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Lens apparatus and imaging apparatus

Abstract

A lens apparatus includes a tripod mount, a cylindrical member supported rotatably around an optical axis on the tripod mount, a roller housed in the tripod mount and including a rolling bearing and a shaft member engaged with the rolling bearing, a roller holding member configured to rotatably hold the roller, and a biasing member configured to bias the roller against the cylindrical member via the roller holding member.

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Background/Summary

BACKGROUND OF THE INVENTION

Field of the Invention

(1) The present invention relates to a lens apparatus and an imaging apparatus having a tripod mount.

Description of the Related Art

(2) A conventional lens apparatus has a revolving mechanism for rotating a lens barrel around the optical axis in an optical system. For example, a lens apparatus having a tripod mount can easily change the longitudinal and lateral composition by rotating the lens and the camera around the optical axis while the tripod mount is fixed onto the tripod.

(3) The revolving mechanism includes a portion (simply referred to as a “click” hereinafter) that provides a click feeling for each specific rotation phase so that the user can recognize the rotational position of the lens through the click feeling. In particular, the lens apparatus having the tripod mount includes click portions in the gravity direction when the lens apparatus is horizontally attached to the tripod, and often provides clicks for every 90° phase. In general, the click feeling is provided by biasing a ball, a pin, a roller or the like pressed by a biasing member on the fixed part side, such as the tripod mount, against a recessed groove provided on the lens body side.

(4) Japanese Patent Laid-Open No. (“JP”) 2012-47898 discloses a lens apparatus that can adjust the click position in revolving.

(5) The lens apparatus disclosed in JP 2012-47898 ca bias the roller supported on the tripod mount unit against the lens apparatus body through a biasing spring, and the outer circumferential surface of the roller contacts the lens apparatus body and a washer member. Hence, depending on the biasing force of the biasing spring, when the lens apparatus body is revolved relative to the tripod mount unit, the roller slides without rotating relative to the lens apparatus body. The roller sliding on the lens apparatus body is likely to wear the lubricating coating applied to the contact portion with the roller in the lens apparatus body and the contact component. Repetitive revolving will generate the abrasion powder through abrasions, peel the lubricating coating, and degrade the operability such as the feeling and torque in the revolving.

SUMMARY OF THE INVENTION

(6) The present invention provides a lens apparatus and an imaging apparatus having a revolving mechanism with an improved durability.

(7) A lens apparatus according to one aspect of the present invention includes a tripod mount, a cylindrical member supported rotatably around an optical axis on the tripod mount, a roller housed in the tripod mount and including a rolling bearing and a shaft member engaged with the rolling bearing, a roller holding member configured to rotatably hold the roller, and a biasing member configured to bias the roller against the cylindrical member via the roller holding member.

(8) Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIGS. **1**A and **1**B are sectional views of a principal part in a lens apparatus according to a first embodiment.

(2) FIG. **2** is an exploded perspective view of the lens apparatus according to the first embodiment.

(3) FIG. **3** is a sectional view of a principal part in a lens apparatus according to a second embodiment.

(4) FIG. **4** is a structural view of an imaging apparatus according to a third embodiment.

DESCRIPTION OF THE EMBODIMENTS

(5) Referring now to the accompanying drawings, a description will be given of embodiments according to the present invention.

First Embodiment

(6) Referring now to FIG. **2**, a description will be given of a lens apparatus (lens barrel) according to a first embodiment of the present invention. FIG. **2** is an exploded perspective view of the lens apparatus **100**. The lens apparatus **100** is an interchangeable lens attachable to and detachable from the imaging apparatus body.

(7) The lens apparatus **100** includes a barrel body **10** configured to hold an optical system (lens), and a tripod mount unit **20** configured to support the barrel body **10** integrally with a camera (imaging apparatus body, camera body) so that the barrel **10** can rotate at a fixed position. The lens barrel body **10** includes a mount member **11** for detachably attaching the lens apparatus **100** to the camera. The mount member **11** is fixed onto an exterior ring (cylindrical member) **12** rotatably supported around an optical axis OA on the tripod mount **22** by a screw or the like.

(8) The tripod mount unit **20** includes a tripod mount ring unit **21** and a tripod mount **22** having a screw portion **22***a* (see FIG. **1**A) engaged with a tripod screw. The tripod mount ring unit **21** includes a tripod mount ring **23** having a diameter engagement portion with the exterior ring **12**, and a lock knob **24** attached to the tripod mount ring **23**. The tripod mounting ring **23** has a roller housing portion **23***a*. The roller housing portion **23***a* houses a roller **25**, a roller holding member **26**, a biasing member **27**, a guide member **28**, and a press plate **29** (see FIG. **1**B). This will be described in detail later.

(9) In incorporating the tripod mount unit **20** into the barrel body **10**, the tripod mount ring unit **21** is first inserted from the backside (image side) of the barrel body **10**, and the roller **13** is inserted into the hole portion **23***b* in the tripod mount ring **23** (See FIG. **1**B) at a predetermined position. The roller **13** is screwed onto the exterior ring **12**. At least three rollers **13** are provided, and the tripod mounting ring unit **21** is rotated, incorporated at a predetermined phase, and fixed onto the exterior ring **12**. The tripod mounting ring **23** has an engaging groove **23***c* for the roller **13** and the engaging groove **23***c* determines the position of the tripod mount ring unit **21** in the optical axis direction. Next, the tripod mount **22** is fixed onto the tripod mount ring unit **21** by a screw **30**. Thereby, the tripod mount unit **20** is completely incorporated into the barrel body **10**.

(10) When the screw portion **22***a* of the tripod mount **22** is fixed onto the tripod screw, the barrel body **10** becomes rotatable at a fixed position relative to the tripod mount unit **20**. Thereby, an image can be captured while the camera is revolved. A relative rotation between the lens barrel body **10** and the tripod mount unit **20** can be suppressed by fastening the lock knob **24**.

(11) Referring now to FIGS. **1**A and **1**B, a description will be given of the roller housing portion **23***a* in the tripod mounting ring **23**. FIG. **1**A is a sectional view of principal part in the lens apparatus **100**, and FIG. **1**B is an enlarged view of an area A in FIG. **1**A. As illustrated in FIG. **1**B, the roller **25** includes a shaft member **25***a*, a rolling bearing **25***b*, and a spacer **25***c*. The shaft member **25***a* is engaged with the groove portion **26***a* on the roller holding member **26**. The roller holding member **26** contacts the biasing member **27** and the biasing force biases the roller **25**

against the exterior ring **12**. The roller holding member **26** is engaged with the guide member **28** and guided so as to move back and forth in a direction (vertical direction in FIG. **1**B) corresponding to the biasing direction of the biasing member **27**. The biasing member **27** also contacts the holding plate **29**, and is fixed by fastening the holding plate **29** and the guide member **28** with the tripod mount ring **23** by a screw **31** together. Thereby, the roller **25** is housed in the roller housing portion **23***a* of the tripod mounting ring **23**.

(12) The shaft member **25***a* in the roller **25** is engaged with the inner ring of the rolling bearing **25***b*, contacts the contact portion **26***b* in the roller holding member **26**, and receives the biasing force from the biasing member **27**. The outer ring of the rolling bearing **25***b* in the roller **25** is forced against the exterior ring **12** under the biasing force of the biasing member **27**. In other words, the biasing force of the biasing member **27** acts between the shaft member **25***a* and the contact portion **26***b* of the roller holding member **26**, between the inner ring of the shaft member **25***a* and the rolling bearing **25***b*, and between the outer ring of the rolling bearing **25***b* and the exterior ring **12**.

(13) As the lens barrel body **10** is rotated relative to the tripod mount unit **20**, the roller holding member **26** receives the shaft member **25***a* of the roller **25** and thus the frictional force applied to the outer ring of the rolling bearing **25***b* becomes small. Therefore, the exterior ring of the rolling bearing **25***b* reliably rotates without slipping on the exterior ring **12**. This configuration can prevent the abrasion powder from being generated by the slippage between the exterior ring and the roller. Hence, a lens apparatus with an enhanced durability in revolving can be provided.

(14) A rolling contact surface **12***a* on the exterior ring **12** with the roller **25** has a plurality of concave (or recessed) portions **12***b*. When the lens barrel body **10** is rotated relative to the tripod mount unit **20**, the roller **25** falls into the concave portion **12***b*, is biased against, and contacts a chamfered portion of the concave portion **12***b*. Thereby, the user can obtain a click feeling. For example, the concave portion **12***b* has a phase for obtaining a click feeling and a phase shifted by 90° from the phase when the camera (or the lens barrel body **10**) is horizontal to the tripod mount unit **20**. Thereby, the user can easily switch between image capturing in the normal state and so-called image capturing at a vertical position.

(15) This embodiment receives the biasing force from the biasing member **27** at both ends of the shaft member **25***a* and the roller holding member **26**. Hence, when the roller **25** falls into the concave portion **12***b*, the roller **25** is prevented from contacting the chamfered portion of the concave portion **12***b* while the shaft of the roller **25** is inclined. Therefore, since a load is uniformly applied to the contact surface between the roller **25** and the chamfered portion of the concave portion **12***b*, the contact surface can be prevented from being worn.

(16) According to this embodiment, the roller holding member **26** has an H shape on a section (illustrated in FIG. **1**B) including the optical axis OA in the lens. The roller holding member **26** has a first concave portion **26***c* and a second concave portion **26***d*, and at least part of the rolling bearing **25***b* is disposed inside the first concave portion **26***c*, and at least part of the biasing member **27** is disposed inside the second concave portion **26***d*. This configuration increases the contact area between the roller holding member **26** and the guide member **28** that guides the roller holding member **26** along the vertical direction in FIG. **1**B, and makes compact the (vertical size) of the tripod mounting ring **23**.

Second Embodiment

(17) Referring now to FIG. **3**, a description will be given of a lens apparatus (lens barrel) according to a second embodiment of the present invention. FIG. **3** is a sectional view of principal part of the lens apparatus according to this embodiment.

(18) In the lens apparatus according to the first embodiment, the shaft member **25***a* in the roller **25** is engaged with the roller holding member **26**, and the rolling bearing **25***b* rolls on the exterior ring **12**. On the other hand, in the lens apparatus according to this embodiment, the roller bearing **32***b* in the roller **32** is engaged with the roller holding member **26**, and the roller body **32***a* rolls on the

exterior ring **12**. Those elements having the same functions or roles in this embodiment as those in the first embodiment are designated by the same reference numerals, and a description thereof will be omitted.

(19) FIG. **3** is a sectional view near the exterior ring **12** and the roller housing portion **23***a* in the tripod ring **23**, and similar to the first embodiment, the roller housing portion **23***a* houses a roller **32**, a roller holding member **26**, a biasing member **27**, a guide member **28**, and a holding plate **29**. The roller **32** includes a shaft member **32***a* as a roller body and a rolling bearing **32***b*, and both ends of the shaft member **32***a* (shaft portions at both ends of the roller body) and the inner ring in the rolling bearing **32***b* are engaged with each other. The outer ring in the rolling bearing **32***b* is engaged with the groove portion **26***a* of the roller holding member **26**, contacts the contact portion **26***b* of the roller holding member **26**, and receives the force from the biasing member **27**. Hence, the biasing force from the biasing member **27** acts between the exterior ring in the rolling bearing **32***b* and the contact portion **26***b* in the roller holding member **26**, between the inner ring in the rolling bearing **32***b* and the shaft member **32***a*, and between the shaft member **32***a* and the exterior ring **12**.

(20) When the lens barrel body **10** is rotated relative to the tripod mount unit **20** in this state, the frictional force acting the roller body **32***a* is small because the roller holding member **26** receives the rolling bearing **32***b* of the roller **32** and the inner ring in the rolling bearing **32***b* and the shaft portions at both ends of the roller body **32***a* are engaged with each other. The roller body **32***a* reliably rotates without slipping relative to the exterior ring **12**. Similar to the first embodiment, this configuration can prevent from being generated the abrasion powder caused by the slippage between the exterior ring and the roller. Hence, a lens barrel with an enhanced durability of revolving can be provided.

Third Embodiment

(21) Referring now to FIG. **4**, a description will be given of an imaging apparatus according to a third embodiment of the present invention. FIG. **4** is a configuration diagram of an imaging apparatus **200** (single-lens reflex camera). In FIG. **4**, the lens apparatus **100** (interchangeable lens) includes an imaging optical system **1** (lens unit). The camera body **120** (imaging apparatus body) includes a quick return mirror **3**, a focus screen **4**, a Penta roof prism **5**, an eyepiece lens **6**, and the like. The quick return mirror **3** upwardly reflects a light flux formed via the imaging optical system **1**. The focus screen **4** is disposed at the image forming position of the imaging optical system **1**. The Penta roof prism **5** converts an inverse image formed on the focus screen **4** into an erect image. The user can observe the erect image through the eyepiece **6**.

(22) An image sensor **7** includes a CCD sensor and a CMOS sensor, photoelectrically converts an optical image (object image) formed via the imaging optical system **1**, and outputs image data. In image capturing, the quick return mirror **3** is retracted from the optical path, and an optical image is formed on the image sensor **7** via the imaging optical system **1**. A control unit **110** has a CPU and controls the operation of each unit of the imaging apparatus **200**.

(23) The imaging apparatus **200** includes, but is not limited to, the camera body **120** having the image sensor **7** and the lens apparatus **100** detachably attached to the camera body **120**. It may be an imaging apparatus in which a camera body and a lens apparatus are integrated with each other, or a mirrorless single-lens reflex camera (mirrorless camera) having no quick return mirror.

(24) Each embodiment can provide a lens barrel and an imaging apparatus with an enhanced durability of the revolving mechanism.

(25) While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

(26) This application claims the benefit of Japanese Patent Application No. 2017-234296, filed on Dec. 6, 2017, which is hereby incorporated by reference herein in its entirety.

Claims

1. A lens apparatus comprising: a lens barrel configured to hold a lens; and a supporting member configured to support the lens barrel rotatably around an optical axis, and including: a rolling bearing that contacts the lens barrel; a shaft member engaged with the rolling bearing; a holding member configured to hold the shaft member; and a biasing member configured to bias the holding member that causes the holding member to contact the shaft member and bias the rolling bearing against the lens barrel in a biasing direction of the biasing member, wherein the rolling bearing and the holding member are arranged at a distance from each other.
2. The lens apparatus according to claim 1, wherein the holding member has an H shape on a section including the optical axis in the lens.
3. The lens apparatus according to claim 2, wherein: the holding member includes a first concave portion and a second concave portion, at least part of the rolling bearing is disposed inside the first concave portion, and at least part of the biasing member is disposed inside the second concave portion.
4. The lens apparatus according to claim 1, wherein the lens barrel includes a plurality of concave portions on a surface that contacts the rolling bearing.
5. The lens apparatus according to claim 1, further comprising a guide member configured to guide the holding member so that the holding member is movable back and forth in a direction corresponding to the biasing direction of the biasing member.
6. The lens apparatus according to claim 5, further comprising: a press plate that contacts the biasing member, wherein the guide member and the press plate are fastened together by a screw.
7. A lens apparatus comprising: a lens barrel configured to hold a lens; and a supporting member configured to support the lens barrel rotatably around an optical axis, and including: a shaft member that contacts the lens barrel; a rolling bearing with which the shaft member is engaged; a holding member configured to hold the rolling bearing; and a biasing member configured to bias the holding member that causes the holding member to contact the rolling bearing and bias the shaft member against the lens barrel in a biasing direction of the biasing member, wherein the shaft member and the holding member are arranged at a distance from each other.
8. The lens apparatus according to claim 7, wherein the holding member has an H shape on a section including the optical axis in the lens.
9. The lens apparatus according to claim 8, wherein: the holding member includes a first concave portion and a second concave portion, at least part of the rolling bearing is disposed inside the first concave portion, and at least part of the biasing member is disposed inside the second concave portion.
10. The lens apparatus according to claim 7, wherein the lens barrel includes a plurality of concave portions on a surface that contacts the shaft member.
11. The lens apparatus according to claim 7, further comprising a guide member configured to guide the holding member so that the holding member is movable back and forth in a direction corresponding to the biasing direction of the biasing member.
12. The lens apparatus according to claim 11, further comprising: a press plate that contacts the biasing member, wherein the guide member and the press plate are fastened together by a screw.
13. A supporting member configured to support a lens barrel rotatably around an optical axis, the lens barrel being configured to hold a lens, the supporting member comprising: a rolling bearing that contacts the lens barrel; a shaft member engaged with the rolling bearing; a holding member configured to hold the shaft member; and a biasing member configured to bias the holding member that causes the holding member to contact the shaft member and bias the rolling bearing against the lens barrel in a biasing direction of the biasing member, wherein the rolling bearing and the holding member are arranged at a distance from each other.

14. The supporting member according to claim 13, wherein the holding member has an H shape on a section including the optical axis in the lens.
15. The supporting member according to claim 14, wherein: the holding member includes a first concave portion and a second concave portion, at least part of the rolling bearing is disposed inside the first concave portion, and at least part of the biasing member is disposed inside the second concave portion.
16. The supporting member according to claim 13, further comprising a guide member configured to guide the holding member so that the holding member is movable back and forth in a direction corresponding to the biasing direction of the biasing member.
17. The supporting member according to claim 16, further comprising: a press plate that contacts the biasing member, wherein the guide member and the press plate are fastened together by a screw.
18. A supporting member configured to support a lens barrel rotatably around an optical axis, the lens barrel being configured to hold a lens, the supporting member comprising: a shaft member that contacts the lens barrel; a rolling bearing with which the shaft member is engaged; a holding member configured to hold the rolling bearing; and a biasing member configured to bias the holding member that causes the holding member to contact the rolling bearing and bias the shaft member against the lens barrel in a biasing direction of the biasing member, wherein the shaft member and the holding member are arranged at a distance from each other.
19. The supporting member according to claim 18, wherein the holding member has an H shape on a section including the optical axis in the lens.
20. The supporting member according to claim 19, wherein: the holding member includes a first concave portion and a second concave portion, at least part of the rolling bearing is disposed inside the first concave portion, and at least part of the biasing member is disposed inside the second concave portion.
21. The supporting member according to claim 18, further comprising a guide member configured to guide the holding member so that the holding member is movable back and forth in a direction corresponding to the biasing direction of the biasing member.
22. The supporting member according to claim 21, further comprising: a press plate that contacts the biasing member, wherein the guide member and the press plate are fastened together by a screw.