected by the angle acquisition unit, and the angle information represents an angle value rotated by the linkage gear; determining, according to the angle information, whether to control the clutch-ejection-push assembly to eject and push the second transmission assembly and the first transmission assembly is separated from the second transmission assembly.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0008] FIG. **1** shows a schematic structural diagram of a door opening and closing device according to one or more embodiments of the disclosure;
[0009] FIG. **2** is an exploded view of a clutch device of the door opening and closing device in FIG. **1**;
[0010] FIG. **3** is a top view of the clutch device in an assembly state of the door opening and closing device in FIG. **1**;
[0011] FIG. **4** is a front view of the clutch device in the assembly state of the door opening and closing device in FIG. **1**;
[0012] FIG. **5** is a cross-sectional view taken along line A-A in FIG. **3**;
[0013] FIG. **6** is a top view of a first transmission assembly of the door opening and closing device in FIG. **1**;
[0014] FIG. **7** is a front view of the first transmission assembly of the door opening and closing device in FIG. **1**;
[0015] FIG. **8** is a cross-sectional view taken along line A-A in FIG. **7**;
[0016] FIG. **9** is a bottom view of the first transmission assembly of the door opening and closing device in FIG. **1**;
[0017] FIG. **10** is a schematic structural diagram of a door rotation mechanism of the door opening and closing device in FIG. **1**;
[0018] FIG. **11** is a schematic diagram showing an arrangement position of the door rotation mechanism of the door opening and closing device in FIG. **1**;
[0019] FIG. **12** is an schematic structural diagram of the door ejection mechanism of the door opening and closing device in FIG. **1**;
[0020] FIG. **13** is another schematic structural diagram of the door ejection mechanism of the door opening and closing device in FIG. **1**;
[0021] FIG. **14** is a schematic diagram showing an assembly state of a drive member and a linkage gear of the door opening and closing device in FIG. **1**;
[0022] FIG. **15** is a schematic diagram showing an assembly state of the linkage member and a linkage gear of the door opening and closing device in FIG. **1**;
[0023] FIG. **16** is a top view of the linkage gear of the door opening and closing device in FIG. **1**;
[0024] FIG. **17** is a front view of the linkage gear of the door opening and closing device in FIG. **1**;
[0025] FIG. **18** is a bottom view of the linkage gear of the door opening and closing device in FIG. **1**;
[0026] FIG. **19** is a schematic diagram of a base of the door opening and closing device in FIG. **1**;
[0027] FIG. **20** is a schematic diagram showing an assembly state of the door opening and closing device in FIG. **1**;

[0028] FIG. **21** is a top view of the door opening and closing device in an assembly state in FIG. **1**;
[0029] FIG. **22** is a bottom view of the door opening and closing device in the assembly state in FIG. **1**;
[0030] FIG. **23** is a schematic diagram showing a principle of a door closing and returning process of the door opening and closing device in FIG. **1**;
[0031] FIG. **24** is a front view of the door opening and closing device in FIG. **1**;
[0032] FIG. **25** is a cross-sectional view taken along line A-A in FIG. **24**;
[0033] FIG. **26** is a schematic diagram showing an assembly arrangement in a refrigerator of the door opening and closing device in FIG. **1**;
[0034] FIG. **27** is an overall schematic diagram of a refrigerator according to an embodiment of the disclosure;
[0035] FIG. **28** is a schematic diagram of the door opening and closing device in FIG. **1** in a door ejection state;
[0036] FIG. **29** is a schematic diagram of the door opening and closing device in FIG. **1** in a state of door opening and door rotation; and
[0037] FIG. **30** is a schematic diagram of the door opening and closing device in FIG. **1** in a state of door closing and door rotation.

ILLUSTRATION OF REFERENCE NUMERALS

[0038] **100**, drive mechanism; **110**, driver; **120**, linkage gear; **121**, third tooth portion; **122**, third ejection-push portion; **1221**, second tooth portion; **123**, rotation limit groove; **1231**, first ejection-push portion; **1232**, second ejection-push portion; **124**, reset-spring accommodation groove; **125**, second fix seat; [0039] **200**, door rotation mechanism; **210**, drive member; **211**, coaxial rotation shaft; **212**, first fix seat; **220**, door rotation member; **230**, hinge seat; **240**, reset spring; [0040] **300**, door ejection mechanism; **310**, linkage member; **311**, linkage-member pivot hole; **312**, thickness reduction groove; **313**, first tooth portion; **314**, third fix seat; **320**, door ejection member; **322**, waist-shaped hole; **330**, ejection-push seat; **340**, shock-absorb pad; **350**, linkage-member pivot shaft; **360**, pin shaft; **370**, elastic limit member; **380**, door ejection profile; **381**, fourth tooth portion; **382**, door ejection portion; **383**, reinforcement rib; [0041] **400**, clutch device; **410**, first transmission assembly; **411**, slot; **412**, central shaft hole; **413**, internal teeth; **414**, extension tube; **420**, second transmission assembly; **421**, first transmission member; **4211**, connection end; **4212**, ejection-push end; **4213**, support flange; **4214**, first-transmission-member inner surface; **4215**, external teeth; **4216**, limit boss; **4217**, axial through groove; **422**, second transmission member; **4221**, second-transmission-member outer surface; **4222**, block; **4223**, transmission-shaft hole; **4224**, first limit surface; **423**, transmission shaft; **4231**, second limit surface; **430**, clutch-ejection-push assembly; **431**, ejection-push sleeve; **4311**, first ejection-push surface; **4312**, first ejection-push groove; **4313**, sinking platform; **432**, push rod; **4321**, second ejection-push surface; **4322**, limit baffle; **4323**, push arm; **4324**, connection portion; **433**, linear driver; [0042] **500**, angle acquisition unit; [0043] **600**, base; **610**, drive-motor fix groove; **620**, second stop member; **621**, stop surface; **630**, first stop member; **631**, elastic-member accommodation groove; **632**, guide groove; **633**, linkage-member first stop surface; **634**, linkage-member second stop surface; **635**, fourth fix seat; **641**, third stop member; **642**, fourth stop member; **650**, coaxial rotation-shaft seat; [0044] **910**, box body; **920**, door body.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0045] The disclosure provides an electrical apparatus, a door opening and closing device and a control method for clutch thereof, to improve an efficiency and convenience of door opening and closing operations to an extent, and at the same time to an extent solve problems of large resistance in an initial stage and too fast rotation in a subsequent stage of manually opening the refrigerator door, and unsmooth door opening and closing processes.

[0046] A door opening and closing device according to some embodiments of the disclosure is configured to be assembled on an electrical apparatus with a door body that is deflectable to be

opened and closed. The door body is driven to be open and closed through an action of the door opening and closing device. The electrical apparatus may be refrigerators, disinfection cabinets, dishwashers and so on.

[0047] Referring to FIG. **1**, in some embodiments, the electrical apparatus includes a box body **910** and a door body **920** which is rotatably disposed on the box body **910**. An access opening is disposed on the box body **910**. The door body **920** is operated to rotate on the box body **910** to close or open the access opening of the box body **910**.

[0048] Referring to FIG. **1**, in some embodiments, the door opening and closing device may include: a drive mechanism **100**, a door rotation mechanism **200**, and a door ejection mechanism **300**. In some embodiments, the drive mechanism **100** outputs a driving force, which can drive the door rotation mechanism **200** and the door ejection mechanism **300** to implement a full rotation operation and an initial door ejection operation of the door body **920**; that is, the door rotation mechanism **200** and the door ejection mechanism **300** according to the embodiments of the disclosure are both driven by the drive mechanism **100**, and the driving forces for the door rotation mechanism **200** and the door ejection mechanism **300** are both provided by the drive mechanism **100**. The drive mechanism **100** includes a driver **110** for providing power and a linkage gear **120** which is respectively connected to a door ejection mechanism **300** and the door rotation mechanism **200**, and the driver **110** drives the door ejection mechanism **300** and the door rotation mechanism **200** to deflect relative to the base **600** through the linkage gear **120**. The drive mechanism **100** is also provided with a clutch device **400**, which is configured to be connected between the linkage gear **120** and the driver **110** to achieve a detachable connection, i.e., connect the linkage gear **120** to the driver **110** or disconnect the linkage gear **120** from the driver **110**, to flexibly control a connection and disconnection of transmission paths between the driver **110** and the door ejection mechanism **300** as well as between the driver **110** and the door rotation mechanism **200**. Therefore, the door ejection mechanism **300** and the door rotation mechanism **200** are avoided from interfering with the drive mechanism **100** during manual door opening and closing operations, and the drive mechanism **100** can be disconnected in an event of device failure or environmental interference, thereby ensuring a safety of structure and avoiding mechanical damage.

[0049] Referring to FIG. **10** and FIG. **12**, in some embodiments, the door rotation mechanism **200** or the door ejection mechanism **300** can be configured to respectively cooperate with the drive mechanism **100** to independently implement a door opening and closing structure solution or a door ejection structure solution. In some embodiments, the door ejection mechanism **300** cooperates with the drive mechanism **100** to break through door opening resistances such as an adsorption resistance, a negative pressure and so on between the door body **920** and the box body **910**, to eject and open the door body **920** to a preset angle to facilitate subsequent automatic or manual door-opening operations. The door ejection mechanism **300** includes a linkage member **310** and a door ejection member **320** which is rotatably connected to the linkage member **310**, and the linkage member **310** is rotatably disposed on the base **600**. The door rotation mechanism **200** includes: a drive member **210** rotatably connected to the base **600** and a door rotation member **220** rotatably connected to the drive member **210**, and the door rotation member **220** is also hinged to the door body **920**; the linkage gear **120** is respectively connected to the drive member **210** and the linkage member **310**.

[0050] Referring to FIG. **1**, in some embodiments, in order to meet an assembly accuracy requirement or achieve an efficient assembly, a separate base **600** may be disposed on the box body **910** to carry the drive mechanism **100**, the door rotation mechanism **200** and the door ejection mechanism **300**, and the drive mechanism **100**, the door rotation mechanism **200** and the door ejection mechanism **300** can be assembled on the base **600**, and then the base **600** is assembled as a whole on the box body **910**, to realize a standardized installation based on the base **600** on the electrical apparatus, thereby ensuring a placement stability while ensuring a matching accuracy and reliability. On the other hand, when the base **600** is assembled as a whole on electrical apparatus

such as refrigerators, it is efficient and reliable due to that the base **600** can be installed as a whole.
[0051] In some embodiments, the base **600** is a separate component disposed in the box body **910**. In other embodiments, the base **600** may also be a portion of the box body **910**, and be formed on the box body **910**, rather than a separate component.
[0052] It is worth noting that, in a condition that an output power remains unchanged, an output force is inversely proportional to a speed. Therefore, in a condition that a driving power remains unchanged, a larger ejecting and pushing force can be obtained at a lower deflection speed for the door body in a door-ejecting stage, and the door ejection mechanism **300** can quickly and reliably eject and push the door body **920** to open. When the door rotation mechanism **200** is put into use, since a rotational resistance is very small, a higher door-rotation speed can be obtained in a condition that a smaller door-rotation force can be maintained, thereby quickly completing a door-rotation operation and achieving door-opening in place.
[0053] Referring to FIGS. **1**, **15**, **22** and **25**, the clutch device **400** controls a transmission connection relationship of the drive mechanism **100** and the door ejection mechanism **300** and the door rotation mechanism **200**, thereby effectively adapting to different needs of manual door opening and automatic door opening and closing as well as various mechanical failures, and improving a reliability of structure and a safety of use. An angle acquisition unit **500** may also be provided to monitor a rotation angle of the linkage gear **120** in real time, and a rotation angle information may be used as a basis for feedback control of the door opening and closing device, thereby further improving a reliability of automatic control.
[0054] In some embodiments, the clutch device **400** is provided with a first transmission assembly **410** and a second transmission assembly **420**, which are detachable to one another, and are respectively connected to the linkage gear **120** and the driver **110**, and a connection and separation of a transmission relationship between the driver **110** and the linkage gear **120** are realized by a connection and disconnection of the first transmission assembly **410** and the second transmission assembly **420**. In order to reliably realize a switching of connection and separation states, the clutch-ejection-push assembly **430** pushes the first transmission assembly **410** and the second transmission assembly **420** to be connected and separated.
[0055] In some embodiments, a start and stop, forward and reverse rotations and so on of the driver **110** can be controlled according to a rotation angle value of the linkage gear **120**. Therefore, the driver **110** can be directly controlled to ensure control efficiency.
[0056] In some embodiments, an action of the clutch-ejection-push assembly **430** can also be controlled according to the rotation angle value of the linkage gear **120** to achieve a feedback control of connection and separation operations of the first transmission assembly **410** and the second transmission assembly **420**.
[0057] In some embodiments, the angle acquisition unit **500** can be configured as a component of the door opening and closing device to be assembled on the base **600**, and can be configured as various types of angle sensors to detect a rotation angle of the linkage gear **120** relative to the base **600**. A magneto electric angle sensor, a magnetic sensitive angle sensor, or a photoelectric angle sensor or an angle encoder and so on can be used as the angle acquisition unit **500**.
[0058] In some embodiments, the angle acquisition unit **500** may be configured as a stroke switch or angle sensor connected between the box body **910** and the door body **920**, for directly detecting an angular position of the door body **920** relative to the box body **910**, and feeding back to the door opening and closing device to implement a control of the drive mechanism **100**.
[0059] In some embodiments, when door opening and closing operations are performed, a deflection angle of the linkage gear **120** can be tracked and detected by the angle acquisition unit **500**, and the deflection angle can be set as a vector angle, that is, a deflection direction of the linkage gear **120**, i.e., a forward rotation and a reverse rotation, can be distinguished, and a detection value can be fed back to a control element of the door opening and closing device in real time to implement a control of the driver **110** and the clutch-ejection-push assembly **430**.

[0060] In some embodiments, the linkage gear **120** is configured as a component to directly drive the door rotation mechanism **200** and the door ejection mechanism **300**, and thus the linkage gear **120** should be able to simultaneously drive the door rotation mechanism **200** and the door ejection mechanism **300**. A detailed structure of the linkage gear **120** is described in detail below.

[0061] Referring to FIGS. **14**, **15**, **16**, **17** and **18**, in some embodiments, a body of the linkage gear **120** may be configured as a rotation member at the base **600**, and is provided with a third tooth portion **121** meshing with a upstream driver **110**, to drive the door ejection mechanism **300** and the drive member **210** in a way of outputting torque through rotation. In order to meet a driving demand of the drive member **210**, a first ejection-push portion **1231** and a second ejection-push portion **1232** may be disposed oppositely at the body, and a space enough to accommodate the drive member **210** is kept between the first ejection-push portion **1231** and the second ejection-push portion **1232**. Therefore, in an actual assembly state, the drive member **210** can, respectively by the first ejection-push portion **1231** and the second ejection-push portion **1232**, be ejected and pushed to rotate at two sides of the moving member **210**. Therefore, when the body of the linkage gear **120** rotates in a forward direction and a reverse direction, the drive member **210** is ejected and pushed to rotate in two opposite directions respectively, thereby driving the door rotation member **220** to eject and push, or pull the door body **920** to realize the door opening and closing operations.

[0062] In some embodiments, the second ejection-push portion **1232** may be configured as a door-opening ejection-push portion, and the first ejection-push portion **1231** may be configured as a door-closing ejection-push portion; that is, when the linkage gear **120** rotates in the forward direction, the second ejection-push portion **1232** pushes the drive member **210** toward the door body **920** to push the door rotation member **220** to eject and push the door body **920** to implement door opening. When the linkage gear **120** rotates in the reverse direction, the first ejection-push portion **1231** pushes the drive member **210** away from the door body **920** to push the door rotation member **220** to pull the door body **920** to implement door closing.

[0063] In some embodiments, during a door opening process, in order to meet a timing control of first implementing a door-ejection operation and then implementing a door-rotation operation, a spacing between the first ejection-push portion **1231** and the second ejection-push portion **1232** can be designed to match the timing control. That is, a deflection space can be left between the first ejection-push portion **1231** and the second ejection-push portion **1232**, and when the drive member **210** deflects relative to the body, the drive member **210** needs to rotate from the first ejection-push portion **1231** to the second ejection-push portion **1232** by a first angle, and thus a time difference between a deflection of the linkage gear **120** and a deflection of the drive member **210** which is pushed is enabled by setting an initial position of the drive member **210**. Therefore during a door opening process, when the linkage gear **120** rotates and drives the door ejection mechanism **300** to implement ejection-push operations, the door rotation mechanism **200** does not implement an active door-rotation operation at the same time, but is delayed for a period of time and then implements, under the driving of the linkage gear **120**, the active door-rotation operation.

[0064] In some embodiments, a position in which the drive member **210** abuts against the first ejection-push portion **1231** may be configured as an initial position of the drive member **210**, and during a door opening process after the linkage gear **120** starts to rotate, the drive member **210** gradually approaches the second ejection-push portion **1232** from the first ejection-push portion **1231**, thereby being capable of accurately controlling a time for the second ejection-push portion **1232** to eject and push the drive member **210**, and the door rotation mechanism **200** and the door ejection mechanism **300** are seamlessly connected, a smooth door opening is achieved, and poor matching defects such as jamming and vibration are avoided.

[0065] A deflection angle of the drive member **210** can be set according to a designed opening degree of the door body **920** to meet door-rotation requirements. The deflection angle of the drive member **210** is correspondingly controlled as a first angle. A value of the first angle is also related to an initial position and length of the drive member **210** and so on, and can be adjusted and set

according to actual assembly conditions.

[0066] Referring to FIG. **1**, FIG. **10** and FIG. **19**, in some embodiments, in order to improve a position control accuracy of the drive member **210** and prevent the drive member **210** from being out of position, a second stop member **620** may be disposed on the base **600** to prevent the drive member **210** from being excessively deflected. The second stop member **620** may be disposed between the second ejection-push portion **1232** and the first ejection-push portion **1231**. A position in which the drive member **210** abuts against the first ejection-push portion **1231** may be configured as an initial position of the drive member **210**, to limit the drive member **210** between the second stop member **620** and the first ejection-push portion **1231** to ensure a reliability of the initial position of the drive member **210**. A position of the second stop member **620** may be set according to a width and a preset initial position of the drive member **210**, with reference to an initial position of the first ejection-push portion **1231**, and with a distance between the second stop member **620** and the first ejection-push portion **1231** being slightly larger than a width of the drive member **210** as a standard.

[0067] In some embodiments, a stop surface **621** matching a profile of a side wall of the drive member **210** may be disposed on the second stop member **620** to ensure uniform force subjected by the drive member **210** in a stopped state and avoid a local force concentration that may cause structural damage.

[0068] In some embodiments, in order to improve a rotation control precision and reliability of the drive member **210**, the body and the first end of the drive member **210** may be coaxially and rotatably disposed on the base **600**, thereby enabling a control of angle of the drive member **210** by controlling a rotation angle of the body, and thus a convenience is greatly improved. In other embodiments, the first end of the drive member **210** may not be coaxially disposed with the body, and the drive member **210** may just be pivotally connected to the body of the linkage gear **120** to form a crankshaft drive-like structure. The drive member **210** may also be rotationally disposed on the base, and two push arms may be simultaneously extended out and the two push arms may be provided with the first ejection-push portion **1231** and the second ejection-push portion **1232**, respectively, and the drive member **210** may be disposed between the two push arms, and thus the ejection-push operations can be realized. Positions, and dimensions of components of the above structures may be determined according to experiments to meet requirements of cooperations.

[0069] In some embodiments, in order to drive the door ejection mechanism **300**, the body of the linkage gear **120** is provided with a third ejection-push portion **122** for connecting and driving the door ejection mechanism **300**. During a door-opening operation, the body of the linkage gear **120** rotates in the forward direction and drives the door ejection mechanism **300** to push the door body **920**. Relatively, during a door-closing operation, the body of the linkage gear **120** rotates in the reverse direction to drive the door ejection mechanism **300** to be reset.

[0070] In some embodiments, a door-ejection operation only needs to break through the door opening resistances mainly composed of the adsorption force between the door body **920** and the box body **910**, and ejects the door body **920** to open by a small angle, and thus an ejecting and pushing stroke of the door ejection mechanism **300** is also small. Accordingly, a connection of the linkage gear **120** to the door ejection mechanism **300** and a stroke and time for ejecting and pushing the door ejection mechanism **300** may also be set according to a relatively short door ejection process, that is, after the door rotation mechanism **200** actively performs a door-rotation operation, the door ejection mechanism **300** and the linkage gear **120** can be disconnected or can be disconnected after a short period of time, thereby simplifying a structural linkage state under a working state and avoiding a mutual interference.

[0071] Referring to FIG. **15**, in order to improve an accuracy and reliability of a time control of connection and disconnection, a first tooth portion **313** may be disposed on the door ejection mechanism **100**. The third ejection-push portion **122** is provided with a second tooth portion **1221** which meshes with the first tooth portion **313** for transmission. Therefore, a stable drive can be

achieved by a way of meshing transmission. Meanwhile, an ejecting and pushing stroke may be adjusted by controlling a length and number of teeth for meshing. During the door opening process, the linkage gear **120** rotates in the forward direction, that is, the linkage gear **120** drives the door ejection mechanism **100** to eject and push the door body **920** through the way of meshing transmission until the second tooth portion **1221** and the first tooth portion **313** is disengaged, and the door ejection mechanism **100** will no longer be subjected to a force. During the door closing process, the linkage gear **120** rotates in the reverse direction, and when the linkage gear **120** rotates to a set angle, the first tooth portion **313** and the second tooth portion **1221** are re-meshed, and then the door ejection mechanism **100**, under the driving of the linkage gear **120**, moves in a direction reverse to a direction along which the door is ejected, until the door ejection mechanism **300** is reset.

[0072] In some embodiments, a control of door ejection stroke of the door ejection mechanism **100** may be achieved based on a deflection control of the drive member **210**. An angle by which the linkage gear **120** rotates during a period from when the first tooth portion **313** and the second tooth portion **1221** begin to mesh to when the first tooth portion **313** and the second tooth portion **1221** separate may be set as a second angle. It is considered that the first angle is an angle by which the body of the linkage gear **120** rotates, when the body starts to rotate, relative to the drive member **210**, that is, the first angle is an angle by which the body of the linkage gear **120** rotates within a time period during which the door rotation mechanism **200** is delayed to implement a door-rotation operation. Therefore, the first angle can be controlled to be less than or equal to the second angle, that is, a time period of meshing is controlled based on a relationship of the first angle and the second angle, thereby controlling a length of the teeth for meshing.

[0073] In some embodiments, in order to ensure a smooth connection between a door ejection process and a door rotation process, a difference between the first angle and the second angle can be controlled as being within 1 degree. That is, when the drive member **210** abuts against the second ejection-push portion **1232**, the first tooth portion **313** and the second tooth portion **1221** still have a short segment thereof to be maintained in a meshing state, or have a last tooth pair to be maintained in the meshing state.

[0074] Referring to FIG. **14** and FIG. **16**, in some embodiments, in order to smoothly control a deflection posture of the drive member **210**, a rotation limit groove **123** may be opened at the body of the linkage gear **120**. The body of the linkage gear **120** and the drive member **210** are kept to be coaxially rotatably disposed on the base **600**. A coaxial rotation shaft **211** may be disposed in the rotation limit groove **123**. The drive member **210** may be rotatably disposed in the rotation limit groove **123**. The first ejection-push portion **1231** and the second ejection-push portion **1232** are configured as groove walls of the rotation limit groove **123** in a radial direction of the linkage gear **120**, that is, the rotation limit groove **123** is configured as a fan-shaped groove. The rotation limit groove **123** accommodates the drive member **210**, thereby reducing an overall assembly height. At the same time, a sinking groove structure can also effectively protect the drive member **210**, and improve an impact and vibration resistance of an ejecting and pushing area, and thus a reliability of the rotation limit groove **123** is ensured.

[0075] In some embodiments, in order to ensure that a position at which the drive member **210** abuts against the first ejection-push portion **1231** is an initial position and in order to resist an influence of vibration on a position and posture of the drive member **210**, a reset spring **240** can be provided. Two ends of the reset spring **240** are respectively connected to the body of the linkage gear **120** and the drive member **210**, to maintain a tension between the drive member **210** and the first ejection-push portion **1231**, thereby forming a tendency to approach one another, and to guide the drive member **210** to abut against the second ejection-push portion **1231** after the door body **920** is opened. In other embodiments, the reset spring **240** may also be replaced with a leaf spring, or other elastic materials, to achieve position limiting by elastic ejecting and pushing, tensioning and so on.

[0076] In some embodiments, in order to facilitate fixation, a first fix seat **212** may be disposed at the drive member **210** for fixing a first end of the reset spring **240**. A second fix seat **125** may also be disposed at the body of the linkage gear **120** to fix a second end of the reset spring **240**.
[0077] Referring to FIG. **16**, in consideration of a deformation characteristics of the reset spring **240**, a reset-spring accommodation groove **124** is opened at the body of the linkage gear **120**. The reset spring **240** can be disposed in the reset-spring accommodation groove **124**. Therefore, not only an assembly of the reset spring **240** on the linkage gear **120** is achieved, but also the reset spring **240** is prevented from external impact or scratch, to ensure a stability of deformation state of the reset spring **240**. In this embodiment, the reset-spring accommodation groove **124** may also be configured as a fan-shaped groove, with a side close to the rotation limit groove **123** being relatively wider, thereby adapting to a deflection process of the drive member **210** and avoiding the reset spring **240** from deformation due to resisting and bending.
[0078] In some embodiments, in order to improve a functional stability and positioning reliability of the linkage gear **120**, a third stop member **641** and a fourth stop member **642** may be disposed on the base **600**, and are respectively disposed at the two ends of a rotation trajectory of the linkage gear **120** to prevent excessive rotation of the linkage gear **120** and ensure positioning accuracies of a forward rotation and a reverse rotation. When the door body **920** is closed, the third stop member **641** stops the linkage gear **120** from revolving. When the door body **642** is opened to a limiting position, the fourth stop member **642** stops the linkage gear **120** from revolving.
[0079] In some embodiments, a limit rotation angle of the linkage gear **120** may be determined according to a designed opening degree of the door body **920**. A rotation angle of the linkage gear **120** between the third stop member **641** and the fourth stop member **642** may be set to be 90 to 130 degrees. The rotation angle may also be disposed to be 120 degrees or other specific degrees.
[0080] Referring to FIG. **14**, in some embodiments, in order to ensure the balanced posture of the drive member **210**, an extension limit portion **213** may be provided at the end of the drive member **210**, and the extension limit portion **213** is pressed against the base **600** to avoid unilateral warping of the drive member **210**. In other embodiments, a self-lubricating material layer may be further disposed on the extension limit portion **213** to reduce a contact friction coefficient.
[0081] A structure of the clutch device **400** is described in detail below.
[0082] Referring to FIGS. **2**, **3**, **4** and **5**, the clutch device **400** according embodiments of the disclosure includes a first transmission assembly **410** and a second transmission assembly **420**, which are connectable and separable, and are configured to respectively connect an upstream structure and a downstream structure to achieve stable and reliable connection and separation of the upstream structure and the downstream structure. Therefore, a connection and separation for an upstream drive mechanism **100** in the door opening and closing device with a downstream door rotation mechanism **200** and the door ejection mechanism **300** can be achieved.
[0083] In order to switch the connection and separation states of the first transmission assembly **410** and the second transmission assembly **420**, the clutch device **400** is further provided with a clutch-ejection-push assembly **430** for pushing the first transmission assembly **410** and the second transmission assembly **420** toward each other for connection or away from each other for separation. Engagement structures may be disposed on the first transmission assembly **410** and the second transmission assembly **420** respectively, to achieve stable connection and convenient separation of the first transmission assembly **410** and the second transmission assembly **420**.
[0084] In some embodiments, the clutch-ejection-push assembly **430** is provided with an ejection-push sleeve **431** which can be sleeved on the second transmission assembly **420**. During assembly, the second transmission assembly **420** is embedded in the ejection-push sleeve **431**, and the second transmission component **420** is stably fixed by the ejection-push sleeve **431**, and at the same time, can be indirectly pushed to move by pushing the ejection-push sleeve **431**, thereby avoiding direct contact with the second transmission component **420**, thereby avoiding affecting an operating state of the second transmission component **420**. A structural stability of the second transmission

assembly **420** can also be ensured by pushing the second transmission component **420** as a whole.
[0085] The clutch-ejection-push assembly **430** is also provided with a push rod **432** for pushing the ejection-push sleeve **431**. The ejection-push sleeve **431** is pushed by the push rod **432** along a first direction, to push the second transmission assembly **420** to be closer to the first transmission assembly **410** to be connected with each other; or the push rod **432** is operated to make the ejection-push sleeve **431** to move in a direction opposite to the first direction, and the second transmission assembly **420** is away from the first transmission assembly **410** to be disconnected.
[0086] Referring to FIGS. **2** and **5**, in some embodiments, the second transmission assembly **420** is provided with a first transmission member **421** which can be transmission-connected to the first transmission assembly **410**. A connection end **4211** may be disposed on the first transmission member **421** for connecting to the first transmission assembly **410**. An ejection-push end **4212** may also be disposed on the first transmission member **421** for being embedded in the ejection-push sleeve **431**, thereby forming a stable fixed structure. Accordingly, the connection end **4211** may protrude from the ejection-push sleeve **431**, ensuring that the connection end **4211** is smoothly connected to the first transmission assembly **410**.
[0087] Referring to FIGS. **6**, **7**, **8** and **9**, in some embodiments, in order to improve a smoothness and convenience of connection and separation of the first transmission assembly **410** and the connection end **4211**, a slot **411** that can accommodate the connection end **4211** can be opened on the first transmission assembly **410**, and a shape of the slot **411** can be set as a structural shape for snapping with the connection end **4211**, and a stable connection state for transmission can be established through one-way ejection-push operations and a convenient engaging process, thereby ensuring a reliability of the transmission state. At the same time, when the first transmission assembly **410** and the second transmission assembly **420** is disconnected, a separation can also be quickly and smoothly achieved through a convenient one-way push away, and an impact on an operating state and structural stability of the first transmission member **421** and the first transmission assembly **410** can also be reduced.
[0088] In some embodiments, based on snapping and separation operations are implemented by way of approaching and moving away, internal teeth **413** may be disposed on a groove wall surface of the slot **411**, and correspondingly, external teeth **4215** may be disposed on an outer peripheral surface of the connection end **4211**. As the first transmission member **421** moves, the internal teeth **413** and the external teeth **4215** can be engaged and disengaged.
[0089] In some embodiments, in order to adapt to meshing requirements of the first transmission member **421** in a rotating state under certain working conditions, a gap between two adjacent internal teeth **413** in the slot **411** may be configured to be larger than a width of the external teeth **4215**, and there is a sufficiently large space to facilitate the external teeth **4215** to be engaged in place and to efficiently establish a meshing connection state.
[0090] In some embodiments, the gap between two adjacent internal teeth **413** may be set to be more than twice the width of the external teeth **4215**.
[0091] In some embodiments, a gap between two adjacent external teeth **4215** on the outer peripheral surface of the connection end **4211** may also be set to be larger than the width of the internal teeth **413**, and there is a sufficiently large space to facilitate the internal teeth **413** to be engaged in place and to efficiently establish a meshing connection state.
[0092] In some embodiments, a gap between two adjacent external teeth **4215** may be set to be more than twice a width of the internal teeth **413**.
[0093] In some embodiments, the first transmission assembly **410** can establish a transmission relationship with other structures by means of meshing transmission. The first transmission assembly **410** may be set as a first transmission gear. Accordingly, the slot **411** may be opened at an axial end of the first transmission gear. The first transmission member **421** moves along an axial direction of the first transmission gear to achieve connection and separation.
[0094] In some embodiments, in order to adapt to a rotating working state of the first transmission

gear, the slot **411** may be configured as a circular slot, and the internal teeth **413** may be disposed on a wall surface of the circular slot at an equal interval, and the number of the internal teeth **413** is at least two. The number of internal teeth **413** may be set as six or eight, and a specific number of internal teeth **413** may be set according to a specification of the slot **411**. Correspondingly, an outer surface of the connection end **4211** may also be configured to be circular, and the external teeth **4215** may be disposed on a circular groove wall surface at an equal interval, and the number of the external teeth **4215** may be set as at least two. The number of the external teeth **4215** may also be set to be six or eight. The specific number of the external teeth **4215** may be the same as the number of internal teeth **413**.

[0095] A central shaft hole **412** of the first transmission gear is coaxially disposed with circular slot **411** to ensure a meshing efficiency and stability of the internal teeth **413**. An extension tube **414** may be coaxially disposed at an orifice of the central axis hole **412** to facilitate an embedded rotation shaft to be stably fixed to the base **600**.

[0096] In some embodiments, since the ejection-push end **4212** is embedded in the ejection-push sleeve **431**, when the first transmission member **421** rotates, an unstable rotation posture and a situation of excessive wear can be easily caused due to a too large contact surface of the ejection-push end **4212** and the ejection-push sleeve **431**. Spaced limit bosses **4216** may be disposed on an outer peripheral surface of the ejection-push end **4212** to separate an inner surface of the ejection-push sleeve **431** and an outer peripheral surface of the ejection-push end **4212**, to leave a certain uniform gap between the ejection-push sleeve **431** and the ejection-push end **4212**, thereby greatly reducing the contact area of the ejection-push sleeve **431** and the ejection-push end **4212**, reducing a degree of wear of the ejection-push sleeve **431** and the ejection-push end **4212**, and ensuring a stability of a rotation posture of the first transmission member **421**.

[0097] In some embodiments, the limit boss **4216** slidably abuts against the inner surface of the ejection-push sleeve **431**, thereby further reducing the degree of wear. A self-lubricating material layer may be disposed on the limit boss **4216** to reduce a friction coefficient, improve a wear resistance, and extend a service life.

[0098] In some embodiments, protrusions arranged at an interval may be further disposed on the outer peripheral surface of the limit boss **4216** to further reduce the contact surface.

[0099] In some embodiments, in order to achieve stable pushing of the first transmission member **421**, a support flange **4213** may be further disposed on the first transmission member **421** for resting on an end surface of the ejection-push sleeve **431**. The support flange **4213** may be disposed between the connection end **4211** and the ejection-push end **4212**. Generally, the transmission member **421** may be integrally formed, or may be formed in respective molds and then assembled together.

[0100] In some embodiments, in order to ensure structural strength, the first transmission member **421**, the ejection-push sleeve **431** and so on often have a certain thickness. After assembly, an overall height is often relatively high, and a required assembly space is correspondingly larger. To this end, a sinking platform **4313** may be disposed on an end surface of the ejection-push sleeve **431** to accommodate the support flange **4213** to reduce the overall height. A stability of a rotation axis of the first transmission member **421** can also be maintained to an extent.

[0101] In some embodiments, in order to meet transmission connection requirements between the first transmission member **421** and an upstream structure, it is required to dispose a connection structure on the first transmission member **421**. Therefore, the second transmission assembly **420** is further provided with a second transmission member **422** for driving the first transmission member **421** and connecting to the upstream structure to achieve a transfer of transmission torque.

[0102] In some embodiments, in consideration that the first transmission member **421** needs to move along a first direction and also needs to transmit a torque, the first transmission member **421** may be sleeved on the second transmission member **422** and can rotate with the second transmission member **422** to achieve a transmission of the torque transmission, and at the same

time, the first transmission member **421** can move along the first direction relative to the second transmission member **422**.

[0103] In some embodiments, in order to achieve relative sliding between the first transmission member **421** and the second transmission member **422** and to achieve the rotation of the first transmission member **421** with the second transmission member **422**, an axial through groove **4217** is opened on an inner surface **4214** of the first transmission member **421**. A block **4222** which can be embedded in the axial through groove **4217** is disposed on a second-transmission-member outer surface **4221**, thereby enabling the first transmission member **421** to rotate with the second transmission member **422**. At the same time, the block **4222** may also slide along the axial through groove **4217**, thereby achieving a sliding of the first transmission member **421** relative to the second transmission member **422** along the first direction.

[0104] In order to meet a torque transmission requirement, a transmission shaft **423** may be coaxially fixed inside the second transmission member **422** for connecting an upstream driver **110** and driving the second transmission member **422**.

[0105] In some embodiments, in order to ensure that the transmission shaft **423** is fixed into the second transmission member **422**, a transmission-shaft hole **4223** may be opened on the second transmission member **422**, and a first limit surface **4224** is disposed in the transmission-shaft hole **4223**. A second limit surface **4231** is disposed on an outer peripheral surface of the transmission shaft **423**. When the transmission shaft **423** is embedded in the transmission-shaft hole **4223**, the second limit surface **4231** abuts against the first limit surface **4224**, thereby limiting a rotation of the transmission shaft **423** relative to the second transmission member **422**.

[0106] In some embodiments, in order to meet process requirements and simplify a molding process, the transmission shaft **423** may be configured as a cylindrical member, and a tangential plane is disposed on an outer circumferential surface of the cylindrical member to form a second limit surface **4231**. Correspondingly, the transmission-shaft hole **4223** is configured to be in a shape fitting with the second limit surface **4231**.

[0107] In some embodiments, the first transmission assembly **410** and the second transmission assembly **422** are coaxially sleeved on the transmission shaft **423**, and the second transmission assembly **420** can stably move along an axial direction of the transmission shaft **423** toward or away from the first transmission assembly **410**, thereby ensuring a stability of the connection and separation between the first transmission assembly **410** and the second transmission assembly **420**.

[0108] In some embodiments, a moving direction of the ejection-push sleeve **431** may be along the first direction, and an ejection-push direction of the pushing rod **432** may be along the first direction.

[0109] In some embodiments, since an overall space in a thickness direction is small and a stroke in the thickness direction is relatively small, a dimension of an ejection-push structure for directly ejecting and pushing along the first direction is required to be very small, and thus a difficulty of molding and assembly the ejection-push structure is undoubtedly greatly increased. Therefore, a structure for ejecting and pushing from another direction may be provided. A first ejection-push surface **4311** that is non-parallel to the first direction may be disposed on the ejection-push sleeve **431**, and the ejection-push operations along an ejection-push direction can be implemented by ejecting and pushing the first ejection-push surface **4311**. The ejection-push sleeve **431** is pushed toward the first transmission assembly **410** by ejecting and pushing the first ejection-push surface **4311** through the push rod **432**.

[0110] In some embodiments, in order to optimize an efficiency of the ejection-push operations, an angle between the first ejection-push surface **4311** and the first direction can be set as ranging from 30 degrees to 60 degrees, for example, 30 degrees, 45 degrees or 60 degrees and so on.

[0111] In some embodiments, an angle between the ejection-push direction of the push rod **432** and the first direction can be controlled as 90 degrees, to minimize a space required for a cooperation of the push rod **432** and the second transmission assembly **420** and reduce an overall volume of the

structure for ejecting and pushing.
[0112] In some embodiments, in order to improve a stability of ejecting and pushing from another direction, a second ejection-push surface **4321** in contact with the first ejection-push surface **4311** may be disposed on the push rod **432**, to improve a uniformity of a force on the first ejection-push surface **4311** through a surface-to-surface contact ejection-push, thereby ensuring a stability of a moving posture of the ejection-push sleeve **431**.
[0113] In some embodiments, in order to balance a force on the ejection-push sleeve **431**, the number of the first ejection-push surfaces **4311** can be set as two, and the push rod **432** is also correspondingly provided with two push arms **4323** to correspondingly eject and push two first ejection-push surfaces **4311**, thereby ensuring the uniformity of the force on the ejection-push sleeve **431** by applying force at two portions. The two push arms **4323** may be connected to a same connection portion **4324** to achieve a synchronous action and ensure a consistent magnitude of applied force, thereby ensuring the evenly applied force on the ejection-push sleeve **431**. Correspondingly, the two push arms **4323** are respectively provided with a second ejection-push surface **4321**.
[0114] In some embodiments, two first ejection-push surfaces **4311** may be disposed on two opposite sides of the ejection-push sleeve **431**. The two push arms **4323** may be disposed in parallel. The second ejection-push surface **4321** may be disposed on an end of the push arm **4323** away from the connection portion **4324**, and the ejection-push operations can be achieved by pushing the connection portion **4324**.
[0115] In some embodiments, the numbers of the first ejection-push surface **4311**, the second ejection-push surface **4321**, and the push arm **4323** may be set to more than two according to specifications of the ejection-push sleeve **431**.
[0116] In some embodiments, in order to limit a rotation of the ejection-push sleeve **431**, a first ejection-push groove **4312** may be opened on the ejection-push sleeve **431**. The push rod **432** is, by embedding the push rod **432** in the ejection-push groove **4312**, connected to the ejection-push sleeve **432** as a whole, thereby limiting a circumferential rotation of the ejection-push sleeve **432** and ensuring a reliability of the ejection-push operations.
[0117] In some embodiments, two first ejection-push grooves **4312** may be provided. The push rod **432** may be provided with two push arms **4323** which are disposed in parallel. The two push arms **4323** may be connected by the connection portion **4324**. The two first ejection-push grooves **4312** are disposed on two opposite sides of the ejection-push sleeve **431**, thereby stably limiting at two points and ensuring a stability of force subjected by the ejection-push sleeve **431**. Correspondingly, first ejection-push surfaces **4311** are respectively disposed on groove walls of the two first ejection-push grooves **4312**.
[0118] In some embodiments, second ejection-push surfaces **4321** may be respectively disposed on ends of the two push arms **4323** away from the connection portion **4324**. Two second ejection-push surfaces **4321** are in contact with the two first ejection-push surfaces **4311** respectively.
[0119] In order to limit a radial deviation of the ejection-push sleeve **431**, a limit baffle **4322** may be respectively disposed on the two push arms **4323**, and the limit baffle **4322** is specifically disposed on a side of the push arm **4323** away from the other push arm, and the two limit baffles **4322** are disposed on two opposite sides of the ejection-push sleeve.
[0120] In order to implement the ejection-push operations of the push rod **432**, a linear driver **433** may be connected to the push rod **432** to eject and push the push rod **432** in a second direction or reset the push rod **432**, and the ejection-push sleeve **431** can be pushed to move in the first direction by the linear driver **433** through the ejection-push sleeve **431**, thereby realizing a connection between the first transmission assembly **410** and the second transmission assembly **420** and establishing a torque transmission structure for the door opening and closing device.
[0121] When the linear driver **433** is reset, the push rod **432** releases the ejection-push sleeve **431**, and the first transmission assembly **410** and the second transmission assembly **420** are

disconnected, that is, the torque transmission structure for the door opening and closing device is disconnected.

[0122] In some embodiments, the linear driver **433** may be a linear movement assembly such as an electromagnetic push rod or a ball screw or the like.

[0123] In some embodiments, the driver **110** may be configured as a reduction motor, or a motor equipped with a reduction gearbox, thereby being capable of properly controlling an output torque and rotation speed.

[0124] When a clutch control is performed, the linear driver **433** is actuated to push the push rod **432** to move toward the ejection-push sleeve **431**, and the second ejection-push surface **4321** opened at a head end of the push rod **432** ejects and pushes the first ejection-push surface **4311**, and the ejection-push sleeve **431** moves upward, that is, the ejection-push sleeve **431** moves toward the first transmission assembly **410** and at the same time drives the first transmission member **421** of the second transmission assembly **420** to move toward the first transmission assembly **410**, until the connection end **4211** of the first transmission member **421** is embedded in the slot **411** of the first transmission member **410**, and a circumferential transmission connection relationship is established. At this time, the linear driver **433** stays in current position, and the ejection-push sleeve **431** is supported at a bottom by the push rod **432**, thereby maintaining a connection state for transmission. The driver **110** rotates to drive the rotation of the second transmission member **422**, and then drive the first transmission member **421**, the first transmission assembly **410** and the linkage gear **120** to rotate, to realize a driving for the door opening and closing. When it is required to disconnect the first transmission assembly **410** from the second transmission assembly **420**, the linear driver **433** is reset, and the ejection-push sleeve **431** falls naturally under an action of own weight of the ejection-push sleeve **431**, and the connection end **4211** gradually disengages from the slot **411** until the first transmission member **421** and the first transmission assembly **410** is disconnected, thereby disconnecting the linkage gear **120** from the driver **110**. During this process, the first transmission member **421** can slide axially relative to the second transmission member **422** to achieve changes in upper and lower positions. A circumferential transmission can be achieved through an embedding-in action between the block **4222** and the axial through groove **4217** inside the first transmission member **421** and the second transmission member **422** respectively. It is worth noting that an action timing of the linear driver **433** is not necessarily earlier than an action timing of the driver **110**, that is to say, there is no necessary order between the action timings of the linear-driver **433** and the driver **110**.

[0125] The door rotation mechanism **200** and the door ejection mechanism **300** will be described below respectively.

[0126] Referring to FIG. **10**, in some embodiments, a hinge seat **230** may be disposed on the door body **920**, and hinged to the door-rotation-member first end **221**. In order to ensure a hinge reliability and force uniformity, the hinge seat **230** may be configured as a U-shaped double-arm hinge seat, and the door-rotation-member first end **221** is embedded in the hinge seat **230** and fixed by a hinge shaft.

[0127] In some embodiments, the drive member **210** and the door rotation member **220** may be configured to be plate-shaped, and in a condition that the drive member **210** and the door rotation member **220** are stacked, an installation height can be greatly reduced.

[0128] Referring to FIG. **14**, in some embodiments, pivoting portions of the drive member **210** and the door rotation member **220** may be respectively configured to have a reduced thickness, and the pivoting portions of the drive member **210** and the door rotation member **220**, when pivoting in a superimposed state, have an overall reduced thickness and height. Pivoting portions of the drive member **210** and the door rotation member **220** may also be configured as a pivot shaft **214** which is rotatably disposed at a lower plate-like member to support an upper plate-like member to form a stable and reliable pivot structure. In other embodiments, an end of one of the drive member **210** and the door rotation member **220** may be configured as a U-shaped pivot seat, and an end of

another one of the drive member **210** and the door rotation member **220** may be embedded in the U-shaped pivot seat and fixed by the pivot shaft **214**.

[0129] In some embodiments, the drive member **210** and the door rotation member **220** may be configured to be rod-shaped, to be compatible with a small-sized and high-strength door rotation structure.

[0130] In some embodiments, the linkage gear **120** is configured as a component to directly drive the drive member **210** and the door ejection mechanism **300**, and thus the linkage gear **120** should be able to simultaneously drive the drive member **210** and the door ejection mechanism **300**.

[0131] In some embodiments, the door ejection mechanism **300** serves as an actuator for initially ejecting and opening the door body **920** to a preset angle, and can realize the door-opening operation by gradually accumulating force under the driving of the drive mechanism **100**. A structure of the door ejection mechanism **300** will be described in detail below.

[0132] Referring to FIG. **1** and FIG. **12**, in some embodiments, the door ejection mechanism **300** includes a linkage member **310** and a door ejection member **320**. An end of the linkage member **310** is connected to the drive mechanism **100** for obtaining the driving force. The linkage member **310** can act under the driving of the drive mechanism **100**. Another end of the door ejection member **320** is configured to eject and push the door body **920** to rotate. The door ejection member **320** is connected to the linkage member **310**, and a door-ejection operation and a reset are implemented under the driving of the linkage member **310**.

[0133] In some embodiments, an end of the linkage member **310** is rotatably disposed on the base **600**, and thus can deflect around a rotation axis under the driving of the drive mechanism **100**. The door ejection member **320** is rotatably connected to the linkage member **310**, and thus can move along an arc trajectory with the linkage member **310**, and continues to eject and push the door body **920** after abutting against the door body **920**. A deflection structure of the linkage member **310** can reduce a front pressure on the door ejection mechanism **300** to an extent while an ejecting and pushing effect is also ensured, thereby ensuring a structural stability and service life and improving a reliability of door-ejection operation.

[0134] In some embodiments, in order to further improve efficiencies of the door-ejection operations, the door ejection member **320** can be rotatably connected to the linkage member **310**, and the door ejection member **320** can be deflected relative to the linkage member **310** and posture of the door ejection member **320** can be adjusted. A direction to which the door ejection member **320** is pointed can be adaptively adjusted according to installation conditions of the door ejection member **320**, and the door ejection member **320** can face the door body **920**, thereby ensuring an efficient ejecting and pushing. On the other hand, the door ejection mechanism **300** can adapt to requirements of different installation conditions, flexibly adjust a fitting state of the linkage member **310** and the door ejection member **320**, and ensure a high-efficiency ejection-push performance.

[0135] In some embodiments, the door ejection member **320** is rotatably connected to a middle portion of the linkage member **310**, thereby leaving a sufficient deflection space for the door ejection member **320** to avoid an interference with other structures.

[0136] In order to ensure a high door ejection efficiency, the ejection-push direction of the door ejection member **320** may be set as being approximately perpendicular to the door body **920** which is closed. Since the door ejection member **320** rotates with the linkage member **310**, the ejection-push direction will also be deflected to an extent. In order to achieve that the door ejection member **320** is as perpendicular to the door body **920** as possible and stably applies an ejection-push force, a waist-shaped hole **322** can be opened on the door ejection member **320**, and a pin shaft **360** is disposed on the linkage member **310**. The door ejection member **320** can be deflected relative to the linkage member **310** by movably embedding the pin shaft **360** in the waist-shaped hole **322**. At the same time, a space along a length direction of the waist-shaped hole **322** can be reserved as a sliding space for the pin shaft **360**, and the door ejection member **320** can relatively slide along the

length direction of the waist-shaped hole **322** without having to move with the linkage member **310**, thereby maintaining a stability of the ejection-push direction of the door ejection member **320**. A length of the waist-shaped hole **322** can be designed according to a length of a door ejection stroke. For example, the longer the door ejection stroke is, the longer the length of the waist-shaped hole **322** is.

[0137] In some embodiments, in order to meet requirements of greater ejection-push force and ejection-push stroke with a smaller size of the waist-shaped hole **322**, the length direction of the waist-shaped hole **322** may be disposed perpendicular to the ejection-push direction of the door ejection member **320**. In other embodiments, the length direction of the waist-shaped hole **322** does not have to be strictly disposed perpendicular to the ejection-push direction of the door ejection member **320**, i.e., there may be an angle between the length direction of the waist-shaped hole **322** and the ejection-push direction of the door ejection member **320**, as long as that a moving stroke of the pin shaft **360** has a component in the ejection-push direction of the door ejection member **320**, thereby ensuring that an axial ejection-push posture of the pushing rod **320** is stable. The angle between the length direction of the waist-shaped hole **322** and the ejection-push direction of the door ejection member **320** may be set as 30 degrees, 45 degrees, or 60 degrees.

[0138] In some embodiments, in order to ensure a balanced force applied on the door ejection member **320**, the linkage member **310** may be disposed below the door ejection member **320** to support the door ejection member **320** to an extent, and the pin shaft **360** can be stably embedded in the waist-shaped hole **322** in an axial direction of the pin shaft **360** without a risk of detachment, thereby ensuring a stability of a pivoting function and sliding function of the waist-shaped hole **322** and the pin shaft **360**.

[0139] In some embodiments, the waist-shaped hole **322** may be disposed on the linkage member **310**, and the pin shaft **360** may be disposed on the door ejection member **320**. In order to ensure a stability of the pivoting function and the sliding function, the linkage member **310** may also be disposed above the door ejection member **320**, which is not limited here.

[0140] In some embodiments, in order to reduce an overall installation height, reduce an apparatus scale and reduce installation space requirements and material costs, a thickness reduction groove **312** may be opened on the linkage member **310** in a condition that a structural strength of the linkage member **310** can be ensured, thereby reducing a stacked thickness of the linkage member **310** and the door ejection member **320**. A width of thickness reduction groove **312** may be configured to be slightly larger than a width of area passed by the door ejection member **320** on the linkage member **310** when the door ejection member **320** deflects in the waist-shaped hole **322**, to prevent a side wall of the thickness reduction groove **312** from blocking a deflection of linkage member **310** relative to the door ejection member **320**.

[0141] Referring to FIGS. **12** and **19**, in some embodiments, during a deflection of the linkage member **310**, the door ejection member **320** will, affected by a friction between the pin shaft **360** and the waist-shaped hole **322**, still have a tendency to move in a direction perpendicular to the ejection-push direction, and thus, a guide groove **632** can be opened on the base **600**. The door ejection member **320** can be slidably disposed in the guide groove **632** along a set door ejection direction, to limit a displacement of the door ejection member **320** in a direction perpendicular to the ejection-push direction and ensure the stability of the door ejection operations. In order to enhance a guiding and limiting effect, a width of the guiding groove **632** along the direction perpendicular to the ejection-push direction may be set to be slightly larger than a width of the door member **320**, with only a gap reserved for sliding.

[0142] In some embodiments, in order to ensure a smooth sliding of the door ejection member **320**, a self-lubricating material layer may be disposed on a groove surface of the guide groove **632**, or a portion of the door ejection member **320** which slides in the guide groove **632** may be provided with a self-lubricating material layer, or both the groove surface of the guide groove **632** and the portion of the door ejection member **320** which slides in the guide groove **632** may be provided

with a self-lubricating material layer, or the guide groove **632** and the door ejection member **320** may be directly formed by self-lubricating material to further reduce an impact of friction.
[0143] Referring to FIG. **12**, in some embodiments, in consideration of influences of assembly accuracy and fitting clearance, an ejection-push seat **330** may be hinged on an end of the door ejection member **320** away from the linkage member **310**, and when the door ejection member **320** contacts the door body **920**, the ejection-push seat **330** will first abut against the door body **920** and can adaptively deflect, and the ejection-push seat **330** and the door body **920** can achieve an surface-to-surface contact, thereby ensuring a stability of size and posture of a contact surface, ensuring a stability of direction and magnitude of a force applied for door ejection, and reducing a risk of excessive contact pressure which will cause damage to the door body or the door ejection member **320** due to a small contact surface.
[0144] In some embodiments, in order to improve an adaptability in all directions, the ejection-push seat **330** and the door member **320** may be connected by a universal hinge structure.
[0145] In some embodiments, in order to reduce a contact vibration between the ejection-push seat **330** and the door body **920** and the ejection-push seat **330**, a shock-absorb pad **340** may be disposed on the ejection-push seat **330**. The shock-absorb pad **340** may be made of a material with a low friction coefficient.
[0146] In some embodiments, a second end of the linkage member **310** is provided with a first tooth portion **313** that meshes with the drive mechanism **100**, and the linkage member **310** is driven to rotate through gear meshing transmission, thereby achieving a precise control of rotation amplitude of the linkage member **310**, and in turn improving a control accuracy of ejection-push stroke of the door ejection mechanism **300**.
[0147] In some embodiments, in consideration that during the door ejection operation, in a condition that the door body **920** is ejected and pushed to have a small opening degree, the adsorption force between the door body **920** and the box body **910** can be broke through, and thus a deflection angle for breaking through the adsorption force of the door body **920** relative to the box body **910** may be set to be about 3 degrees, and thus the ejection-push stroke is also correspondingly smaller, and a deflection angle of the linkage **310** can also be set to be small. Usually, a position of the linkage member **310** on the base **600** can be determined according to the deflection angle for breaking through the adsorption force and the door-rotation resistance, and a preset position of linkage member **310** on the base **600** is determined.
[0148] Referring to FIG. **12**, in some embodiments, in order to ensure a control accuracy of rotation angle of the linkage member **310**, an elastic limit member **370** may be connected between the base **600** and the linkage member **310** to always pull the linkage member **310** toward a preset position. Therefore a control accuracy of the linkage member **310** can be ensured, and a positioning accuracy and stability of a meshing connection of the linkage member **310** with the drive mechanism **100** can also be ensured.
[0149] In some embodiments, the elastic limit member **370** may be a tension spring, two ends of which are respectively connected to the linkage member **310** and the base **600**. A stable elastic tensioning force can be applied through elastic elongation and deformation of the elastic limit member **370**. A deflection process of the linkage member **310** can be adapted based on an adaptive deformation of the tension spring, and a stability of elastic tensioning effect can be ensured. In other embodiments, the elastic limit member **370** may also be an elastic member in other forms such as a spring plate.
[0150] Referring to FIGS. **12**, **14** and **19**, in some embodiments, a third fix seat **314** may be disposed on the linkage member **310**, and a fourth fix seat **635** may be disposed on the base **600**. The third fix seat **314** and the fourth fix seat **635** are respectively configured to fix two ends of the tension spring, thereby improving a stability of the tension spring under deflection and deformation.
[0151] In some embodiments, a first stop member **630** may be further disposed on the base **600** and

disposed at an end point of a preset deflection stroke of the linkage member **310**. The door ejection mechanism **300**, when deflected to a preset angle relative to the base **600**, abuts against the first stop member **630**, thereby limiting an excessive deflection of the linkage member **310** and limiting further deflection of the door ejection mechanism **300** as a whole. At the same time, the first stop member **630** can also ensure that a stable meshing connection of the first tooth portion **313** and the drive mechanism **100** can be established.

[0152] Referring to FIG. **19**, in some embodiments, the linkage member **310** is driven by the drive mechanism **100** to perform a door ejection deflection and door reset deflection, and thus two deflections in opposite directions relative to the base **600** will be generated, and there are two deflection limiting position. In order to ensure a position control accuracy of the linkage member **310**, a first stop surface **633** and a second stop surface **634** may be respectively disposed on the first stop member **630**, and are respectively arranged at two end points of the preset deflection stroke of the linkage member **310** to realize a limit for two deflections in opposite directions. In some embodiments, the first stop surface **633** and the second stop surface **634** may be configured to be surfaces which match with outer profile surfaces of the linkage member **310**, thereby improving a reliability of limit.

[0153] In some embodiments, the first stop member **630** may be an independent structural member installed on the base **600**, and a height of the first stop member **630** is slightly higher than a height of the linkage member **310**, thereby realizing a stop function. In other embodiments, the first stop member **630** may also be directly formed on the base **600**, that is, an integrated structure having a stop surface or a stop member portion may be formed on the base **600**.

[0154] In some embodiments, the first stop member **630** may be disposed corresponding to the elastic limit member **370**, that is, the linkage member **310** may be elastically tightened or elastically pressed toward the first stop member **630** by configuring an installation position of the elastic limit member **370**.

[0155] Referring to FIGS. **12** and **19**, in some embodiments, an elastic-member accommodation groove **631** may be opened on the first stop member **630**. A first end of the elastic limit member **370** may be connected in the elastic accommodation groove **631** to not only enable the elastic limit member **370** to be assembled on the base **600**, but also protect the elastic limit member **370** through a groove structure to avoid scratches and collisions that affect a deformation state of the elastic limit member **370**, thereby ensuring a reliability and accuracy of the linkage member **310**.

[0156] Referring to FIGS. **12**, **14** and **19**, in some embodiments, the fourth fix seat **314** may be disposed on a portion of the linkage member **310** between the first tooth portion **313** and the pin shaft **360**, that is, the fourth fix seat **314** is located between a force bearing point and a force application point of the linkage member **310**, thereby improving an elastic limiting effect to an extent and improving a performance of the linkage member **310** in resisting vibration and external interference.

[0157] In some embodiments, in order to adapt to a deflection action of the linkage member **310**, a second end of the elastic limit member **370** will also deflect to a degree, and the elastic limit member **370** as a whole will deflect with the first end of the elastic limit member **370** as a center. In order to prevent the elastic accommodation groove **631** from scratching, abutting against the elastic limit member **370** to affect a deformation state of the elastic limit member **370**, a groove body shape of the elastic accommodation groove **631** may be configured as a fan-shaped shape to leave sufficient space for deflection.

[0158] In some embodiments, the linkage member **310** may be configured as a plate, and a thickness direction of the linkage member **310** is configured to be perpendicular to the deflection direction, thereby ensuring a structural strength under a condition of the door ejection operation, and also reducing an overall assembly thickness of the linkage member **310** and a height requirement for installation. The door ejection member **320** may also be configured as a plate member, and a thickness direction of the door ejection member **320** is configured to be

perpendicular to the deflection direction and the ejection-push direction, thereby reducing an overall assembly height. In other embodiments, the linkage member **310** and the door ejection member **320** may also be configured as rod members.

[0159] Referring to FIGS. **14** and **15**, in some embodiments, the first tooth portion **313** may be disposed at a first end of a plate body of the linkage member **310**, and a linkage-member pivot hole **311** is opened at a second end of the plate body of the linkage member **310**. A linkage-member pivot shaft **350** is disposed on the base **600**, and the linkage-member pivot shaft **350** is rotatably embedded in the linkage-member pivot hole **311**, and the linkage member **310** can rotate relative to the base **600**, thereby reducing an overall volume of the linkage member **310** in a condition that a linkage function is achieved. In other embodiments, a waist-shaped hole **322** may also be disposed at a first end of plate body of the door ejection member **320**, to reduce a length and width and overall volume of the door ejection member **320** while functional requirements for door ejection can be met.

[0160] In some embodiments, in order to improve a structural strength of the linkage member **310** and the door ejection member **320**, reinforcement ribs may be disposed on plate bodies of the linkage member **310** and the door ejection member **320**.

[0161] When the door opening and closing device is assembled to an electrical apparatus having a box body **910** and a door body **920** hinged to the box body **910**, the base **600** may be fixed on the box body **910**, and the door ejection direction of the door ejection member **320** directly faces to the door body **920**. When the door opening operation is performed, the drive mechanism **100** drives the linkage member **310** to deflect in a forward direction relative to the base **600**, to drive the door ejection member **320** to slide along the guide groove **632** until the door ejection member **320** contacts the door body **920** and the ejection-push force gradually increases until the ejection-push force breaks through the adsorption force and other rotation resistance between the door body **920** and the box body **910**, thereby ejecting and opening the door body **920**. When the door closing operation is performed, the drive mechanism **100** drives the linkage member **310** to deflect in a reverse direction relative to the base **600**, to drive the door ejection member **320** to slide in the reverse direction along the guide groove **632** until the door ejection member **320** is reset.

[0162] Referring to FIG. **13**, the door ejection mechanism **300** may be configured as a door ejection profile **380**. The door ejection profile **380** may be rotatably disposed on the base **600** via a linkage-member pivot shaft **350**. Areas of the door ejection profile **380** may be divided according to functions thereof, that is, a fourth tooth portion **381** for meshing and connecting the drive mechanism **100** is provided. The door ejection profile **380**, under the driving of the drive mechanism **100**, is driven to rotate. A door ejection portion **382** may be disposed on the door ejection profile **380**. The door ejection portion **382**, when driven by the drive mechanism **100** to rotate, ejects and pushes the door body **920** until the door body **920** is pushed to open to an opening degree.

[0163] In some embodiments, the door ejection profile **380** is a fan-shaped structural member. The door ejection portion **382** is a corner portion of an end of the fan-shaped structural member. The door ejection profile **380**, when rotating, ejects and pushes the door body **920** along an arc trajectory. In other embodiments, the door ejection profile **380** may be configured as a shape of a cam, and the first tooth portion **381** and the door ejection portion **382** may be disposed on a rim of the cam. The door ejection profile **380** in a cam shape rotates relative to the base **600** and is driven by the drive mechanism **100** to rotate to smoothly eject and push the door body **920** along an arc trajectory, thereby reducing a severity of impact vibration of the ejection-push operations.

[0164] In some embodiments, in order to improve a structural strength, reinforcement ribs **383** may be disposed on a fan-shaped structural member.

[0165] Referring to FIG. **20**, FIG. **21** and FIG. **22**, in some embodiments, the base **600** is configured to be assembled by two independent housings that are matched and snap-fitted together, and fasteners such as fastening screws may be correspondingly provided for locking. A window

may be opened in areas where the door ejection member **320** or the door ejection profile **380**, the door rotation member **220** and the drive member **210** pass by, to facilitate extensions of the door ejection member **320** or the door ejection profile **380**, the door rotation member **220** and the drive member **210**, and thus a smooth execution of door opening and closing operations is ensured, while orderly storage can be achieved and an internal functional structure can be protected.

[0166] In some embodiments, a shaft reinforcement fixing structure may be configured corresponding to positions of the coaxial rotation shaft **211** and the linkage-member pivot shaft **350** to ensure a reliability of a pivot structure.

[0167] In some embodiments, a coaxial rotation-shaft seat **650** is disposed on the base **600** for rotating and fixing the coaxial rotation shaft **211**, thereby improving structural stability, fully improving impact resistance, and ensuring that the door rotation mechanism **200** and the linkage gear **20** are stably and reliably coaxially pivoted on the base **600**. A driving-motor fix groove **610** for fixing the driver **110** is disposed on the base **600**.

[0168] Referring to FIG. **26** and FIG. **27**, in some embodiments, a refrigerator is further provided. The refrigerator includes a box body **910** and a door body **920**, and the door body **910** is rotatably disposed on the box body **910**. A door opening and closing device is connected between the box body **910** and the door body **920** to eject and push or deflect the door body **920** relative to the box body **910**, thereby realizing the door opening and closing operations.

[0169] In some embodiments, the door opening and closing device is provided with a base **600** which is fixed at the box body **910**. The door ejection member **320** or the door ejection profile **380** is directed to or pressed against the door body **920**. The door rotation member **220** is hinged on the door body **920** through the hinge seat **230**. In other embodiments, the base **600** may be an integrated profile structure formed at a top of the box body **910** to serve as the base. In other embodiments, the door ejection member **320** or the door ejection profile **380** is directed to or is pressed against the box body **910**. The door rotation member **220** is hinged to the box body **910** via the hinge seat **230**. In some embodiments, the refrigerator may be provided with door bodies **920**. An independent door opening and closing device may be provided corresponding to each door body **920**, to realize an automatic door opening and closing functionality of the multi-door body refrigerator.

[0170] Referring to FIGS. **28** and **29**, when the door opening operation is performed, the linkage gear **120** rotates in a forward direction to drive the door ejection mechanism **300** to directly eject and push the door body **920**. After the linkage gear **120** rotates by an angle, an increasing ejection-push force reaches a critical value of breaking through the door opening resistance, and the door body is ejected and pushed to open and is maintained at an angle. As the linkage gear **120** continues to rotate in a forward direction, the first tooth portion **313** and the second tooth portion **1221** are disengaged, and a linkage rod **310** is tightened on the first stop member **630** under an action of the elastic limit member **370**. During the above process, the drive member **210** of the door rotation mechanism **200** approaches the second ejection-push portion **1232** from the first ejection-push portion **1231** until the drive member **210** abuts against the second ejection-push portion **1232**, and then the second ejection-push portion **1232** can continue to rotate in the forward direction with the linkage gear **120** to eject and push the door body **920** until the door body **920** reaches a set limit position, thereby realizing the door opening operation and the door rotation operation.

[0171] Referring to FIGS. **23**, **24**, **25** and **30**, when the door closing operation is performed, the linkage gear **120** rotates in the reverse direction, and the first ejection-push portion **1231**, when abutting against the drive member **210**, continues to rotate in the reverse direction and eject and pushes the drive member **210** to rotate in the reverse direction to pull the door rotation member **320** and the door body **920** to rotate toward the box body **910** until the box body **920** is closed to achieve the door closing operation. During the door closing operation, the linkage gear **120** rotates to an angle and is meshed with the first tooth portion **313** through the second tooth portion **1221** to eject and push the linkage member **310** to rotate in the reverse direction until the linkage member

310 reaches an initial position.

[0172] A door opening and closing control method for controlling the door opening and closing operations of an electrical apparatus equipped with the door opening and closing device is provided according to embodiments of the disclosure. The electrical apparatus includes a box body **910** and a door body **920**, and the door body **910** is rotatably disposed on the box body **910**. The door opening and closing device is disposed on the box body **910**, and the door body **920** is ejected and pushed and rotated, and the door rotation operation or the door opening and closing operations can be achieved. The door opening and closing device is a door ejection mechanism **300** and a door rotation mechanism **200** which are disposed on a base **600** and can rotate relative to the base **600**. The door ejection mechanism **300** and the rotating door mechanism **200** are driven by the linkage gear **120** of the drive mechanism **100** to realize a mechanical door ejection and door rotation operations and perform the door opening and closing operations.

[0173] Referring to FIG. **11**, in some embodiments, in order to ensure a door rotation efficiency and structural stability of the door rotation mechanism **200** and reduce an influence of a relative deflection state and extension length of the drive member **210** and the door rotation member **220** on an opening degree and door-rotation speed of the door body **920**, the door rotation mechanism **200** and a hinge point C of the door rotation mechanism **200** and the door body **920** can be planned and arranged in combination with a rotation center B of the door body **920** of the electrical apparatus and a layout position of the base **600**. The hinge point C between an end of the door rotation member **220** and the door body **920**, a hinge point A between the drive member **210** and an end of the door rotation member **220**, and a hinge point D through which another end of the drive member **210** is rotatably disposed on the base **600**, can be designed in a distribution state, that is, the hinge point A and the rotation center B are respectively located at two sides of a connection line between the hinge point C and the hinge point D, and thus a convex quadrilateral is formed by connecting hinge points A, B, C and D in sequence, thereby avoiding the drive member **210** and the door rotation member **220** from forming a deflection of more than 180 degrees during a rotation process. The deflection of more than 180 degrees may result in an extreme state that there is no force that can be acted on the door rotation member **220**, and thus the door rotation member **220** is unable to rotate the door body **920**, and a range of opening degree of the door body **920** is also limited and reduced.

[0174] In some embodiments, in order to maximize an opening angle of the door body **920** and the box body **910** themselves without being overly restricted by the door rotation mechanism **200**, a position of the hinge point C between an end of the door rotation member **220** and the door body **920**, a position of the hinge point D between another end of the drive member **210** and the base **600**, and a length of two hinge points of the drive member **210** and the door rotation member **220** may be set according to a principle that a quadrangle formed by connecting the hinge point A, the hinge point C, the rotation center B and the hinge point D in sequence is a parallelogram. In this state, regardless of factors such as a width and thickness of structural components such as a rotation shaft and a hinge, the opening degree of the door body **920** can be close to 180 degrees. In one embodiment, the opening degree of the door body **920** of a refrigerator is not the bigger the better, but it is determined based on multiple factors such as installation conditions, usage requirements, convenience and so on. In other embodiments, with the above arrangement, the opening degree of 130 degrees can be stably and reliably achieved for the door body **920**.

[0175] Referring to FIGS. **2**, **3**, **4** and **5**, in some embodiments, a clutch device is provided between the driver **110** and the linkage gear **120** to control a transmission of driving force between the linkage gear **120** and the driver **110**, thereby realizing a suspending and a start-stop control of the door opening and closing operations. The clutch device is provided with a first transmission assembly **410** and a second transmission assembly **420** that cooperate with each other and have a separated state and a connected state, and is also provided with a clutch-ejection-push assembly **430** for establishing a connection relationship and disconnecting a connection relationship between

the first transmission assembly **410** and the second transmission assembly **420**. In some embodiments, the second transmission assembly **420** is connected to the driver **110** to obtain the driving force; the first transmission assembly **410** is connected to the linkage gear **120** to transmit the driving force to the driving linkage **120**. The clutch-ejection-push assembly **430** pushes the second transmission assembly **420** and the first transmission assembly **410** toward each other to establish the connection state, thereby transmitting the driving force of the driver **110** to the linkage gear **120** through the second transmission assembly **420** and the first transmission assembly **410** in turn, to drive the linkage gear **120** to rotate. The clutch-ejection-push assembly **430** can also push the second transmission assembly **420** and the first transmission assembly **410** away from each other to disconnect the connection state, thereby cutting off a path for the linkage gear **120** to obtain the driving force and stopping a rotation of the linkage gear **120**. Therefore, an action of the clutch-ejection-push assembly **430** can be controlled by a stop rotation instruction to achieve a control of the linkage gear **120**, thereby meeting use requirements of some emergency conditions or accidental stop of the door body **920**.

[0176] In some embodiments, an in-place information of the door body **920** of the refrigerator can be obtained by configuring an angle acquisition unit **500** for detecting a rotation angle value of the linkage gear **120**, and by pre-establishing an association between the rotation angle value of the linkage gear **120** and the in-place information of the door body **920**, and a position of the door body **920** can be indirectly determined by detecting a real-time angle information of the linkage gear **120**, that is, the rotation angle value, and based on this, a door opening and closing control of the drive mechanism **100**, that is, a start and stop control of the driver **110**, and a control of an action of the clutch-ejection-push assembly **430** can be implemented, and then the connection and separation of the second transmission assembly **420** and the first transmission assembly **410** can be controlled. In other embodiments, the clutch-ejection-push assembly **430** can be configured to control a movement of the second transmission assembly **420** to achieve a clutch function, while the first transmission assembly **410** is configured as a structure a position of which remains unchanged relative to the base **600**.

[0177] In some embodiments, a rotation angle information of the linkage gear **120** can be monitored in real time to achieve a feedback control of an action of the clutch device **400**, that is, the clutch-ejection-push assembly **430** is controlled to control a separation and connection between the first transmission assembly **410** and the second transmission assembly **420**, thereby realizing a control of the door rotation operation.

[0178] In some embodiments, the angle acquisition unit **500** monitors the rotation angle information of the linkage gear **120** in real time, and based on the rotation angle information determines whether to execute an ejection-push action of the clutch-ejection-push assembly **430** to control the separation and connection of the first transmission assembly **410** and the second pushing assembly **420**.

[0179] In some embodiments, the rotation angle information is configured to represent an angle value rotated by the linkage gear **120**, and the angle value is compared with a preset angle value. If the angle value rotated by the linkage gear **120** is less than the preset angle value, the ejection-push-clutch assembly **430** will not act, and the connection state of the first transmission assembly **410** and the second transmission assembly **420** will be maintained. If the angle value rotated by the linkage gear **120** is greater than or equal to the preset angle value, the ejection-push-clutch **430** will act to push the first transmission assembly **410** and the second transmission assembly **420** to separate and disconnect the connection state.

[0180] In some embodiments, a size of the preset angle value is set according to the rotation angle value corresponding to a preset position during a door opening and closing process. The preset angle value may be a rotation angle value corresponding to a maximum opening degree, or may be a rotation angle value corresponding to any intermediate position. Therefore, when the door is fully opened or fully closed, the connection between the first transmission assembly **410** and the second

transmission assembly **420** can be cut off.
[0181] In some embodiments, the rotation angle information may be configured as a vector angle value, that is, the rotation angle information can output an angle value in the forward direction and an angle value in the reverse rotation corresponding to a forward and reverse rotation of the linkage gear **120**. Accordingly, the preset angle value is also configured as a vector threshold. When a forward rotation angle or a reverse rotation angle of the linkage gear **120** reaches the preset angle value in corresponding direction, the clutch-ejection-push assembly **430** separates the first transmission assembly **410** and the second transmission assembly **420**. In other embodiments, an action of the driver **110** may also be stopped.
[0182] In some embodiments, the angle information may also be configured to represent an angle acceleration value of the linkage gear **120**, and an action of the clutch-ejection-push assembly **430** is controlled based on the angle acceleration value to separate or maintain the connection state of the first transmission assembly **410** and the second transmission assembly **420**.
[0183] In some embodiments, the action of the clutch-ejection-push assembly **430** is controlled by comparing the angle acceleration value with a preset acceleration value.
[0184] In some embodiments, in order to prevent the door from rotating too fast and causing excessive impact on people or objects in a deflection area, causing stored materials to vibrate and fall and causing collision safety risks, the clutch-ejection-push assembly **430** may be driven to act to separate the first transmission assembly **410** and the second transmission assembly **420** when the angle acceleration value is greater than or equal to the preset acceleration value. A corresponding acceleration value at this time is an angle acceleration maximum limit.
[0185] In some embodiments, in consideration a situation that the door body abuts against a person or object, a rotation structure of the door body is stuck, or the door opening and closing mechanism fails and so son, and the angle acceleration value is too small, that is, less than an angle acceleration lower limit, a protective operation can also be implemented, that is, the clutch-ejection-push assembly **430** is driven to separate the first transmission assembly **410** and the second transmission assembly **420** to avoid damage to the door opening and closing device, the rotation structure of the door body and so on.
[0186] In some embodiments, the driver **110** is a motor. In other embodiments, a controller may be further configured to receive control instructions and control actions of the motor and the clutch-ejection-push assembly **430**.
[0187] In some embodiments, door opening commands, door closing commands, and stop rotation commands can be input through an active input device. The active input device is operated to apply a set trigger signal, and the drive mechanism **100** of the door opening and closing device is controlled to perform corresponding actions, thereby driving the door ejection mechanism **300** and the door rotation mechanism **200** to act to implement the door opening operation. In other embodiments, the active input device may be configured as a voice input terminal, an infrared sensing terminal, a touch terminal and so on. In other embodiments, the active input device may also be a sensor element such as a pressure sensor disposed on the door body **920** or the box body **910** that senses an operating pressure.
[0188] A refrigerator using the above control method is also provided by the disclosure. The refrigerator is provided with a controller, and the above door opening and closing device is connected to the controller, and a door opening and closing control is implemented through the controller. In some embodiments, the door opening and closing device may also be integrated into a controller system of the refrigerator.
[0189] With an electrical apparatus, a door opening and closing device and a control method for a clutch thereof according to some embodiments of the disclosure, automatic door-ejection operation and door rotation operation are realized respectively through a door ejection mechanism and a door rotation mechanism driven by a drive mechanism, and thus a convenience and safety of door-opening operation are improved. The door body can be ejected and pushed by the door ejection

mechanism, to accumulate force to break through a door opening resistance to eject and open the door to a set angle, thereby greatly reducing a subsequent door-rotation resistance of the door rotation mechanism and increasing an automatic door-opening speed. Furthermore, the first transmission assembly and the second transmission assembly which are separably connected are provided. An active clutching is achieved under the action of the clutch-ejection-push assembly. The second transmission assembly is connected to the driver, and the first transmission assembly is connected to the door ejection mechanism and the door rotation mechanism, thereby enabling a clutching between the drive mechanism and an actuator, thereby effectively avoiding an interference between automatic door opening and closing operations and manual door opening and closing operations. The driver, the door ejection mechanism and the door rotation mechanism can be protected through a flexible and controllable clutch function. With an angle monitoring unit, the rotation angle of the linkage gear is monitored in real time, which serves as a basis for determining a working condition and feedback controlling the action of the clutch-ejection-push assembly and the drive mechanism, thereby greatly improving a reliability of opening and closing the door.

[0190] Although some embodiments of the disclosure have been described, additional changes and modifications may be made to these embodiments. Therefore, it is intended that the appended claims be interpreted as including the embodiment as well as all changes and modifications that fall within the scope sought for by the disclosure.

[0191] Various changes and modifications to the disclosure without departing from the spirit and scope of the disclosure. Thus, if these modifications and variations of the disclosure fall within the scope of the claims of the disclosure and the equivalent technologies thereof, the disclosure is also intended to include these modifications and variations.

Claims

1. A door opening and closing device, comprising: a drive mechanism, a door ejection mechanism, a door rotation mechanism and an angle acquisition unit, wherein the drive mechanism comprises: a driver; a first transmission assembly; a second transmission assembly, connected to the driver and simultaneously separably connected to the first transmission assembly; a clutch-ejection-push assembly, pushing the second transmission assembly to separate from or connect to the first transmission assembly; a linkage gear, connected to the first transmission assembly and simultaneously connected to the door ejection mechanism and the door rotation mechanism; and wherein the angle acquisition unit is configured to acquire a rotation angle of the linkage gear.

2. The door opening and closing device according to claim 1, wherein the linkage gear further comprises: a body, rotatably disposed on a base; a first ejection-push portion, disposed on the body, and pushing, when the body rotates in a forward direction, the door rotation mechanism to rotate and open a door body; and a second ejection-push portion, disposed on the body, and pushing, when the body rotates in a reverse direction, the door rotation mechanism to rotate and to close the door body.

3. The door opening and closing device according to claim 2, wherein the door rotation mechanism rotates between the first ejection-push portion and the second ejection-push portion by a first angle; and the body and the door rotation mechanism are coaxially rotatably disposed on the base.

4. The door opening and closing device according to claim 3, wherein the door ejection mechanism comprises a first tooth portion; the linkage gear further comprises a third ejection-push portion which is provided with a second tooth portion for meshing with the first gear for transmission; and when the body rotates in the forward direction, the third ejection-push portion drives the door ejection mechanism to push the door body.

5. The door opening and closing device according to claim 2, wherein a rotation limit groove is disposed at the body; the body and the door rotation mechanism are coaxially rotatably disposed on the base; the door rotation mechanism is rotatable in the rotation limit groove; and the first

ejection-push portion and the second ejection-push portion are groove walls of the rotation limit groove in a radial direction of the linkage gear.

6. The door opening and closing device according to claim 1, wherein the door rotation mechanism comprises a transmission member and a door rotation member; a first end of the door rotation member is rotatably disposed on a door body; a second end of the door rotation member is rotatably connected to a first end of the transmission member; a second end of the transmission member is rotatably disposed on a base; and the linkage gear drives the transmission member to rotate and to drive the door rotation member to rotate the door body.

7. The door opening and closing device according to claim 1, wherein the door ejection mechanism comprises: a linkage member, a first end of which is rotatably disposed on the base, and a second end of which is connected to the linkage gear; a door ejection member, a first end of the door ejection member which is rotatably connected to the linkage member, and a second end of which is configured for ejecting and pushing a door body; and wherein, the linkage gear drives a rotation of the linkage member to drive the door ejection member to eject and push the door body.

8. The door opening and closing device according to claim 7, wherein the door ejection mechanism further comprises: an elastic limit member, being respectively connected to the linkage member and the base to maintain the linkage member at a preset angle.

9. The door opening and closing device according to claim 7, wherein one of the door ejection member and the linkage member is provided with a waist-shaped hole; the other one of the door ejection member and the linkage member is provided with a pin shaft; and the pin shaft is rotatably disposed in the waist-shaped hole.

10. The door opening and closing device according to claim 1, wherein the door ejection mechanism is rotatably disposed on the base, and comprises: a first tooth portion meshing with the linkage gear and a door ejection portion for ejecting and pushing a door body, and wherein the linkage gear drives, by the first tooth portion, the door ejection mechanism to rotate relative to the base, and to drive the door ejection portion to eject and push the door body.

11. The door opening and closing device according to claim 10, wherein the door ejection mechanism further comprises: a limit member, disposed on the base, wherein the door ejection mechanism abuts against the limit member upon the door ejection mechanism rotates to a preset angle relative to the base; and a tensioning member, two ends of which are respectively connected to the door ejection mechanism and the base to maintain the door ejection mechanism at the preset angle.

12. The door opening and closing device according to claim 10, wherein the door ejection mechanism is in a shape of a cam; and the first tooth portion and the door ejection portion are located at a rim of the cam.

13. The door opening and closing device according to claim 1, wherein the clutch-ejection-push assembly comprises an ejection-push sleeve which is sleeved on the second transmission assembly, and a push rod for pushing the ejection-push sleeve, and wherein the ejection-push sleeve is ejected and pushed by the push rod to separate the first transmission assembly from the second transmission assembly.

14. The door opening and closing device according to claim 13, wherein the second transmission assembly comprises: a first transmission member, comprising a connection end which is separably connected to the first transmission assembly and an ejection-push end which is embedded in the ejection-push sleeve, an axial through groove being opened on an inner surface of the first transmission member; a second transmission member, an outer surface of which is provided with a block thereon, wherein upon the first transmission member is sleeved on the second transmission member, the block is axially slidably embedded in the axial through groove; and a transmission shaft, connected to the driver, wherein the second transmission member and the first transmission assembly are both sleeved on the transmission shaft.

15. The door opening and closing device according to claim 13, wherein the ejection-push sleeve

ejects and pushes the second transmission assembly along a first direction; the ejection-push sleeve is provided with a first ejection-push surface; the push rod is provided with a second ejection-push surface which is in contact with the first ejection-push surface; and an angle between the first direction and the first ejection-push surface is an acute angle.

16. The door opening and closing device according to claim 13, wherein the ejection-push sleeve ejects and pushes the second transmission assembly along the first direction; the ejection-push sleeve is opened with two first ejection-push grooves; the two first ejection-push grooves are disposed on two opposite sides of the ejection-push sleeve; and groove walls of the two first ejection-push grooves are respectively provided with first ejection-push surfaces; and the push rod comprises two push arms which are disposed in parallel and a connection portion which connects the two push arms; and ends of the two push arms away from the connection portion are provided with second ejection-push surfaces; and the two second ejection-push surfaces are in contact with the two first ejection-push surfaces, respectively.

17. An electrical apparatus, comprising: a box body, a door body rotatably disposed on the box body, and the door opening and closing device according to claim 1, wherein the door opening and closing device is disposed between the box body and the door body, wherein the electrical apparatus is one of a refrigerator, a disinfection cabinet, and a dishwasher.

18. (canceled)

19. A door opening and closing control method, applied to the electrical apparatus according to claim 17, comprising: obtaining an angle information collected by the angle acquisition unit, wherein the angle information represents an angle value rotated by the linkage gear; and determining, according to the angle information, whether to control the clutch-ejection-push assembly to eject and push the second transmission assembly so that the first transmission assembly is separated from the second transmission assembly.

20. The door opening and closing control method according to claim 19, wherein the determining, according to the angle information, whether to control the clutch-ejection-push assembly to eject and push the second transmission assembly, comprises: determining whether the angle value represented by the angle information is greater than or equal to a preset angle value; and controlling, if the angle value is greater than or equal to the preset angle value, the clutch-ejection-push assembly to eject and push the second transmission assembly so that the first transmission assembly is separated from the second transmission assembly.

21. The door opening and closing control method according to claim 19, wherein the determining, according to the angle information, whether to control the clutch-ejection-push assembly to eject and push the second transmission assembly, comprises: obtaining, according to the angle information, an angle acceleration value of the linkage gear; and determining, according to the angle acceleration value, whether to control the clutch-ejection-push assembly to eject and push the second transmission assembly so that the first transmission assembly is separated from the second transmission assembly, wherein the determining, according to the angle acceleration value, whether to control the clutch-ejection-push assembly to eject and push the second transmission assembly, comprises: determining whether the angle acceleration value is greater than or equal to a preset acceleration value, and controlling, if the angle acceleration value is greater than or equal to the preset acceleration value, the clutch-ejection-push assembly to eject and push the second transmission assembly so that the first transmission assembly is separated from the second transmission assembly.

22. (canceled)