

A FLEXIBLE PRINTED CIRCUIT BOARD MOUNTING APPARATUS OF A LENS

The present invention relates to a flexible printed circuit board mounting apparatus of a lens which electrically connects a shutter unit on a lens side, particularly on a zoom lens side, and a control circuit on a camera body side.

In recent cameras, a lens is usually provided with a shutter unit which receives operation signals issued from a camera body in accordance with an object distance value and a luminance value of an object to be taken. The operation signals are usually transmitted by a flexible printed circuit board (FPC board), to a zoom lens in which a large movement of the shutter unit in the optical axis direction takes place together with a group of movable lenses.

The FPC board must be capable of deforming so as to absorb the displacement of the movable lens group. The amount of deformation of the flexible printed circuit board becomes large as the displacement of the movable lens group increases. To this end, usually, the FPC board is bent twice between the shutter unit and the camera body. However, it is very difficult to provide sufficient space at the bent portions and ensure a stability (immovability) of the bent portions. Namely, there is a possibility of an accidental separation of the bent portions of the FPC board from a receiving groove formed in an annular member. The separation may cause the FPC board to interfere with the annular member or another annular member(s) which move in the optical axis direction. Thus, the FPC board may be damaged and no movement of the movable lens can occur.

In addition to the foregoing, since no precise restriction of the axial

movement of the conventional FPC board in the optical axis direction can be effected, the axial movement of the shutter unit causes the FPC board to move in the same direction, thus resulting in an interference of the FPC board with the annular member(s).

An object of the present invention is to provide a flexible printed circuit board mounting apparatus of a lens having a flexible printed circuit board, wherein the flexible circuit board can be firmly supported at the bent portions thereof by an annular member.

Another object of the present invention is to provide a flexible printed circuit board mounting apparatus of a lens in which the axial position of the flexible printed circuit board can be precisely restricted.

According to one aspect of the present invention there is provided a flexible printed circuit board mounting apparatus of a lens comprising:-a movable lens which moves in an optical axis direction;

a shutter unit provided on the movable lens;

a flexible printed circuit board for connecting the shutter unit to a control circuit on a camera body side;

an annular member located on the outer periphery of the shutter unit;

a receiving groove which is formed in the inner surface of the annular member to receive the flexible printed circuit board; and,

a securing member which holds a bent portion of the flexible printed circuit board which is located in the receiving groove.

With this arrangement, a bent portion of the flexible printed circuit board can be securely supported in the receiving groove of the annular member so as to prevent the flexible printed circuit board from interfering with any movable member which moves in the optical axis direction.

Preferably, said flexible printed circuit board extends rearwardly

from the shutter unit and is bent to extend forwardly at a first bent portion for insertion in the receiving groove, and is then bent to extend rearwardly again at a second bent portion which is immovably held by the securing member.

In this case, said first bent portion of the flexible printed circuit board is free to deform.

Conveniently, said receiving groove has a wide portion and a narrow portion which is connected to the wide portion through a stepped portion.

Thus, said flexible printed circuit board can have a wide portion and a narrow portion which is connected to the wide portion through a stepped portion, and which correspond to the wide portion, the narrow portion and the stepped portion of the receiving groove, respectively.

In a preferred embodiment, said securing member is made of a plate having a keeping portion which can be located in the receiving groove and an engaging means which extends in a direction perpendicular to the receiving groove.

In this case said annular member has an insertion groove in which the engaging means can be fitted and a prevention wall which is located adjacent to the insertion groove to prevent the engaging means from coming out thereof.

Conveniently, said securing member is made of an elastically deformable leaf spring.

It is preferred that said flexible printed circuit board is bent at least twice to be able to connect said shutter unit and said control circuit.

It is also preferred that said receiving groove extends in a direction parallel to the optical axis direction.

According to another aspect of the present invention, there is provided a flexible printed circuit board mounting apparatus of a lens comprising:-

a movable lens which moves in an optical axis direction;

a shutter unit provided on the movable lens;

a flexible printed circuit board being bent at least twice for connecting the shutter unit to a control circuit on a camera body side and having a wide portion and a narrow portion which is connected to the wide portion through a stepped portion;

an annular member located on the outer periphery of the shutter unit; and

a receiving groove which is formed in the inner surface of the annular member to receive the flexible printed circuit board and has a wide portion and a narrow portion which is connected to the wide portion through a stepped portion, which correspond to the wide portion, narrow portion and the stepped portion of the flexible printed circuit board respectively.

By the engagement of the stepped portion of the FPC board with the corresponding stepped portion of the receiving groove, the axial position of the FPC board in the optical axis direction can be restricted, so that no accidental movement of the FPC board occurs.

The restriction mechanism of the axial position of the FPC board can be applied not only to a flexible printed circuit board having the above mentioned securing device, but also to a flexible printed circuit board having no securing device.

The present invention encompasses a camera including a flexible printed circuit board mounting apparatus of a lens as hereinbefore defined.

An example of the present invention will be described below in detail with reference to the accompanying drawings showing preferred embodiments of the present invention, in which:-

Figure 1 is a perspective view of a main part of a flexible printed circuit board mounting apparatus of a lens for the present invention, shown in

: : : : :

- 5 -

a position before mounting;

Fig. 2 is a perspective view of a main part of a flexible printed circuit board mounting apparatus of a lens for the present invention, shown in a position after mounting;

Figs. 3, 4 and 5 are sectional views taken along the lines III-III, IV-IV and V-V in Fig. 2, respectively;

Figs. 6, 7 and 8 are longitudinal sectional views of an upper half of a lens shutter type of zoom lens to which the present invention is applied, shown in an accommodation position, a WIDE-extremity position and a TELE-extremity position, respectively; and,

Fig. 9 is an expanded view of a cam ring, a lens guide ring and an inner helicoid ring in a lens shutter type of zoom lens shown in Figs. 6 through 8.

The illustrated embodiments are applied to a lens shutter type of zoom lens camera. Figs. 6, 7 and 8 show an accommodation position, a WIDE-extremity position and a TELE-extremity position of the zoom lens camera, respectively.

A camera body 11 of a lens shutter type of zoom lens camera has a stationary barrel 12 secured thereto. Numerals 13 and 14 designate an outer rail and an inner rail provided on the camera body 11 to form a film guide, respectively. The outer and inner rails 13 and 14 and a pressure plate (not shown) are per se known and define a film passing plane.

An outer helicoid ring 18, which is provided on its inner periphery with helicoid teeth, is secured to the stationary barrel 12 through set screws 19.

The outer helicoid ring 18 is engaged by an inner helicoid ring 20 which is provided on its outer periphery with helicoid teeth 20a. To the inner helicoid ring 20 is secured a cam ring 22 by means of set screws 21 (Fig. 9).

On the outer periphery of the inner helicoid ring 20 is formed a gear

20b which is inclined in the same direction as the lead angle of the helicoid teeth 20a and which has an optical axis thread extending in parallel with the optical axis direction. The inner helicoid ring 20 is rotated in the forward and reverse directions through a pinion (not shown) which is engaged by the gear 20b and a motor (not shown) which drives the pinion. Consequently, when the inner helicoid ring 20 is rotated in the forward direction and the reverse direction, since the outer helicoid ring 18 engaging therewith is secured to the stationary barrel 12, the inner helicoid ring 20 moves in the optical axis direction together with the cam ring 22 while rotating, in accordance with the lead of the helicoid teeth 20a.

In the inner periphery of the cam ring 22 is fitted a lens guide ring 24 which moves in the optical axis direction together therewith and rotates relative thereto. A linear movement guide plate 26 is secured by means of a set screw 25 to the rear end of the lens guide ring 24. The linear movement guide plate 26 is provided on its outer periphery with a projection 26a which is engaged in a lens guide ring guide groove 27 formed on the inner surface of the stationary barrel 12.

An inner flange 29 which is formed on the rear end of the cam ring 22 is relatively fitted in an annular groove 28 which is formed between the linear movement guide plate 26 and the rear end of the lens guide ring 24 so that the lens guide ring 24 can move in the optical axis direction together with the cam ring 22. The rotational movement of the lens guide ring 24 is restricted by the lens guide ring guide groove 27. The cam ring 22 can rotate relative to the lens guide ring 24.

A front movable lens group 15 and a rear movable lens group 16 are secured to a front lens frame 30 and a rear lens frame 31, which frames are located inside the lens guide ring 24, respectively. The front lens frame 30 is engaged by a helicoid ring 33 secured to a shutter unit 32. The shutter unit 32 is secured to a front movable frame 34 which is provided on its outer periphery with at least three guide pins 35. The rear lens frame 31 is

provided on its outer periphery with at least three guide pins 36. The guide pins 35 and 36 are overlapped in Figs. 6 and 8.

Numerals 38 and 39 designate a cylindrical lens cover integral with the front movable frame 34 and a decorative cylinder which covers the lens guide ring 24 and the cam ring 22, projecting from an outer body shell 11a, respectively.

The cam ring 22 has front cam grooves 41 and rear cam grooves 42 in which the guide pins 35 and 36 are fitted. The lens guide ring 24 has lens guide grooves 43 and 44 corresponding to the front and rear cam grooves 41 and 42. In the illustrated embodiment, the lens guide grooves 43 and 44 are straight grooves extending in the optical axis direction. The guide pins 35 are inserted in the front cam grooves 41 and the lens guide grooves 43, and the guide pins 36 are inserted in the rear cam grooves 42 and the lens guide grooves 44.

The shape of the front cam grooves 41 and the corresponding lens guide grooves 43 and the shape of the rear cam grooves 42 and the corresponding lens guide grooves 44 are such that the axial movement of the cam ring 22 and the lens guide ring 24 due to the rotation of the inner helicoid ring 20 and the relative rotation of the cam ring 22 and the lens guide ring 24 cause a predetermined axial displacement of the movable lenses 15 and 16.

In Fig. 9, the section $\varnothing 1$ in the front cam grooves 41 and the adjacent rear cam grooves 42 is a zooming section (normal photographing section), the section $\varnothing 2$ is a macro transfer section connected to a TELE extremity of the zooming section $\varnothing 1$, and the section $\varnothing 3$ is an accommodation section connected to the WIDE extremity of the zooming section $\varnothing 1$. The macro transfer section $\varnothing 2$ has a lead angle opposite to that of the zooming section $\varnothing 1$, with respect to the direction parallel to the optical axis. In other words, if the lead angle of the zooming section $\varnothing 1$ is positive, the lead angle of the macro transfer section $\varnothing 2$ is negative.

In the zoom lens as constructed above, when the inner helicoid ring 20

is rotated in the forward direction or the reverse direction, the inner helicoid ring 20 moves in the optical axis direction in accordance with the lead of the helicoid teeth 20a while rotating. Namely, the cam ring 22 secured to the inner helicoid ring 20 not only rotates together therewith but also moves in the optical axis direction in accordance with the lead of the helicoid teeth 20a.

When the cam ring 22 moves in the optical axial direction, the lens guide ring 24 which is attached to the cam ring 22 so as to rotate relative thereto and to move together in the axial direction moves in the optical axis direction without rotating. The relative rotation of the cam ring 22 and the lens guide ring 24 causes the movable lenses 15 and 16 to move in the optical axis direction due to the relationship between the front cam grooves 41 and the lens guide grooves 43 and between the rear cam grooves 42 and the lens guide grooves 44.

Thus, the movement of the cam ring 22 and the lens guide ring 24 causes the movable lenses 15 and 16 to move from the accommodation position shown in Fig. 6 to the TELE extremity position shown in Fig. 8. It should be appreciated that the lens accommodation length is extremely short, since neither the cam ring 22 nor the lens guide ring 24 protrude from the body shell 11a and the cylindrical lens cover 38.

The shutter unit 32, as is well known, rotates a drive pin 32a by an angle corresponding to an object distance signal which is issued by an object distance detecting device to rotate the front lens frame 30 associated with the drive pin 32a through a pin 30a so that the front lens frame 30 moves in the optical axis direction in accordance with the helicoid 33 to effect the focusing. Furthermore, shutter and diaphragm blades 32b operate in accordance with the luminance signal which is issued by a photometer. The distance signal and the luminance signal are fed from a control circuit 50 provided in the camera body 11 to the shutter unit 32 through a flexible printed circuit board 51.

The FPC board 51 connected to the control circuit 50 extends through an aperture formed in the stationary barrel 12 into a space defined between the stationary barrel 12 and the cam ring 22. In the space, the FPC board 51 extends rearwardly along the inner surface of the stationary barrel 12 to come further rearwardly through a gap between the projection 26a of the linear movement guide plate 26 and the stationary barrel 12.

The FPC board 51 is bent in a generally U-shape at a first bent portion A in the vicinity of the rear end of the stationary ring 12 to be adhered to the outer surface of the linear movement guide plate 26 by an adhesive portion B. The FPC board 51 further extends toward the optical axis and then along the inner surface of the lens guide ring 24. The FPC board 51 is bent forwardly at the rear end flange 24A of the lens guide ring 24.

The lens guide ring 24 is provided on its inner periphery with a receiving groove 45 which extends in the optical axis direction to receive the FPC board 51 (Figs. 1 ~5). The FPC board 51 which extends along the inner surface of the lens guide ring 24 is inserted in the receiving groove 45 to extend forwardly and is bent rearwardly at a second bent portion C in the vicinity of the front end of the lens guide ring 24, so that the FPC board 51 is brought rearwardly into the receiving groove 45 to be superimposed on the portion of the FPC board already in the receiving groove 45.

The receiving groove 45 has a rear relatively wider portion 45a and a front relatively narrower portion 45b which is connected to the wide portion 45a through a stepped portion 45c. The FPC board 51 has a wide portion 51a, a narrow portion 51b and a stepped portion 51c corresponding to the wide portion 45a, the narrow portion 45b and the stepped portion 45c of the receiving groove 45 so that when the stepped portion 45c of the receiving groove 45 is engaged by the stepped portion 51c of the FPC board 51, the axial displacement of the FPC board 51 is restricted.

The lens guide ring 24 has a through hole 54 to the front of the receiving groove 45 which receives the bent portion C of the FPC board 51. On

the opposite sides of the receiving groove 45 are formed an insertion groove 55 which extends perpendicularly to the receiving groove 45. The rear end wall of the insertion groove 55 defines a prevention wall 56. To the front of the through hole 54 is formed a stepped portion 57 for receiving a securing member 60.

The second bent portion C of the FPC board 51 is held between the securing member 60 and the bottom of the receiving groove 45 by means of the insertion groove 55 and the prevention wall 56. Namely, the securing member 60 which is preferably made of a leaf spring has a flat plate portion 60a of a width corresponding to the width of the receiving groove 45 and engaging legs 60b which can be fitted in the insertion groove 55. The flat plate portion 60a of the securing member 60 is provided on its front end with an elastically deformable keeping portion 60c which is slightly bent toward the receiving groove 45.

The securing member 60 is superimposed on the second bent portion C of the FPC board 51 after the latter is fitted in the receiving groove 45, so that the engaging leg 60b of the securing member 60 is inserted in the insertion groove 55. Thereafter, the securing member 60 is slid rearwardly to engage the engaging legs 60b with the prevention wall 56 which prevents the engaging leg 60b from coming out of the insertion groove 55. The end of the keeping portion 60c comes into engagement in the stepped portion 57. Thus, the securing member 60 is firmly held. In this state, the flat plate portion 60a of the securing member 60 firmly comes into elastic contact with the FPC board 51 so that the second bent portion C of the FPC board 51 is firmly held between the securing member 60 and the bottom of the receiving groove 45. The shape and the thickness of the securing member 60 are such that it can be snugly fitted within the lens guide ring 24.

The FPC board 51 extends further rearwardly in the receiving groove 45 from the mounting position of the securing member 60 and is bent forwardly again at a third bent portion D to be connected to the shutter unit 32.

As can be seen from the foregoing, as viewed from the shutter unit unit, the FPC board 51 extends rearwardly, is bent forwardly at the bent portion D, is inserted in the receiving groove 45, and is bent rearwardly at the bent portion C which is secured to the receiving groove 45 by the securing member 60.

As mentioned above, since the second bent portion C of the FPC board 51 is mounted to the bottom of the receiving groove 45 by the securing member 60, the second bent portion C of the FPC board does not accidentally hang down toward the optical axis, so that no interference of the second bent portion C of the FPC board 51 with the cylindrical lens cover 38 occurs. Furthermore, since the stepped portions 45c and the 51c restrict the axial position of the FPC board 51, there is no possibility that the second bent portion C of the FPC board 51 projects outside through the through hole 54 to interfere with the cam ring 22.

The loop-like shapes of the first bent portion A and the third bent portion D of the FPC board 51 deform during the zooming operation in which the lens barrel moves between the accommodation position shown in Fig. 6 and the TELE extremity position shown in Fig 8. The length of the FPC board 51 and the movement of the moving members in the optical axis direction of the zoom lens are set, even in the TELE extremity position in which the largest deformation takes place, so that neither the first bent portion A nor the third bent portion D interfere with the other elements and come onto the optical axis of the lens barrel.

As can be understood from the above discussion, with the present invention, in a camera in which a shutter unit moving in the optical axis direction on a lens side is connected to a control circuit on the camera body side by a flexible printed circuit board which is bent at least twice, since the bent portions of the FPC board are firmly held between a securing member and the bottom of an axially extending receiving

groove which is formed in the annular member, the bent portions are prevented

from being accidentally displaced or accidentally hanging. Consequently, no interference of the FPC board with a member which moves in the optical axis direction occurs, thus resulting in no damage of the FPC board and no failure of zooming.

Furthermore, the axial position of the flexible printed circuit board can be securely restricted by the receiving groove of the annular member which has a wide portion and a narrow portion which is connected to the wide portion through a stepped portion, and the flexible printed circuit board which has a corresponding wide portion, narrow portion and stepped portion.



- 13 -

CLAIMS

1. A flexible printed circuit board mounting apparatus of a lens comprising:-

a movable lens which moves in an optical axis direction;

a shutter unit provided on the movable lens;

a flexible printed circuit board for connecting the shutter unit to a control circuit on a camera body side;

an annular member located on the outer periphery of the shutter unit;

a receiving groove which is formed in the inner surface of the annular member to receive the flexible printed circuit board; and,

a securing member which holds a bent portion of the flexible printed circuit board which is located in the receiving groove.

2. A mounting apparatus according to claim 1, wherein said flexible printed circuit board extends rearwardly from the shutter unit and is bent to extend forwardly at a first bent portion for insertion in the receiving groove, and is then bent to extend rearwardly again at a second bent portion which is immovably held by the securing member.

3. A mounting apparatus according to claim 2, wherein said first bent portion of the flexible printed circuit board is free to deform.

4. A mounting apparatus according to any preceding claim, wherein said receiving groove has a wide portion and a narrow portion which is connected to the wide portion through a stepped portion.



- 14 -

5. A mounting apparatus according to claim 4, wherein said flexible printed circuit board has a wide portion and a narrow portion which is connected to the wide portion through a stepped portion and which correspond to the wide portion, the narrow portion and the stepped portion of the receiving groove, respectively.

6. A mounting apparatus according to any preceding claim, wherein said securing member is made of a plate having a keeping portion which can be located in the receiving groove and an engaging means which extends in a direction perpendicular to the receiving groove.

7. A mounting apparatus according to claim 6, wherein said annular member has an insertion groove in which the engaging means can be fitted and a prevention wall which is located adjacent to the insertion groove to prevent the engaging means from coming out thereof.

8. A mounting apparatus according to any preceding claim wherein said securing member is made of an elastically deformable leaf spring.

9. A mounting apparatus as claimed in any preceding claim wherein said flexible printed circuit board is bent at least twice to be able to connect said shutter unit and said control circuit.

10. A mounting apparatus as claimed in any preceding claim wherein said receiving groove extends in a direction parallel to the optical axis direction.

11. A flexible printed circuit board mounting apparatus of a lens comprising:-



- 15 -

a movable lens which moves in an optical axis direction;

a shutter unit provided on the movable lens;

a flexible printed circuit board being bent at least twice for connecting the shutter unit to a control circuit on a camera body side and having a wide portion and a narrow portion which is connected to the wide portion through a stepped portion;

an annular member located on the outer periphery of the shutter unit; and

a receiving groove which is formed in the inner surface of the annular member to receive the flexible printed circuit board and has a wide portion and a narrow portion which is connected to the wide portion through a stepped portion which correspond to the wide portion, narrow portion and the stepped portion of the flexible printed circuit board respectively.

12. A camera including of a flexible printed circuit board mounting apparatus of a lens as claimed in any preceding claim.

13. A flexible printed circuit board mounting apparatus substantially as hereinbefore described with reference to the accompanying drawings.
