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DESCRIPTION

LENS DRIVING APPARATUS

Technical Field

The present invention relates to a lens driving apparatus which performs focus adjustment (hereinafter abbreviated as focusing) by performing lens position adjustment of a master lens when a subject is photographed using a video camera or the like and, more particularly, to a lens driving apparatus which can prevent defocusing during zooming operation at manual focusing or defocusing of a photographed image which is involved by a difference between positions at photographing.

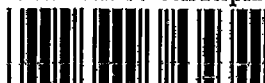
Background Art

Conventionally, a focusing operation of a lens driving apparatus included in a video camera or the like, which is disclosed in Japanese Published Patent Application No. Hei.6-308361, has been known, and this will be described with reference to figures hereinafter. Figure 8 is a perspective view illustrating a main portion of a conventional lens driving apparatus, figure 9 is an expanded cross sectional view illustrating a relationship between a feed screw and a first arm of a driving member in the lens driving apparatus shown in figure 8, figure 10 is an expanded cross sectional view

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illustrating a relationship between the feed screw and a second arm of the driving member in the lens driving apparatus shown in figure 8, figure 11 is an expanded cross sectional view illustrating a combination relationship between the driving member and a lens holding frame in the lens driving apparatus shown in figure 8, figure 12 is an expanded cross sectional view illustrating a combination and protection relationship between the driving member and the lens holding frame in the lens driving apparatus shown in figure 8, figure 13 is a cross sectional section of a main section illustrating the conventional lens driving apparatus when the apparatus is faced in the horizontal direction to perform photographing, and figure 14 is a cross sectional view of a main section illustrating the conventional lens driving apparatus at tilt-photographing.

A structure of the conventional lens driving apparatus will be described hereinafter. In figure 8, a lens 1 which performs focusing of a subject is fixed to a lens holding frame 2 made of a resin, by a means such as heat-staking, and is held by a first guide pole 3 and a second guide pole 4 which are arranged in a fixed body tube (not shown) so as to be slidable in the direction of a lens optical axis 5. Further, there is provided a groove 2a for connection on the upper part of the lens holding frame 2, which groove connects a driving member 9 to the lens holding frame 2, and further, there is provided a feed screw 7a in a driving axis 7 of a motor for driving 6

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which motor is attached to the fixed body tube, and the driving member 9 made of a resin is slidably held by a third guide pole 10 arranged at a motor mounting body 8 in parallel with the driving axis 7. Furthermore, this driving member 9 is provided with a notch nut 9a which is threadedly engaged with the feed screw 7a as shown in figure 9, and a first arm 9b having spring characteristics for supporting the feed screw 7a by sandwiching the screw 7a is formed.

On the other hand, a second arm 9d is formed in the driving member 9 as shown in figure 10, and a gap between the second arm 9d and a thread part of the feed screw 7a is constructed so as to have a smaller gap size than a screw thread height size of the notch nut 9a. Further, there is provided an edge portion 9c having enough rigidity to slidably move the lens holding frame 2 and having spring characteristics, in a connected portion of the driving member 9 with the lens holding frame 2 as shown in figure 11, and this edge portion 9c is inserted into the groove 2a in an arrow direction, thereby constructing a backlash-free connection in the direction of the lens optical axis 5. Further, there is provided a stopper edge portion 9e which does not abut against the groove 2a in the connected portion of the driving member 9 as shown in figure 12, so that the edge portion 9c having the spring characteristics is not curved to a spring limit due to shock.

In the conventional lens driving apparatus so constructed,

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the operation thereof will be described hereinafter. The feed screw 7a formed in the driving axis 7 is inserted in the notch nut 9a of the driving member 9 so as to be pressured and energized by the first arm 9b having the spring characteristics. In this case, since the driving member 9 is slid by the third guide pole 10 to move in the direction of the lens optical axis 5 when the motor for driving 6 rotates, the lens holding frame 2 connected to the driving member 9 is also slid by the first guide pole 3 and the second guide pole 4 in accordance with a rotation of the motor for driving 6 to move in the direction of the lens optical axis 5, thereby to obtain focusing by the lens 1.

However, in this construction, the driving member 9 supports the feed screw 7a by sandwiching it through the notch nut 9a and the first arm 9b. Therefore, when the feed screw 7a vibrates at the rotation of the motor for driving 6, this vibration is directly transmitted to the driving member 9, thereby vibrating around the third guide pole 10. Since the driving member 9 and the lens holding frame 2 are connected to each other in the direction of the lens optical axis 5 by the edge portion 9c having the spring characteristics without backlash, the vibration is transmitted to the lens holding frame 2 without being completely absorbed in the edge portion 9c having the spring characteristics, and therefore, the lens vibrates, whereby, when focusing is performed, an image shakes so that a photographed video becomes hard to view.

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Further, even when a tilt-photography is performed by a video camera which is provided with this lens driving apparatus, there is a problem as follows. That is, when a focusing operation is performed while photographing is performed in a state where the video camera is horizontal, the lens holding frame 2 which holds the lens 1 is slid by the first guide pole 3 and the second guide pole 4, further, the driving member 9 is slid by the third guide pole 10, and the lens holding frame 2 and the driving member 9, having the respective clearances d , horizontally move in the direction of the lens optical axis 5 to perform focusing as shown in figure 13.

When photographing is performed in a slightly tilted state from this state, as shown in figure 14, the edge portion 9c having the spring characteristics cannot absorb a slope of the lens holding frame 2, and therefore, the lens holding frame 2 tilts in a self-weight direction of the lens 1 shown by an arrow W3, by a smaller clearance of a clearance D2 held by the first guide pole 3 and the lens holding frame 2 or a clearance D3 held by the third guide pole 10 and the driving member 9, thereby accordingly generating a tilt in the lens 1 and then a single blur phenomenon of the photographed video.

The present invention is made to solve these problems, and has for its object to provide a lens driving apparatus which faithfully transmits a feed displacement by the motor for driving as the feed displacement of the lens and has a stable

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driving performance, as well as in which apparatus the photographed video does not vibrate due to a vibration by the motor for driving.

Disclosure of the Invention

In a lens driving apparatus according to the present invention (Claim 1) having a lens holding frame which holds a lens and is guided by a first guide pole and a second guide pole to slidably move in the lens optical axis direction, a driving shaft having a feed screw which is rotated and driven by a motor, and a driving member which has a rack threadedly engaged with the feed screw of the driving shaft at one end and is engaged with the lens holding frame at the other end, wherein the driving member is mounted rotatably to a positioning dowel which is provided in the lens holding frame and extends in the lens optical axis direction by a positioning hole provided in the driving member, and a spring member, which presses the rack of the driving member against the driving shaft as well as provides an elastic rotating force in a direction along which the lens holding frame is pressed against the second guide pole, is provided between the lens holding frame and the driving member, and a moment in a direction along which the lens holding frame is pressed against the second guide pole by a self-weight of the lens holding frame is added in the elastic rotating force of the spring member. Thereby, it can be avoided that a

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photographed video vibrates due to a random vibration produced by a rotation of the motor for driving, and further a feed displacement by the motor for driving can be faithfully transmitted as the feed displacement of the lens.

According to the lens driving apparatus of the present invention (Claim 2), in the lens driving apparatus of Claim 1, the driving member is made of a resin material, and two leg parts capable of elastic deformation and parallel with each other, which are respectively provided with positioning holes at their tips, are formed integrally with the driving member, and the positioning dowel formed in the lens holding frame has a taper shape the diameter of which becomes smaller toward a tip, and the diameter of a bottom part of the positioning dowel is constructed so as to be larger than the diameter of the positioning hole of the driving member. Thereby, the feed displacement by the motor for driving at photographing can be faithfully transmitted as the feed displacement of the lens, and a continually stable driving performance of the lens can be guaranteed.

According to the lens driving apparatus of the present invention (Claim 3), in the lens driving apparatus of Claim 2, a stopper which restricts deformation and omission of the driving member is formed integrally with the driving member and the lens holding frame. Thereby, when an external force acts on the lens holding frame due to a fall, shock, or the like,

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the driving member can be prevented from being separated away from the lens holding frame.

Brief Description of the Drawings

Figure 1 is an exploded perspective view of a main portion according to an embodiment of a lens driving apparatus of the present invention.

Figure 2 is a side view illustrating a state where a driving member and a coil spring are attached to a lens holding frame of the lens driving apparatus shown in figure 1.

Figure 3 is a vector diagram illustrating directions of forces to act between a position where the lens holding frame and the coil spring are abutted and a position where the lens holding frame and a second guide pole are abutted in the lens driving apparatus shown in figure 1.

Figure 4 is a cross sectional view of a main section illustrating a state where a leg part of the driving member is attached to a positioning dowel of the lens holding frame in the lens driving apparatus shown in figure 1.

Figure 5 is a cross sectional view of a main section illustrating a stopper of the driving member in the lens driving apparatus shown in figure 1.

Figure 6 is a cross sectional view of a main section illustrating a state where an external force acts on the lens holding frame to create displacement in the lens driving

apparatus shown in figure 1.

Figure 7 is a cross sectional view of a main section illustrating a state where the lens driving apparatus shown in figure 1 is tilted upward.

Figure 8 is a perspective view of a main section in a conventional lens driving apparatus.

Figure 9 is a partially cross sectional view illustrating an engagement of a first arm having spring characteristics of the driving member and a feed screw in the conventional lens driving apparatus.

Figure 10 is a partially cross sectional view illustrating an engagement of a second arm of the driving member and the feed screw in the conventional lens driving apparatus.

Figure 11 is a partially cross sectional view illustrating a state where an edge portion having spring characteristics of the driving member and the lens holding frame engage with each other in the conventional lens driving apparatus.

Figure 12 is a partially cross sectional view illustrating a state where a stopper edge portion of the driving member is inserted in a groove for a joint of the lens holding frame in the conventional lens driving apparatus.

Figure 13 is a cross sectional view of a main section when the conventional lens driving apparatus is faced in a horizontal direction to perform photographing.

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Figure 14 is a cross sectional view of a main section illustrating a state where the conventional lens driving apparatus is tilted upward.

Best Mode for Carrying out the Invention

Hereinafter, an embodiment of the present invention will be described with reference to figures. Further, the same numerals are given to the same parts as the above-described conventional example, and the detailed description thereof will be omitted.

Figure 1 is an exploded perspective view of a main portion of a lens driving apparatus according to an embodiment of the present invention, figure 2 is a side view illustrating a state where a driving member and a coil spring are attached to a lens holding frame in the lens driving apparatus shown in figure 1, figure 3 is a vector diagram illustrating directions of forces which act between a position where the lens holding frame and the coil spring are abutted and a position where the lens holding frame and a second guide pole are abutted in the lens driving apparatus shown in figure 1, figure 4 is a cross sectional view of a main section illustrating a state where a leg part of the driving member is attached to a positioning dowel of the lens holding frame in the lens driving apparatus shown in figure 1, figure 5 is a cross sectional view of a main section illustrating a stopper of the driving member in the lens driving apparatus

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shown in figure 1, figure 6 is a cross sectional view of a main section illustrating a state where an external force acts on the lens holding frame to create displacement in the lens driving apparatus shown in figure 1, and figure 7 is a cross sectional view of a main section illustrating a state where the lens driving apparatus shown in figure 1 is tilted upward.

In figures 1 and 2, numeral 1 denotes a lens, and numeral 2 denotes a lens holding frame made of a resin, for holding the lens 1. The lens holding frame 2 is held by a first guide pole 3 and a second guide pole 4, and has a constant clearance D1 positioned in the second guide pole 4 to be guided, and slidably moves in the direction of a lens optical axis 5. Numeral 9 denotes a driving member which connects the lens holding frame 2 with a feed screw 7a formed in a driving axis 7 of a motor for driving 6. On the driving member 9, the following components are integrally formed: a leg part 9j capable of elastic deformation, which part is composed of two plates having spring characteristics and extending in parallel with each other, a mounting dowel 9h which mounts a coil spring 11, a first groove 9g against which an end portion of the coil spring 11 abuts, and a rack part 9 which is pressured and energized by the feed screw 7a and makes the driving member 9 itself move in the direction of the lens optical axis 5 together with a rotation of the feed screw 7a. Further, the leg part 9j is provided with a positioning hole 9i which engages with the

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positioning dowel 2b formed in the lens holding frame 2 and makes the leg part 9j and the lens holding frame 2 rotatable to each other.

Further, the coil spring 11 is engaged with the mounting dowel 9h, and the first end portion 11a and the second end portion 11b abut against the first groove 9g formed in the driving member 9 and the second groove 2e formed in the lens holding frame 2, respectively, and the rack part 9f abuts against the feed screw 7a by a reaction force of the coil spring 11, as well as the lens holding frame 2 is constructed so as to rotate in a counterclockwise direction by using the first guide pole 3 as a rotation fulcrum shaft. Further, the lens holding frame 2 is provided with an engaging part 2c integrally formed with this lens holding frame 2 as a stopper.

In a lens driving apparatus so constructed, as shown in figure 2, a force always acts on a C-point of the lens holding frame 2 which has a constant clearance D1 in the second guide pole 4 to be slidably and movably held in a counterclockwise direction shown by an arrow, by the reaction force of the coil spring 11, and this will be described in details with reference to the vector view shown in figure 3.

In figure 3, A shows a center of the first guide pole 3 shown in figure 2, B shows a contact point between the second groove 2e and the coil spring 11, and C shows a contact point between the second guide pole 4 and the lens holding frame 2.

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When a vertical direction component of an elastic rotating force generated by the coil spring 11 to a line segment which links A to B is FB, a rotation moment is generated in the counterclockwise direction by taking the center A of the first guide pole 3 as reference. Accordingly, when a component which acts in a vertical direction to a line segment which links the A-point to the C-point is FC in the C-point, a force in a direction of $FC=FB \times AB/AC$ always acts. Further, the moment in a direction along which the lens holding frame 2 press-contacts with the second guide pole 4 by a self-weight W1 of the lens holding frame 2 including the lens 1 is added in the elastic rotating force.

Next, as shown in figure 4, the positioning dowel 2b having a taper-like projecting shape the diameter of which becomes smaller toward a tip, which dowel is formed integrally with the lens holding frame 2, is attached to the leg part 9j of the driving member 9 in a state where the positioning dowel 2b is elastically supported by being sandwiched, and, as shown in figure 2, the driving member 9 is rotated by the coil spring 11 in a clockwise direction, whereby the rack part 9f formed in this driving member 9 is threadedly engaged with the feed screw 7a. Further, the positioning hole 9i formed in the leg part 9j has a taper-like projecting shape the diameter of which becomes smaller toward a tip such that the driving member 9 easily rotates, and is in linear contact so as not to generate

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a backlash due to a clearance between the positioning hole 9i and the positioning dowel 2b of the lens holding frame 2, whereby the rotating friction resistance is small. Further, as shown in figure 5, a projection 9k is provided at a tip of the driving member 9, and an engaging part 2c is integrally formed on the lens holding frame 2 in a position which is apart from a tip of the projection 9k by clearance, so as to constitute the stopper by engaging with the projection 9k.

In this way, the driving member 9 and the lens holding frame 2 engage with each other, whereby, as shown in figure 6, when a force in a direction shown by an arrow F acts on the lens holding frame 2 due to a fall, shock, or the like, lift is produced against the positioning dowel 9b in the leg part 9j. However, at this time, the projection 9k integrally formed at a tip of the driving member 9 abuts against the engaging part 2c beforehand, so that the leg part 9j is not separated away from the positioning dowel 2b.

In the lens driving apparatus so constructed, an operation thereof will be described hereinafter. When the video camera is trained on a given subject, the lens driving apparatus built in the video camera operates to perform focusing on the subject, and the lens 1 in this lens driving apparatus is moved to the focusing position, by an automatic focusing control circuit not shown. At this focusing operation, the lens driving apparatus shown in figures 1 and 2 operates so that the motor for driving

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6 rotates, the driving member 9 pressed against the feed screw 7a by the coil spring 11 moves in the direction of the lens optical axis 5 in accordance with the rotation of the motor for driving 6, and the lens holding frame 2 connected to the driving member 9 is also guided by the first guide pole 3 and the second guide pole 4 in accordance with the rotation of the motor for driving 6 to slidably move in the direction of the lens optical axis 5, thereby obtaining focusing by using the lens 1.

At this time, although the feed screw 7a vibrates by a rotational vibration of the motor for driving 6, a vibration of the feed screw 7a is transmitted to the driving member 9, because the rack part 9f of the driving member 9 is always pressed against the feed screw 7a. However, since the coil spring 11 which provides the elastic rotating force is disposed between the driving member 9 and the lens holding frame 2, and further a moment in a direction along which the lens holding frame 2 is pressed against the second guide pole 4 by the self-weight of the lens holding frame 2 including the lens 1 is also added in the elastic rotating force, the vibration which is produced in the lens holding frame 2 is absorbed.

Next, a description will be given of a case where the lens driving apparatus according to this embodiment is tilted upward with reference to figure 7. As shown in figure 7, the leg part 9j of the driving member 9 elastically supports the positioning dowel 2b having a taper-like projecting shape, which dowel is

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formed in the lens holding frame 2, by sandwiching the dowel 2b. In addition, the positioning hole 9i formed in the leg part 9j has a taper-like projecting shape and is in linear contact so as not to generate a backlash due to a clearance between the positioning hole 9i and the positioning dowel 2b of the lens holding frame 2. Further, the driving member 9 is pressed against the feed screw 7a by the above-described action of the coil spring 11, and a moment in a direction along which the lens holding frame 2 press-contacts with the second guide pole 4 is provided. Therefore, such a conventional phenomenon that focusing is off by that the lens 1 is tilted due to a difference between positions is removed. In addition, the driving member 9 can faithfully transmit the feed displacement of the feed screw 7a to the lens holding frame 2 as the feed displacement, and the lens 1 is guided by the first guide pole 3 and the second guide pole 4, thereby moving the lens 1 in the direction of the lens optical axis 5. Further, W2 denotes a self-weight in the direction of the lens optical axis 5.

Further, while an example in which the leg part 9j is integrally formed in the driving member 9 is described in this embodiment, this leg part 9j may be a different member that is separated from the driving member 9. Further, while the coil spring 11 is described as a different member from the driving member 9, the driving member 9 may be provided with a member having spring characteristics as an integrated part.

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As described above, according to this embodiment, the vibration of the motor for driving 6 is absorbed by the coil spring 11 which is disposed between the driving member 9 and the lens holding frame 2, and by the press from the lens holding frame 2 against the second guide pole 4 due to the self-weight of the lens holding frame 2 including the lens 1. Therefore, the vibration of the lens 1 can be removed, thereby removing the vibration of the photographed video. Further, the positioning dowel 2b provided in the lens holding frame 2 is constructed so as to be elastically supported by being sandwiched by the positioning dowel 9i provided in the leg part 9j of the driving member 9, thereby removing an occurrence of the backlash due to a clearance between the members, faithfully transmitting the feed displacement by the motor for driving 6 at photographing as the feed displacement of the lens 1, and guaranteeing the continually stable driving performance of the lens 1.

Industrial Availability

As described above, the lens driving apparatus according to the present invention relates to a lens driving apparatus which performs focus adjustment (focusing) by performing lens position adjustment of a master lens when a subject is photographed by using a video camera or the like, and, more particularly, the lens driving apparatus can prevent defocusing

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during a zooming operation at manual focusing or defocusing of a photographed image which is involved by a difference between positions at photographing.

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CLAIMS

1. A lens driving apparatus having a lens holding frame which holds a lens and is guided by a first guide pole and a second guide pole to slidably move in the lens optical axis direction, a driving shaft having a feed screw which is rotated and driven by a motor, and a driving member which has a rack threadedly engaged with the feed screw of the driving shaft at one end and is engaged with the lens holding frame at the other end, wherein

the driving member is mounted rotatably to a positioning dowel which is provided in the lens holding frame and extends in the lens optical axis direction by a positioning hole provided in the driving member, and

a spring member, which presses the rack of the driving member against the driving shaft as well as provides an elastic rotating force in a direction along which the lens holding frame is pressed against the second guide pole, is provided between the lens holding frame and the driving member, and a moment in a direction along which the lens holding frame is pressed against the second guide pole by a self-weight of the lens holding frame is added in the elastic rotating force of the spring member.

2. The lens driving apparatus of Claim 1 wherein the driving member is made of a resin material, and two

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leg parts capable of elastic deformation and parallel with each other, which are respectively provided with positioning holes at their tips, are formed integrally with the driving member, and

the positioning dowel formed in the lens holding frame has a taper shape the diameter of which becomes smaller toward a tip, and the diameter of a bottom part of the positioning dowel is constructed so as to be larger than the diameter of the positioning hole of the driving member.

3. The lens driving apparatus of Claim 2 wherein

a stopper which restricts deformation and omission of the driving member is formed integrally with the driving member and the lens holding frame.