

DOOR HINGE DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a door hinge device, and more particularly, the present invention relates to a door hinge device which is installed to a door in a state that any torsional moment does not act on a torsional coil spring disposed therein and allows torsional moment of the torsional coil spring to be adjusted by a separate elasticity adjusting procedure, thereby causing installation thereof and the elasticity adjusting procedure for the torsional coil spring to be performed in a simple, easy and rapid manner, which enables the door to be adjusted in its opening and closing velocity in a more subdivided manner, and which makes the door to be smoothly opened by small force and to be slowly and automatically closed at predetermined velocity, thereby increasing valuableness of itself.

Description of the Related Art

Generally, a door hinge is mounted to a door in most buildings and functions to support the door in a state that the door is rotatably suspended by a corresponding door frame. A door hinge includes a pair of vertical support elements

which are arranged in a side by side relationship in a vertical direction or a pair of horizontal support elements which are arranged in a side by side relationship in a horizontal direction. Between a pair of horizontal support elements or a pair of vertical support elements, one support element is fastened to a door and the other support element is fastened to a door frame.

The door hinge having a simple construction as mentioned above encounters a problem in that since a door cannot be automatically closed, inconvenience is caused upon opening and closing the door. To solve this problem, a hydraulically-actuated door automatic closing device is used. However, this door automatic closing device is expensive, and it is difficult to install the device to a door.

Recently, to overcome these problems, a door hinge device which includes a torsional coil spring for enabling a door to be automatically closed, is disclosed in the art by the applicant of this application, et al. Because this type of door hinge device is inexpensive, an advantage is provided in that it can be widely used.

However, this type of door hinge device suffers from defects in that since the door hinge device must be installed to a door and a door frame in a state that a desired torsional moment acts on the torsional coil spring, installation of the door hinge device and an elasticity adjusting procedure, that

is, a torsional moment adjusting procedure for the torsional coil spring cannot be easily performed. According to this, if torsional moment is not properly adjusted, for example, the door is likely to be rapidly closed to hurt the human body. Further, in the door hinge device of the prior art, which uses a torsional coil spring, because the door is so stiff that it is opened with difficulty or is so loose that it is closed too quickly, door operation feeling is impaired, whereby valuableness of the entire door hinge device is deteriorated.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been made in an effort to solve the problems occurring in the related art, and an object of the present invention is to provide a door hinge device which is installed to a door in a state that any torsional moment does not act on a torsional coil spring disposed therein and allows torsional moment of the torsional coil spring to be adjusted by a separate elasticity adjusting procedure, thereby causing installation thereof and the elasticity adjusting procedure to be performed in a simple, easy and rapid manner..

Another object of the present invention is to provide a door hinge device which enables the door to be adjusted in its opening and closing velocity in a more subdivided manner.

Still another object of the present invention is to provide a door hinge device which makes the door to be smoothly opened by small force and to be slowly and automatically closed at predetermined velocity, thereby increasing valuableness of itself.

According to one aspect of the present invention, there is provided a door hinge device comprising: a first support element fastened to a door and having a rotary cylindrical part; a second support element fastened to a door frame and having a pair of fixed cylindrical parts which are vertically aligned with both ends of the rotary cylindrical part of the first support element, respectively; a plug member inserted into a first fixed cylindrical part of the second support element and locked to one end of the rotary cylindrical part of the first support element; a rotational shaft having one end inserted into the rotary cylindrical part of the first support element through a second fixed cylindrical part of the second support element to be rotatably supported by the plug member and a middle portion formed with a larger diameter part; a torsional coil spring wound around the rotational shaft in the rotary cylindrical part of the first support element and having one end secured to the plug member and the other end secured to the larger diameter part of the rotational shaft; a first ratchet wheel fitted into the second fixed cylindrical part of the second support element such that

it cannot be rotated, the first ratchet wheel being seated onto the larger diameter part of the rotational shaft and having a plurality of first axial ratchets which are radially inwardly formed; a first cam member fitted into the second fixed cylindrical part of the second support element such that it cannot be rotated, the first cam member being seated onto the first ratchet wheel and having at least one axial camming protrusion; a second cam member having one end which is inserted into the second fixed cylindrical part of the second support element such that it can be rotated and can be moved in an axial direction, the one end being formed with at least one axial camming groove into which the axial camming protrusion can be engaged; a second ratchet wheel inserted into the second cam member such that it can be rotated integrally with the rotational shaft and can be moved in the axial direction, the second ratchet wheel having one end being formed with a plurality of second axial ratchets which can be engaged with the plurality of first axial ratchets of the first ratchet wheel; a cap member fastened to the other end of the rotational shaft which extends through the first ratchet wheel, the first cam member, the second cam member and the second ratchet wheel; and a coil spring wound around the rotational shaft between the second ratchet wheel and the cap member.

The first and second support elements are a pair of

vertical support elements which are arranged in a side by side relationship in a vertical direction. The other end of the second cam member is formed with a first outward flange portion which is seated onto one end of the second fixed cylindrical part of the second support element; a circumferential inner surface of the first outward flange portion is formed with a stepped portion; and the other end of the second ratchet wheel is formed with a second outward flange portion which is seated onto the stepped portion. The first ratchet wheel and the first cam member have a ring-shaped configuration, and the second cam member and the second ratchet wheel have a cylindrical configuration.

A circumferential inner surface of the second ratchet wheel is formed with at least one key, and a circumferential outer surface of the rotational shaft between the larger diameter part and the other end thereof is formed with at least one key groove into which the key is fitted; a circumferential inner surface of the second fixed cylindrical part is formed with an inward spline, and a circumferential outer surface of each of the first ratchet wheel and the first cam member is formed with an outward spline; and the cap member is formed with a tool inserting groove. The plug member has a support shaft portion which extends into the rotary cylindrical part of the first support element; a free end of the support shaft portion and the one end of the

rotational shaft are formed with a pair of inserting grooves, respectively; both ends of a round bar are inserted into the pair of inserting grooves, respectively; a pair of balls are intervened between bottom surfaces of the pair of inserting grooves and both ends of the round bar, respectively, to guide rotation of the rotational shaft; and a pair of ring washers are sandwiched between both ends of the rotary cylindrical part and the first and second fixed cylindrical parts, respectively. The plurality of first axial ratchets of the first ratchet wheel and the plurality of second axial ratchets of the second ratchet wheel have a configuration which is the same as that of the conventional gear teeth.

When the plurality of first axial ratchets of the first ratchet wheel and the plurality of second axial ratchets of the second ratchet wheel are engaged with each other, the rotational shaft can be rotated in one direction and cannot be rotated in the other direction; when the rotational shaft is rotated in the one direction by a tool inserted into the tool inserting groove which is formed in the cap member, force acts on the torsional coil spring in a winding direction thereof to increase torsional moment of the torsional coil spring; and when the second ratchet wheel is moved upward by raising the first outward flange portion of the second cam member while overcoming biasing force of the coil spring, engagement between the first ratchet wheel and the second ratchet wheel

is released and the torsional coil spring is unwound to be decreased in its torsional moment.

The larger diameter part of the rotational shaft is formed with a circumferential groove; a pair of semi-circular washers are fitted into the circumferential groove; and the pair of semi-circular washers are squeezed by a predetermined squeezing force against a bottom surface of the circumferential groove by means of a screw which extends through a wall of the rotary cylindrical part of the first support element. A friction-resistant and heat-resistant lining or pad is attached to a circumferential inner surface of each semi-circular washer.

The one direction is a clockwise direction and the other direction is counterclockwise direction; the torsional coil spring is a left-handed torsional coil spring which is wound left; and when the rotary cylindrical part is rotated in the counterclockwise direction as the door is opened, force acts on the torsional coil spring in the winding direction thereof to increase torsional moment of the torsional coil spring.

According to another aspect of the present invention, there is provided a door hinge device comprising: a first support element fastened to a door and having a rotary cylindrical part one end of which is closed; a second support element fastened to a door frame and having a fixed cylindrical part which is vertically aligned with the other

end of the rotary cylindrical part of the first support element; a rotational shaft having one end inserted into the rotary cylindrical part of the first support element through the fixed cylindrical part of the second support element to be rotatably supported by the closed one end of the rotary cylindrical part and a middle portion formed with a larger diameter part; a torsional coil spring wound around the rotational shaft in the rotary cylindrical part of the first support element and having one end secured to the closed one end of the rotary cylindrical part and the other end secured to the larger diameter part of the rotational shaft; a first ratchet wheel fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first ratchet wheel being seated onto the larger diameter part of the rotational shaft and having a plurality of first axial ratchets which are radially inwardly formed; a first cam member fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first cam member being seated onto the first ratchet wheel and having at least one axial camming protrusion; a second cam member having one end which is inserted into the fixed cylindrical part of the second support element such that it can be rotated and can be moved in an axial direction, the one end being formed with at least one axial camming groove into which the axial camming protrusion can be engaged; a second ratchet wheel inserted

into the second cam member such that it can be rotated integrally with the rotational shaft and can be moved in the axial direction, the second ratchet wheel having one end being formed with a plurality of second axial ratchets which can be engaged with the plurality of first axial ratchets of the first ratchet wheel; a cap member fastened to the other end of the rotational shaft which extends through the first ratchet wheel, the first cam member, the second cam member and the second ratchet wheel; and a coil spring wound around the rotational shaft between the second ratchet wheel and the cap member.

The first and second support elements are a pair of horizontal support elements which are arranged in a side by side relationship in a horizontal direction.

According to still another aspect of the present invention, there is provided a door hinge device comprising: a first support element fastened to a door and having a rotary cylindrical part a middle section of which is closed to define two operating chambers in the rotary cylindrical part; a second support element fastened to a door frame and having a pair of fixed cylindrical parts which are vertically aligned with both ends of the rotary cylindrical part of the first support element, respectively; first door hinge means disposed in a first fixed cylindrical part of the second support element and a first operating chamber of the rotary

cylindrical part of the first support element; and second door hinge means disposed in a second fixed cylindrical part of the second support element and a second operating chamber of the rotary cylindrical part of the first support element.

Each of the first and second door hinge means comprises: a rotational shaft having one end inserted into the operating chamber of the rotary cylindrical part of the first support element through the fixed cylindrical part of the second support element to be rotatably supported by the closed middle section of the rotary cylindrical part and a middle portion formed with a larger diameter part; a torsional coil spring wound around the rotational shaft in the operating chamber of the rotary cylindrical part of the first support element and having one end secured to the closed middle section of the rotary cylindrical part and the other end secured to the larger diameter part of the rotational shaft; a first ratchet wheel fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first ratchet wheel being seated onto the larger diameter part of the rotational shaft and having a plurality of first axial ratchets which are radially inwardly formed; a first cam member fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first cam member being seated onto the first ratchet wheel and having at least one axial camming protrusion; a second cam member having

one end which is inserted into the fixed cylindrical part of the second support element such that it can be rotated and can be moved in an axial direction, the one end being formed with at least one axial camming groove into which the axial camming protrusion can be engaged; a second ratchet wheel inserted into the second cam member such that it can be rotated integrally with the rotational shaft and can be moved in the axial direction, the second ratchet wheel having one end being formed with a plurality of second axial ratchets which can be engaged with the plurality of first axial ratchets of the first ratchet wheel; a cap member fastened to the other end of the rotational shaft which extends through the first ratchet wheel, the first cam member, the second cam member and the second ratchet wheel; and a coil spring wound around the rotational shaft between the second ratchet wheel and the cap member.

The first and second door hinge means are arranged such that they are in a plane symmetry while being centered on the middle section of the rotary cylindrical part; and torsional moment of the respective torsional coil springs of the respective first and second door hinge means can be independently adjusted. The torsional coil spring of the first door hinge means and the torsional coil spring of the second door hinge means are wound in the same direction, so that, when the rotary cylindrical part is rotated by rotation

of the door, one torsional coil spring receives force which acts in a winding direction thereof and the other torsional coil spring receives force which acts in an unwinding direction thereof; and the one torsional coil spring receiving force which acts in the winding direction thereof has larger torsional moment than the other torsional coil spring receiving force which acts in the unwinding direction thereof, thereby allowing opening and closing operations of the door to be smoothly performed. The middle section comprises a fixed middle piece which is fitted into the rotary cylindrical part and is fixed thereto by a screw. The first and second support elements are a pair of vertical support elements which are arranged in a side by side relationship in a vertical direction.

In each of the first and second door hinge means, when the plurality of first axial ratchets of the first ratchet wheel and the plurality of second axial ratchets of the second ratchet wheel are engaged with each other, the rotational shaft can be rotated in one direction and cannot be rotated in the other direction; when the rotational shaft is rotated in the one direction by a tool inserted into the tool inserting groove which is formed in the cap member, force acts on the torsional coil spring in a winding direction thereof to increase torsional moment of the torsional coil spring; and when the second ratchet wheel is moved upward by raising the

first outward flange portion of the second cam member while overcoming biasing force of the coil spring, engagement between the first ratchet wheel and the second ratchet wheel is released and the torsional coil spring is unwound to be decreased in its torsional moment.

The one direction is a clockwise direction and the other direction is counterclockwise direction; the torsional coil springs of the first and second door hinge means are a left-handed torsional coil spring which is wound left; and as the door is opened, the rotary cylindrical part is rotated in the counterclockwise direction.

The torsional coil spring of the first door hinge means and the torsional coil spring of the second door hinge means are wound in different directions, so that, when the rotary cylindrical part is rotated by the rotation of the door, both of the torsional coil springs receive force which acts in the winding direction, whereby torsional moment of the torsional coil springs is used for supporting and opening and closing the door.

The first and second support elements are a pair of horizontal support elements which are arranged in a side by side relationship in a horizontal direction; and at this time, the second support element is connected to the first fixed cylindrical part which is in turn connected to the second fixed cylindrical part via a connection piece.

By the features of the present invention, advantages are provided in that since a door hinge device is installed to a door in a state that any torsional moment does not act on a torsional coil spring and then, torsional moment of the torsional coil spring is adjusted by virtue of inserting a tool into a tool inserting groove of a cap member and thereby rotating a rotational shaft or by virtue of grasping a first outward flange portion of a second cam member and lifting a second ratchet wheel by rotating the second cam member, installation of the door hinge device and an elasticity adjusting procedure, that is, a torsional moment adjusting procedure for the torsional coil spring can be performed in a simple, easy and rapid manner. According to this, valuableness of the door hinge device is elevated, and there is no possibility for the door to be rapidly closed to hurt the human body due to the fact that torsional moment of the torsional coil spring is not properly adjusted. In addition, thanks to the fact that a pair of door hinge means are disposed up and down and torsional coil springs of the pair of door hinge means receive force which acts in reverse directions, respectively, such that their torsional moment is independently adjusted, opening and closing velocity of the door can be adjusted in a more subdivided manner, and the door is smoothly opened by small force and is slowly and automatically closed, whereby the valuableness of the door

hinge device is more elevated. Moreover, due to the fact that means for separately and additionally controlling rotating velocity of the rotational shaft is formed in a larger diameter part of the rotational shaft, the rotating velocity of the rotational shaft, that is, the opening and closing velocity of the door can be additionally adjusted in a further more subdivided manner.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects, and other features and advantages of the present invention will become more apparent after a reading of the following detailed description when taken in conjunction with the drawings, in which:

FIG. 1 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of a door hinge device in accordance with a first embodiment of the present invention;

FIG. 2 is an exploded perspective view illustrating various components constituting the door hinge device of FIG. 1;

FIG. 3 is a partially broken-away cross-sectional view for explaining a procedure for increasing torsional moment of a torsional coil spring by rotating a rotational shaft in a clockwise direction thereby causing the torsional coil spring

to be wound to be increased in its elastic force;

FIG. 4 is a partially broken-away cross-sectional view for explaining a procedure for decreasing torsional moment of the torsional coil spring by lifting a cylindrical cam member and a cylindrical ratchet wheel in an axial direction thereby causing the torsional coil spring to be unwound to be decreased in its elastic force;

FIG. 5 is a perspective view illustrating configurations of a ring-shaped ratchet wheel and a cylindrical ratchet wheel which are modified according to the present invention;

FIG. 6 is a perspective view illustrating a state wherein a door hinge device in accordance with a second embodiment of the present invention is installed between an upper end of a door and a door frame;

FIG. 7 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of the door hinge device of FIG. 6;

FIG. 8 is an exploded perspective view illustrating various components constituting the door hinge device of FIG. 6;

FIG. 9 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of a door hinge device in accordance with a third embodiment of the present invention;

FIG. 10 is an exploded perspective view illustrating

various components constituting the door hinge device of FIG. 9;

FIG. 11 is a partially broken-away longitudinal cross-sectional view illustrating a state wherein a first torsional coil spring and a second torsional coil spring are wound in reverse directions in the third embodiment of the present invention;

FIG. 12 is a perspective view illustrating an appearance of a door hinge device in accordance with a fourth embodiment of the present invention; and

FIG. 13 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of the door hinge device of FIG. 12.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference will now be made in greater detail to a preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings. Wherever possible, the same reference numerals will be used throughout the drawings and the description to refer to the same or like parts.

FIG. 1 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of a door hinge device in accordance with a first embodiment of the

present invention; FIG. 2 is an exploded perspective view illustrating various components constituting the door hinge device of FIG. 1; FIG. 3 is a partially broken-away cross-sectional view for explaining a procedure for increasing torsional moment of a torsional coil spring by rotating a rotational shaft in a clockwise direction thereby causing the torsional coil spring to be wound to be increased in its elastic force; FIG. 4 is a partially broken-away cross-sectional view for explaining a procedure for decreasing torsional moment of the torsional coil spring by lifting a cylindrical cam member and a cylindrical ratchet wheel in an axial direction thereby causing the torsional coil spring to be unwound to be decreased in its elastic force; and FIG. 5 is a perspective view illustrating configurations of a ring-shaped ratchet wheel and a cylindrical ratchet wheel which are modified according to the present invention.

The door hinge device 100 in accordance with the first embodiment of the present invention includes a pair of vertical support elements 102 and 103. A first vertical support element 102 is fastened to a door to be integrally rotated therewith, and a second vertical support element 103 is fastened to a door frame to be fixedly held. A rotary cylindrical part 104 is integrally fastened to a lengthwise middle portion of widthwise one end of the first vertical support element 102, which faces the second vertical support

element 103, and a pair of fixed cylindrical parts 106 and 107 are integrally fastened to lengthwise both ends of widthwise one end of the second vertical support element 103, which faces the first vertical support element 102. The pair of fixed cylindrical parts 106 and 107 are aligned with a lower end and an upper end of the rotary cylindrical part 104, respectively, and a pair of ring washers 158 and 159 are intervened between the pair of fixed cylindrical parts 106 and 107 and the rotary cylindrical part 104, respectively. A plug member 108 is inserted into a first fixed cylindrical part 106 from bottom to top. By the fact that a threaded portion which is formed on an upper end of the plug member 108 is screwed into a circumferential inner surface of the lower end of the rotary cylindrical part 104, the plug member 108 is fastened to the rotary cylindrical part 104. A lower end of the plug member 108 is formed with a head portion 110, and the upper end of the plug member 108 is formed with a support shaft portion 112 which extends upward while having a reduced diameter. When the plug member 108 is screwed into the rotary cylindrical part 104, the head portion 110 of the plug member 108 is seated onto a lower end of the first fixed cylindrical part 106.

A lower end of a rotational shaft 114 is inserted into the rotary cylindrical part 104 from top to bottom. A middle portion of the rotational shaft 114 is formed with a larger

diameter part 116 which is enlarged in its diameter. The lower end of the rotational shaft 114 is seated onto a free end of the support shaft portion 112 of the plug member 108. The lower end of the rotational shaft 114 and the free end of the support shaft portion 112 are formed with a pair of inserting grooves 168 and 169, respectively. Both ends of a round bar 170 are inserted into the pair of inserting grooves 168 and 169, respectively, and a pair of balls 118 and 119 are intervened between bottom surfaces of the pair of inserting grooves 168 and 169 and both ends of the round bar 170, respectively, to guide rotation of the rotational shaft 114. In the rotary cylindrical part 104, a torsional coil spring 120 is wound around a circumferential outer surface of the rotational shaft 114. An upper end of the torsional coil spring 120 is fitted into a spring fixing groove which is defined on a lower surface of the larger diameter part 116 of the rotational shaft 114, to be fixed therein, and a lower end of the torsional coil spring 120 is fitted into another spring fixing groove which is defined on an upper end surface of the plug member 108, to be fixed therein. In FIG. 1, the torsional coil spring 120 is a left-handed torsional coil spring which is wound left. Accordingly, when the rotational shaft 114 is rotated in a clockwise direction, force acts on the torsional coil spring 120 in a winding direction thereof to increase torsional moment of the torsional coil spring 120.

On the contrary, when the rotational shaft 114 is rotated in a counterclockwise direction, force acts on the torsional coil spring 120 in an unwinding direction thereof to decrease torsional moment of the torsional coil spring 120. Above the larger diameter portion 116, the circumferential outer surface of the rotational shaft 114 is formed with at least one key groove 146. When the rotational shaft 114 is inserted into the rotary cylindrical part 104, substantially a middle portion of the larger diameter part 116 projects upward beyond the ring washer 159 which is positioned upward.

A ring-shaped ratchet wheel 122 and a ring-shaped cam member 126 are sequentially fitted into the second fixed cylindrical part 107 of the second vertical support element 103, from top to bottom. The ring-shaped ratchet wheel 122 is seated onto an upper surface of the larger diameter part 116 of the rotational shaft 114, and the ring-shaped cam member 126 is seated onto the ring-shaped ratchet wheel 122. A circumferential inner surface of the second fixed cylindrical part 107 is formed with an inward spline 152, and circumferential outer surfaces of the ring-shaped ratchet wheel 122 and the ring-shaped cam member 126 are formed with outward splines 154 and 155, respectively. The outward splines 154 and 155 of the ring-shaped ratchet wheel 122 and the ring-shaped cam member 126 are coupled to the inward spline 152 of the second fixed cylindrical part 107.

Accordingly, by the fact that the second fixed cylindrical part 107 is maintained in a state that it is fastened to the door frame, the ring-shaped ratchet wheel 122 and the ring-shaped cam member 126 cannot be rotated in a circumferential direction and can only be moved in an axial direction. On a circumferential portion of the ring-shaped ratchet wheel 122, which is moved radially and inward from the circumferential outer surface thereof by a distance which corresponds to a thickness of the ring-shaped cam member 126 seated thereon, the ring-shaped ratchet wheel 122 is formed with a plurality of first axial ratchets 124. On an upper surface of the ring-shaped cam member 126, there are formed at least two camming protrusions 128 such that they extend upward in the axial direction.

A cylindrical cam member 130 is seated onto the ring-shaped cam member 126. On a lower surface of the cylindrical cam member 130, there are formed at least two camming grooves 132 into which the camming protrusions 128 of the ring-shaped cam member 126 can be engaged, respectively. An upper end of the cylindrical cam member 130 is formed with a first outward flange portion 134 which projects radially outward. Inwardly of the first outward flange portion 134, a circumferential inner surface of the cylindrical cam member 130 is formed with a stepped portion 136. The first outward flange portion 134 of the cylindrical cam member 130 is seated onto an upper end

of the second fixed cylindrical part 107. A cylindrical ratchet wheel 138 is fitted into the cylindrical cam member 130, and an upper end of the cylindrical ratchet wheel 138 is formed with a second outward flange portion 142 which is seated onto the stepped portion 136 of the cylindrical cam member 130. On a lower surface of the cylindrical ratchet wheel 138, there are formed a plurality of second axial ratchets 140 which can be engaged with the plurality of first axial ratchets 124 of the ring-shaped ratchet wheel 122. A circumferential inner surface of the cylindrical ratchet wheel 138 is formed with at least one key 144. The other end of the rotational shaft 114 extends upward through the ring-shaped ratchet wheel 122, the ring-shaped cam member 126, the cylindrical cam member 130 and the cylindrical ratchet wheel 138. At this time, by the fact that the key 144 of the cylindrical ratchet wheel 138 is fitted into the key groove 146 of the rotational shaft 114, the cylindrical ratchet wheel 138 can be rotated integrally with the rotational shaft 114. Also, by the fact that the second outward flange portion 142 which is formed in the cylindrical ratchet wheel 138 is seated onto the stepped portion 136 which is formed in the cylindrical cam member 130, if the first outward flange portion 134 of the cylindrical cam member 130 which is seated onto the upper end of the second fixed cylindrical part 107, is grasped and rotated, the cylindrical cam member 130 and the

cylindrical ratchet wheel 138 can be integrally moved in the axial direction along the rotational shaft 114 while the camming grooves 132 of the cylindrical cam member 130 slide on the camming protrusions 128 of the ring-shaped cam member 126, respectively.

Each of the first axial ratchet 124 and the second axial ratchet 140 is formed with a sloped surface and an upright surface. In FIG. 1, the second axial ratchet 140 which is engaged with the first axial ratchet 124, can be rotated in the clockwise direction due to the fact that its sloped surface slides on the sloped surface of the first axial ratchet 124, and cannot be rotated in the counterclockwise direction due to the fact that its upright surface is brought into contact with the upright surface of the first axial ratchet 124. Of course, although it is explained in the above embodiment that the ring-shaped ratchet wheel 122 and the cylindrical ratchet wheel 138 have the first axial ratchet 124 and the second axial ratchet 140, respectively, each of which has the sloped surface and the upright surface, it is to be readily understood that the ring-shaped ratchet wheel 122 and the cylindrical ratchet wheel 138 can have a plurality of first axial ratchets 125 and a plurality of second axial ratchets 141, respectively, each of which has a configuration which is the same as that of the conventional gear teeth.

A cap member 148 is screwed around the other end of the

rotational shaft 114 which extends upward through the cylindrical ratchet wheel 138, to be fastened thereto. A coil spring 150 is intervened between the cap member 148 and the cylindrical ratchet wheel 138 to bias downward the cylindrical ratchet wheel 138, that is, in a direction wherein the second axial ratchet 140 is engaged with the first axial ratchet 124. An upper end surface of the cap member 148 is formed with a tool inserting groove 156. By inserting a tool into the tool inserting groove 156 and rotating the tool, the rotational shaft 114 can be rotated. A protective cap 160 is screwed around a circumferential outer surface of the cap member 148. The protective cap 160 serves to protect a number of components which project out of the second fixed cylindrical part 107.

The door hinge device 100 in accordance with the first embodiment of the present invention, constructed as mentioned above, is mounted to the door and the door frame in a state that any torsional moment does not act on the torsional coil spring 120, and according to this, mounting operations for the door hinge device 100 can be performed in a simple and easy manner. When required after mounting operations for the door hinge device 100 are completed or while the door hinge device 100 is used, operations for adjusting elasticity of the door hinge device 100, that is, of the torsional coil spring 120 can be implemented as described below.

When it is desired to increase elasticity, that is, elastic force of the door hinge device 100, the protective cap 160 is unscrewed from the cap member 148, and after inserting a tool such as a wrench or the like into the tool inserting groove 156 which is formed in the cap member 148, the cap member 148 is rotated in the clockwise direction by rotating the tool (see FIG. 3). If the cap member 148 is rotated in the clockwise direction, the rotational shaft 114 which is integrally fastened to the cap member 148, is also rotated in the clockwise direction. Further, due to the fact that the key 144 which is formed on the circumferential inner surface of the cylindrical ratchet wheel 138 is fitted into the key groove 146 which is formed on the circumferential outer surface of the rotational shaft 114, force acts on the cylindrical ratchet wheel 138 in the clockwise direction. According to this, as the sloped surface of the second axial ratchet 140 of the cylindrical ratchet wheel 138 slides on the sloped surface of the first axial ratchet 124 of the ring-shaped ratchet wheel 122, the cylindrical ratchet wheel 138 is rotated in the clockwise direction. At this time, as the second axial ratchet 140 rotating in the clockwise direction passes an upper end of the corresponding first axial ratchet 124, the second axial ratchet 140 is moved downward along the upright surface of the corresponding first axial ratchet 124 by biasing force of the coil spring 150. Therefore,

counterclockwise rotation of the second axial ratchet 140 which is moved downward, is prevented by the fact that the upright surface of the second axial ratchet 140 is brought into contact with the upright surface of the first axial ratchet 124. By this, because the counterclockwise rotation of the rotational shaft 114 is prevented, the torsional coil spring 120 which has the upper end fixed to the larger diameter part 116 of the rotational shaft 114 and the lower end fixed to the plug member 108, is wound in the winding direction by an angle through which the rotational shaft 114 is rotated in the clockwise direction, to be increased in its torsional moment. Consequently, the more the number of the first axial ratchets 124 which the second axial ratchet 140 passes while being rotated in the clockwise direction, is increased, the more the torsional moment of the torsional coil spring 120 is increased.

When it is desired to decrease elasticity, that is, elastic force of the door hinge device 100, the first outward flange portion 134 of the cylindrical cam member 130 which is seated onto the upper end of the second fixed cylindrical part 107 is grasped by the hand and rotated in the clockwise direction or in the counterclockwise direction (see FIG. 4). If the first outward flange portion 134 is rotated in the clockwise direction or in the counterclockwise direction, the cylindrical cam member 130 is moved upward along a sloped

surface of the camming protrusion 128 of the ring-shaped cam member 126. If the cylindrical cam member 130 is moved upward, by the fact that the second outward flange portion 142 of the cylindrical ratchet wheel 138 is seated onto the stepped portion 136 of the cylindrical cam member 130, and by the fact that the key 144 which is formed on the circumferential inner surface of the cylindrical ratchet wheel 138 is fitted into the key groove 146 which is formed on the circumferential outer surface of the rotational shaft 114, the cylindrical ratchet wheel 138 is moved upward in the axial direction along the rotational shaft 114, and according to this, the engagement between the plurality of first axial ratchets 140 of the ring-shaped ratchet wheel 122 and the plurality of second axial ratchets 140 of the cylindrical ratchet wheel 138 is released. Therefore, because the rotational shaft 114 can be freely rotated in the counterclockwise direction by torsional moment of the torsional coil spring 120 which is in a state that it is wound, the torsional moment of the torsional coil spring 120 can be decreased by an angle through which the rotational shaft 114 rotates in the counterclockwise direction.

The door which is provided with the door hinge device 100 as shown in FIG. 1, is used such that it is opened by being rotated in the counterclockwise direction in a state that elasticity, that is, elastic force of the door hinge device

100, that is, of the torsional coil spring 120 is adjusted as described above. In other words, if the door is rotated in the counterclockwise direction, the first vertical support element 102 which is fastened to the door is also integrally rotated in the counterclockwise direction, and the plug member 108 which is fastened to the lower end of the rotary cylindrical part 104 of the first vertical support element 102 is also integrally rotated in the counterclockwise direction. Accordingly, due to the fact that the lower end of the torsional coil spring 120 is secured to the plug member 108, the torsional coil spring 120 receives force which acts in the winding direction, and by this, the torsional moment of the torsional coil spring 120 is increased. Thereafter, if the hand which opens the door is taken off from the door, the door is automatically rotated in the clockwise direction toward a closed position by the torsional moment of the torsional coil spring 120, which is increased when the door is opened.

According to the present embodiment of the present invention, the larger diameter part 116 of the rotational shaft 114 is formed with a circumferential groove 162. A pair of semi-circular washers 164 are fitted into the circumferential groove 162, and the pair of semi-circular washers 164 are squeezed by a predetermined squeezing force against a bottom surface of the circumferential groove 162 by means of a screw 166 which extends through a wall of the

rotary cylindrical part 104 of the first support element 102. Accordingly, depending upon a degree to which the pair of semi-circular washers 164 are squeezed against the bottom surface of the circumferential groove 162, rotational velocity of the rotational shaft 114, that is, opening and closing velocity of the door can be adjusted in a more subdivided manner. For this precise adjustment in opening and closing velocity of the door, a friction-resistant and heat-resistant lining or pad is attached to a circumferential inner surface of each semi-circular washer 164.

FIG. 6 is a perspective view illustrating a state wherein a door hinge device in accordance with a second embodiment of the present invention is installed between an upper end of a door and a door frame; FIG. 7 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of the door hinge device of FIG. 6; and FIG. 8 is an exploded perspective view illustrating various components constituting the door hinge device of FIG. 6.

Since a construction of a door hinge device 200 in accordance with a second embodiment of the present invention is substantially similar to that of the door hinge device 100 of the first embodiment aforementioned above, explanations hereinafter will be concentrated onto portions which are different from those of the door hinge device 100 of the first embodiment and the same reference numerals will be used for

representing the same parts. The door hinge device 200 of the present embodiment includes a pair of horizontal support elements 202 and 203. A first horizontal support element 202 is fastened to a door 212 to be integrally rotated therewith, and a second horizontal support element 203 is fastened to a door frame 214 to be fixedly held. An upper end of a rotary cylindrical part 104 is fastened to one end of the first horizontal support element 202, and a lower end of a fixed cylindrical part 204 is fastened to one end of the second support element 203. The fixed cylindrical part 204 is aligned with the upper end of the rotary cylindrical part 104, and a ring washer 210 is intervened between the fixed cylindrical part 204 and the rotary cylindrical part 104. A plug member 206 is inserted into the rotary cylindrical part 104 from bottom to top. By the fact that a threaded portion 208 which is formed at an upper end of the plug member 206 is screwed into a circumferential inner surface of a lower end of the rotary cylindrical part 104, the plug member 206 is fastened to the rotary cylindrical part 104. A lower end of a rotational shaft 114 is seated onto a free end of the plug member 206, and the lower end of the rotational shaft 114 and the upper end of the plug member 206 are formed with a pair of inserting grooves 168 and 169, respectively. Both ends of a round bar 170 are inserted into the pair of inserting grooves 168 and 169, respectively. A pair of balls 118 and 119 are

intervened between bottom surfaces of the pair of inserting grooves 168 and 169 and both ends of the round bar 170, respectively, to guide rotation of the rotational shaft 114.

Therefore, according to the present embodiment, the same effects as obtained by the door hinge device 100 of the first embodiment, which has the pair of vertical support elements 102 and 103, are accomplished.

FIG. 9 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of a door hinge device in accordance with a third embodiment of the present invention; FIG. 10 is an exploded perspective view illustrating various components constituting the door hinge device of FIG. 9; and FIG. 11 is a partially broken-away longitudinal cross-sectional view illustrating a state wherein a first torsional coil spring and a second torsional coil spring are wound in reverse directions in the third embodiment of the present invention.

Also, in a door hinge device 300 in accordance with a third embodiment of the present invention, the same reference numerals will be used for representing the same parts when compared to the door hinge device 100 of the first embodiment. The door hinge device 300 according to the present embodiment includes a pair of vertical support elements 324 and 325. A first vertical support element 324 is fastened to a door to be integrally rotated therewith, and a second vertical support

element 325 is fastened to a door frame to be fixedly held. A rotary cylindrical part 104 is integrally fastened to a lengthwise middle portion of widthwise one end of the first vertical support element 324, which faces the second vertical support element 325, and a pair of fixed cylindrical parts 106 and 107 are integrally fastened to lengthwise both ends of widthwise one end of the second vertical support element 325, which faces the first vertical support element 324. The pair of fixed cylindrical parts 106 and 107 are aligned with a lower end and an upper end of the rotary cylindrical part 104, respectively, and a pair of ring washers 158 and 159 are intervened between the pair of fixed cylindrical parts 106 and 107 and the rotary cylindrical part 104, respectively.

A fixed middle piece 302 is fitted into a middle portion of the rotary cylindrical part 104. By the fact that the fixed middle piece 302 is fastened to the rotary cylindrical part 104 by a screw 304, an inner space of the rotary cylindrical part 106 is divided into a first operating chamber 310 which is defined above the fixed middle piece 302 and a second operating chamber 312 which is defined below the fixed middle piece 302. First door hinge means 306 is provided in the first operating chamber 310 of the rotary cylindrical part 104 and the second fixed cylindrical part 107, and second door hinge means 308 is provided in the second operating chamber 312 of the rotary cylindrical part 104 and the first fixed

cylindrical part 106. The first door hinge means 306 and the second door hinge means 308 are arranged such that they are in a plane symmetry while being centered on the fixed middle piece 302. Because constructions of the respective first door hinge means 306 and second door hinge means 308 are similar to the construction of the door hinge device 100 of the first embodiment aforementioned above, except that one ends of two rotational shafts 114 are inserted into grooves which are formed on upper and lower surfaces of the fixed middle piece 302, respectively, to be rotatably supported by the fixed middle piece 302, hereinafter, explanations for respective components of the first and second door hinge means 306 and 308 will be omitted, and instead, descriptions will be concentrated onto matters which must be particularly mentioned.

In the present embodiment, torsional moment of a first torsional coil spring 314 which is provided in the first door hinge means 306 and torsional moment of a second torsional coil spring 316 which is provided in the second door hinge means 308 can be independently adjusted. In FIG. 9, the first torsional coil spring 314 and the second torsional coil spring 316 are left-handed torsional coil springs which are simultaneously wound left. According to this, if the first vertical support element 324 which is fastened to the door, that is, the rotary cylindrical part 104 is rotated in a

counterclockwise direction, the first torsional coil spring 314 which is disposed up receives force which acts in the winding direction thereof to be increased in its torsional moment, and the second torsional coil spring 316 which is disposed down receives force which acts in the unwinding direction thereof to be decreased in its torsional moment. Accordingly, a pair of forces which act in reverse directions are applied to the entire door. Therefore, when the door is opened, due to the fact that torsional moment of the first torsional coil spring 314 is increased and torsional moment of the second torsional coil spring 316 is decreased, the door can be smoothly opened. On the contrary, when the door is closed, due to the fact that torsional moment of the first torsional coil spring 314 is decreased and torsional moment of the second torsional coil spring 316 is increased, the door can be slowly closed. Of course, at this time, it is to be readily understood that, in an initial state before the door is opened, torsional moment of the second torsional coil spring 316 must be established to be less than torsional moment of the first torsional coil spring 314, to allow the door to be held in a closed state.

Of course, it is to be readily understood that right-handed torsional coil springs can be also used as the first torsional coil spring 314 and the second torsional coil spring 316. However, in this case, the first axial ratchets 124 of

the ring-shaped ratchet wheel 122 and the second axial ratchets 140 of the cylindrical ratchet wheel 138 must be oppositely formed such that the first torsional coil spring 314 which is disposed up receives force which acts in the winding direction thereof and the second torsional coil spring 316 which is disposed down receives force which acts in the unwinding direction thereof, when the rotational shaft 114 or the rotary cylindrical part 104 is rotated in the clockwise direction. Of course, at this time, it is to be readily understood that, in an initial state before the door is opened, torsional moment of the first torsional coil spring 314 must be established to be greater than torsional moment of the second torsional coil spring 316, to allow the door to be held in a closed state.

Also, as shown in FIG. 11, the first torsional coil spring 314 provided in the first door hinge means 306 and the second torsional coil spring 316 provided in the second door hinge means 308 can be wound in the reverse directions from each other. In FIG. 11, the first torsional coil spring 314 is shown as a left-handed torsional coil spring and the second torsional coil spring 316 is shown as a right-handed torsional coil spring. As described above, in the case that the first torsional coil spring 314 and the second torsional coil spring 316 are wound in the reverse directions, when the rotary cylindrical part 104 is rotated in the counterclockwise

direction, both of the first and second torsional coil springs 314 and 316 receive force which acts in the winding direction thereof. Consequently, by the fact that torsional moments of the first and second torsional coil spring 314 and 316 are used together to support and open/close the door, load bearing capacity of the door hinge device according to the present invention can be improved.

FIG. 12 is a perspective view illustrating an appearance of a door hinge device in accordance with a fourth embodiment of the present invention; and FIG. 13 is a partially broken-away longitudinal cross-sectional view illustrating an entire structure of the door hinge device of FIG. 12.

Since a construction of a door hinge device 400 in accordance with a fourth embodiment of the present invention is substantially similar to that of the door hinge device 300 of the third embodiment aforementioned above, explanations hereinafter will be concentrated onto portions which are different from those of the door hinge device 300 of the third embodiment, and the same reference numerals will be used for representing the same parts. The door hinge device 400 of the present embodiment includes a pair of horizontal support elements 402 and 403. A first horizontal support element 402 is fastened to a door to be integrally rotated therewith, and a second horizontal support element 403 is fastened to a door frame to be fixedly held. An upper end of a rotary

cylindrical part 104 is integrally fastened to one end of the first horizontal support element 402, and a lower end of a second fixed cylindrical part 107 is integrally fastened to one end of the second support element 403. A first fixed cylindrical part 106 is provided below a lower end of the rotary cylindrical part 104. The first fixed cylindrical part 106 is integrally connected to the second fixed cylindrical part 107 via a connection piece 404. The pair of fixed cylindrical parts 106 and 107 are aligned with the lower end and the upper end of the rotary cylindrical part 104.

Therefore, according to the present embodiment, the same effects as obtained by the door hinge device 300 of the third embodiment, which has the pair of vertical support elements 324 and 325, are accomplished.

As described above, by the present invention, advantages are provided in that since a door hinge device is installed to a door in a state that any torsional moment does not act on a torsional coil spring and then, torsional moment of the torsional coil spring is adjusted by virtue of inserting a tool into a tool inserting groove and thereby rotating a rotational shaft or by virtue of pressing a push rod and thereby disengaging a pawl of a pawl member from a ratchet of an inward ratchet wheel, installation of the door hinge device and an elasticity adjusting procedure, that is, a torsional moment adjusting procedure for the torsional coil spring can

be performed in a simple, easy and rapid manner. According to this, valuableness of the door hinge device is elevated, and there is no possibility for the door to be rapidly closed to hurt the human body due to the fact that torsional moment of the torsional coil spring is not properly adjusted.

In addition, thanks to the fact that a pair of door hinge means are disposed up and down and torsional coil springs of the pair of door hinge means receive force which acts in reverse directions, respectively, such that their torsional moment is independently adjusted, opening and closing velocity of the door can be adjusted in a more subdivided manner, and the door is smoothly opened by small force and is slowly and automatically closed, whereby the valuableness of the door hinge device is more elevated.

Moreover, due to the fact that means for separately and additionally controlling rotating velocity of the rotational shaft is formed in a larger diameter part of the rotational shaft, the rotating velocity of the rotational shaft, that is, the opening and closing velocity of the door can be additionally adjusted in a further more subdivided manner.

In the drawings and specification, there have been disclosed typical preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the

following claims.

WHAT IS CLAIMED IS:

1. A door hinge device comprising:

a first support element fastened to a door and having a rotary cylindrical part;

a second support element fastened to a door frame and having a pair of fixed cylindrical parts which are vertically aligned with both ends of the rotary cylindrical part of the first support element, respectively;

a plug member inserted into a first fixed cylindrical part of the second support element and locked to one end of the rotary cylindrical part of the first support element;

a rotational shaft having one end inserted into the rotary cylindrical part of the first support element through a second fixed cylindrical part of the second support element to be rotatably supported by the plug member and a middle portion formed with a larger diameter part;

a torsional coil spring wound around the rotational shaft in the rotary cylindrical part of the first support element and having one end secured to the plug member and the other end secured to the larger diameter part of the rotational shaft;

a first ratchet wheel fitted into the second fixed cylindrical part of the second support element such that it cannot be rotated, the first ratchet wheel being seated onto the larger diameter part of the rotational shaft and having a



plurality of first axial ratchets which are radially inwardly formed;

a first cam member fitted into the second fixed cylindrical part of the second support element such that it cannot be rotated, the first cam member being seated onto the first ratchet wheel and having at least one axial camming protrusion;

a second cam member having one end which is inserted into the second fixed cylindrical part of the second support element such that it can be rotated and can be moved in an axial direction, the one end being formed with at least one axial camming groove into which the axial camming protrusion can be engaged;

a second ratchet wheel inserted into the second cam member such that it can be rotated integrally with the rotational shaft and can be moved in the axial direction, the second ratchet wheel having one end being formed with a plurality of second axial ratchets which can be engaged with the plurality of first axial ratchets of the first ratchet wheel;

a cap member fastened to the other end of the rotational shaft which extends through the first ratchet wheel, the first cam member, the second cam member and the second ratchet wheel; and

a coil spring wound around the rotational shaft between



the second ratchet wheel and the cap member.

2. A door hinge device as claimed in claim 1, wherein the first and second support elements are a pair of vertical support elements which are arranged in a side by side relationship in a vertical direction.

3. A door hinge device as claimed in claim 1, wherein the other end of the second cam member is formed with a first outward flange portion which is seated onto one end of the second fixed cylindrical part of the second support element; a circumferential inner surface of the first outward flange portion is formed with a stepped portion; and the other end of the second ratchet wheel is formed with a second outward flange portion which is seated onto the stepped portion.

4. A door hinge device as claimed in claim 1, wherein the first ratchet wheel and the first cam member have a ring-shaped configuration, and the second cam member and the second ratchet wheel have a cylindrical configuration.

5. A door hinge device as claimed in claim 1, wherein a circumferential inner surface of the second ratchet wheel is formed with at least one key, and a circumferential outer surface of the rotational shaft between the larger diameter



part and the other end thereof is formed with at least one key groove into which the key is fitted; a circumferential inner surface of the second fixed cylindrical part is formed with an inward spline, and a circumferential outer surface of each of the first ratchet wheel and the first cam member is formed with an outward spline; and the cap member is formed with a tool inserting groove.

6. A door hinge device as claimed in claim 1, wherein the plug member has a support shaft portion which extends into the rotary cylindrical part of the first support element; a free end of the support shaft portion and the one end of the rotational shaft are formed with a pair of inserting grooves, respectively; both ends of a round bar are inserted into the pair of inserting grooves, respectively; a pair of balls are intervened between bottom surfaces of the pair of inserting grooves and both ends of the round bar, respectively, to guide rotation of the rotational shaft; and a pair of ring washers are sandwiched between both ends of the rotary cylindrical part and the first and second fixed cylindrical parts, respectively.

7. A door hinge device as claimed in claim 1, wherein the plurality of first axial ratchets of the first ratchet wheel and the plurality of second axial ratchets of the second



ratchet wheel have a configuration which is the same as that of the conventional gear teeth.

8. A door hinge device as claimed in claim 1, wherein, when the plurality of first axial ratchets of the first ratchet wheel and the plurality of second axial ratchets of the second ratchet wheel are engaged with each other, the rotational shaft can be rotated in one direction and cannot be rotated in the other direction; when the rotational shaft is rotated in the one direction by a tool inserted into the tool inserting groove which is formed in the cap member, force acts on the torsional coil spring in a winding direction thereof to increase torsional moment of the torsional coil spring; and when the second ratchet wheel is moved upward by raising the first outward flange portion of the second cam member while overcoming biasing force of the coil spring, engagement between the first ratchet wheel and the second ratchet wheel is released and the torsional coil spring is unwound to be decreased in its torsional moment.

9. A door hinge device as claimed in claim 1, wherein the larger diameter part of the rotational shaft is formed with a circumferential groove; a pair of semi-circular washers are fitted into the circumferential groove; and the pair of semi-circular washers are squeezed by a predetermined



squeezing force against a bottom surface of the circumferential groove by means of a screw which extends through a wall of the rotary cylindrical part of the first support element.

10. A door hinge device as claimed in claim 9, wherein a friction-resistant and heat-resistant lining or pad is attached to a circumferential inner surface of each semi-circular washer.

11. A door hinge device as claimed in claims 1 or 8, wherein the one direction is a clockwise direction and the other direction is counterclockwise direction; the torsional coil spring is a left-handed torsional coil spring which is wound left; and when the rotary cylindrical part is rotated in the counterclockwise direction as the door is opened, force acts on the torsional coil spring in the winding direction thereof to increase torsional moment of the torsional coil spring.

12. A door hinge device comprising:

a first support element fastened to a door and having a rotary cylindrical part one end of which is closed;

a second support element fastened to a door frame and having a fixed cylindrical part which is vertically aligned



with the other end of the rotary cylindrical part of the first support element;

a rotational shaft having one end inserted into the rotary cylindrical part of the first support element through the fixed cylindrical part of the second support element to be rotatably supported by the closed one end of the rotary cylindrical part and a middle portion formed with a larger diameter part;

a torsional coil spring wound around the rotational shaft in the rotary cylindrical part of the first support element and having one end secured to the closed one end of the rotary cylindrical part and the other end secured to the larger diameter part of the rotational shaft;

a first ratchet wheel fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first ratchet wheel being seated onto the larger diameter part of the rotational shaft and having a plurality of first axial ratchets which are radially inwardly formed;

a first cam member fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first cam member being seated onto the first ratchet wheel and having at least one axial camming protrusion;

a second cam member having one end which is inserted into the fixed cylindrical part of the second support element such that it can be rotated and can be moved in an axial direction,



the one end being formed with at least one axial camming groove into which the axial camming protrusion can be engaged;

a second ratchet wheel inserted into the second cam member such that it can be rotated integrally with the rotational shaft and can be moved in the axial direction, the second ratchet wheel having one end being formed with a plurality of second axial ratchets which can be engaged with the plurality of first axial ratchets of the first ratchet wheel;

a cap member fastened to the other end of the rotational shaft which extends through the first ratchet wheel, the first cam member, the second cam member and the second ratchet wheel; and

a coil spring wound around the rotational shaft between the second ratchet wheel and the cap member.

13. A door hinge device as claimed in claim 12, wherein the first and second support elements are a pair of horizontal support elements which are arranged in a side by side relationship in a horizontal direction.

14. A door hinge device comprising:

a first support element fastened to a door and having a rotary cylindrical part a middle section of which is closed to define two operating chambers in the rotary cylindrical part;



a second support element fastened to a door frame and having a pair of fixed cylindrical parts which are vertically aligned with both ends of the rotary cylindrical part of the first support element, respectively;

first door hinge means disposed in a first fixed cylindrical part of the second support element and a first operating chamber of the rotary cylindrical part of the first support element; and

second door hinge means disposed in a second fixed cylindrical part of the second support element and a second operating chamber of the rotary cylindrical part of the first support element.

15. A door hinge device as claimed in claim 14, wherein each of the first and second door hinge means comprises:

a rotational shaft having one end inserted into the operating chamber of the rotary cylindrical part of the first support element through the fixed cylindrical part of the second support element to be rotatably supported by the closed middle section of the rotary cylindrical part and a middle portion formed with a larger diameter part;

a torsional coil spring wound around the rotational shaft in the operating chamber of the rotary cylindrical part of the first support element and having one end secured to the closed middle section of the rotary cylindrical part and the other



end secured to the larger diameter part of the rotational shaft;

a first ratchet wheel fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first ratchet wheel being seated onto the larger diameter part of the rotational shaft and having a plurality of first axial ratchets which are radially inwardly formed;

a first cam member fitted into the fixed cylindrical part of the second support element such that it cannot be rotated, the first cam member being seated onto the first ratchet wheel and having at least one axial camming protrusion;

a second cam member having one end which is inserted into the fixed cylindrical part of the second support element such that it can be rotated and can be moved in an axial direction, the one end being formed with at least one axial camming groove into which the axial camming protrusion can be engaged;

a second ratchet wheel inserted into the second cam member such that it can be rotated integrally with the rotational shaft and can be moved in the axial direction, the second ratchet wheel having one end being formed with a plurality of second axial ratchets which can be engaged with the plurality of first axial ratchets of the first ratchet wheel;

a cap member fastened to the other end of the rotational shaft which extends through the first ratchet wheel, the first

cam member, the second cam member and the second ratchet wheel; and

a coil spring wound around the rotational shaft between the second ratchet wheel and the cap member.

16. A door hinge device as claimed in claim 14, wherein the first and second door hinge means are arranged such that they are in a plane symmetry while being centered on the middle section of the rotary cylindrical part; and torsional moment of the respective torsional coil springs of the respective first and second door hinge means can be independently adjusted.

17. A door hinge device as claimed in claim 15, wherein the torsional coil spring of the first door hinge means and the torsional coil spring of the second door hinge means are wound in the same direction, so that, when the rotary cylindrical part is rotated by rotation of the door, one torsional coil spring receives force which acts in a winding direction thereof and the other torsional coil spring receives force which acts in an unwinding direction thereof; and the one torsional coil spring receiving force which acts in the winding direction thereof has larger torsional moment than the other torsional coil spring receiving force which acts in the unwinding direction thereof, thereby allowing opening and



closing operations of the door to be smoothly performed.

18. A door hinge device as claimed in claim 14, wherein the middle section comprises a fixed middle piece which is fitted into the rotary cylindrical part and is fixed thereto by a screw.

19. A door hinge device as claimed in claim 14, wherein the first and second support elements are a pair of vertical support elements which are arranged in a side by side relationship in a vertical direction.

20. A door hinge device as claimed in claim 14, wherein, in each of the first and second door hinge means, when the plurality of first axial ratchets of the first ratchet wheel and the plurality of second axial ratchets of the second ratchet wheel are engaged with each other, the rotational shaft can be rotated in one direction and cannot be rotated in the other direction; when the rotational shaft is rotated in the one direction by a tool inserted into the tool inserting groove which is formed in the cap member, force acts on the torsional coil spring in a winding direction thereof to increase torsional moment of the torsional coil spring; and when the second ratchet wheel is moved upward by raising the first outward flange portion of the second cam member while



overcoming biasing force of the coil spring, engagement between the first ratchet wheel and the second ratchet wheel is released and the torsional coil spring is unwound to be decreased in its torsional moment.

21. A door hinge device as claimed in claims 17 or 20, wherein the one direction is a clockwise direction and the other direction is counterclockwise direction; the torsional coil springs of the first and second door hinge means are a left-handed torsional coil spring which is wound left; and as the door is opened, the rotary cylindrical part is rotated in the counterclockwise direction.

22. A door hinge device as claimed in claims 17 or 20, wherein the torsional coil spring of the first door hinge means and the torsional coil spring of the second door hinge means are wound in different directions, so that, when the rotary cylindrical part is rotated by the rotation of the door, both of the torsional coil springs receive force which acts in the winding direction, whereby torsional moment of the torsional coil springs is used for supporting and opening and closing the door.

23. A door hinge device as claimed in claim 14, wherein the first and second support elements are a pair of horizontal



support elements which are arranged in a side by side relationship in a horizontal direction; and at this time, the second support element is connected to the first fixed cylindrical part which is in turn connected to the second fixed cylindrical part via a connection piece.

