

GUIDE APPARATUS FOR A CAM RING

The present invention relates to a cam ring guide apparatus which has an inner cam groove in which a cam pin of a movable member is fitted, so that when the cam ring rotates, the movable member is moved in a predetermined direction.

A cam ring guide apparatus as mentioned above is widely used for example as a lens guide apparatus in a zoom lens. Namely, a lens holding frame which holds a lens group has a cam pin which is fitted in a cam groove of a cam ring, so that the rotation of the cam ring causes the lens holding frame to move in the optical axis direction thereof. In a recent cam ring guide apparatus, the cam groove is formed as an inner cam groove which has a bottom wall. A cam pin is continuously biased to outwardly project from the lens holding frame in the radial direction, so as to ensure the engagement of the cam pin and the inner cam groove.

In a known cam ring guide apparatus, in order to bias the cam pin outwardly, a compression spring is provided in a cam pin supporting hole in which the cam pin is inserted. Upon assembly, after the compression spring is inserted in the cam pin supporting hole, the cam pin is pushed into the cam pin supporting hole while compressing the compression spring. Then, the lens group is fitted in the cam ring while registering the cam pin with the inner cam groove. However, these operations are troublesome and need high skill. Accordingly, for example, a beginner tends to fail to

fit the cam pin in the inner cam groove, so that the cam pin comes out or is ejected from the cam pin supporting hole by the compression spring, resulting in the loss thereof.

An object of the present invention is to provide a simple cam ring guide apparatus which can be easily assembled.

The improvement of the present invention is focused on a leaf spring which supports and biases a cam pin.

According to the present invention there is provided a cam ring guide apparatus comprising a rotatable cam ring having at least one inner cam groove into which at least one cam follower pin engages, said cam follower pin being radially movably provided in a cam pin supporting recess in a movable member and being biased by a leaf spring supported in a leaf spring holding portion assigned to each cam pin supporting recess so as to urge the cam follower pin radially outwardly with respect to the cam ring wherein the leaf spring comprises an elongate opening and a receiving portion of the cam follower pin connected therewith, characterized in that the elongate opening has a width such that said cam follower pin can freely pass through the opening when being inserted into the cam pin supporting recess, and that the receiving portion for the cam follower pin engages with said cam follower pin when the leaf spring is adjusted relative to the leaf spring holding portion.

With this arrangement, since the cam pin can be easily supported by a lens holding frame so as not to be released therefrom and can be biased to project radially outwardly, assembly can be simplified. This makes automatic assembly possible.

In a preferred embodiment the movable member is a lens holding frame for holding a lens group.

The cam pin may have a shaft portion adapted to pass through the elongate opening, and said receiving portion may comprise a peripheral groove having a diameter smaller than that of the shaft portion. In such an arrangement the shaft portion may comprise a larger diameter portion which can not

pass through the elongate opening.

In another arrangement the portion may be engaged by the cam pin when the leaf spring is moved relative to the leaf spring holding portion. In such an arrangement the leaf spring may have at its one end an engaging portion which engages with the leaf spring holding portion, and an abutting portion which abuts against a rear end of the leaf spring holding portion to restrict a movement of the leaf spring.

In another arrangement the receiving portion may be engaged by the cam pin when the leaf spring is moved relative to the leaf spring holding portion. In such an arrangement the leaf spring may have at its one end an engaging portion which engages with the leaf spring holding portion, and an abutting portion which abuts against a rear end of the leaf spring holding portion to restrict a movement of the leaf spring.

In another arrangement the inner cam groove may open at least one end thereof into the end of the cam ring, so that the cam pin which is held by the movable member through the leaf spring can be fitted into the inner cam groove from the open end thereof.

In such an embodiment the larger diameter portion of the cam pin may have at its top a tapered peripheral surface which can be brought into sliding contact with the inner cam groove when the cam pin is inserted in the inner cam groove.

In another feature of the invention the movable member may have a plurality of cam pin supporting legs which project radially outwardly so as to be held by the inner surface of the cam ring and, each of said legs having said elongate opening and said leaf spring holding portion. In such an arrangement the supporting legs may have leg portions which project in the radial direction of a lens group, and plate portions which are bent substantially at right angles from the associated leg portions to extend in a direction substantially parallel with the optical axis of the lens and which can slide in the cam ring. Further the leaf spring holding portions may be provided

with dovetail grooves which are located at the front ends of the plate portions of the cam pin supporting legs to extend in a direction parallel with the optical axis, so that one end of the leaf springs can be fitted in the dovetail grooves of the associated leaf spring holding portions to be held thereby.

The invention also provides that the, or each, said leaf springs may have engaging fingers and said leaf spring holding portions may have engaging recesses in which the associated engaging fingers can be engaged to prevent the leaf springs from coming out of the associated leaf spring holding portions.

An example of the present invention will now be described below in detail by way of illustration only with reference to the accompanying drawings, in which:-

Figure 1 is an exploded perspective view of a lens portion of a lens guide apparatus to which the present invention is applied;

Figure 2 is an enlarged perspective view of a cam pin supporting mechanism of a rear lens frame in a lens portion shown in Figure 1;

Figure 3 is a side view of Figure 2; and

Figure 4 is a side sectional view of a cam pin when a rear lens frame is fitted in a cam ring, embodying the present invention.

Figure 1 shows an exploded perspective view of a lens portion of a lens guide apparatus, according to an embodiment of the present invention. In Figure 1, "0" designates the

optical axis and the left side of the drawing corresponds to the front of the apparatus.

A lens portion 11 attached to a camera has a lens barrel 12 and a cam ring 13. A linear movement guide ring 15 is inserted in the cam ring 13 and is secured by set screws 43 to a guide ring securing plate 16 which is attached thereto from the rear side of the cam ring 13. Thus, the linear movement guide ring 15 is secured to the camera body (not shown). The cam ring 13 is provided on its outer periphery with a code plate 18 secured thereto to output data of the angular position of the cam ring 13. The cam ring 13 is provided on its inner peripheral surface with inner cam grooves 17 which open at least at its one end to the front end 13a of the cam ring 13.

15 A rear lens frame 19 which is inserted in the cam

ring 13 has a lens 20 at its center portion. The rear lens frame 19 constitutes a movable member which moves in the optical axis direction O when the cam ring 13 rotates. The rear lens frame 19 has three cam pin supporting legs 21, each of which has a leg portion 21a which project in the radial direction of the lens 20 from the rear of the lens frame 19 and an arched plate portion 21b which is bent at right angles from the leg portion 21a to extend in a direction substantially parallel with the optical axis O. The three plate portions 21a are located along an imaginary circle to define an imaginary cylinder.

The linear movement guide ring 15 has a center opening 25 and three arched key plates 23 around the center opening 25. The three key plates 23 which extend in a direction parallel with the optical axis O are located along an imaginary circle to define an imaginary cylinder.

As can be seen in Figs. 2 and 3, the plate portions 21b of the cam pin supporting legs 21 have leaf spring receiving grooves (recesses) 27 which extend in the direction substantially parallel with the optical axis O and which are provided on their front ends with leaf spring holding portions 28 having a width smaller than that of the leaf spring receiving grooves 27. The holding portions 28 have side dovetail grooves 29 at the opposite sides thereof. The leaf spring receiving grooves 27 are provided at their rear ends with cam pin supporting holes 30 which extend in the radial direction of the lens 20. Cam pins 26 which are fitted in the cam pin supporting holes 30 have smaller diameter shaft portions 34 which are slidably inserted in the cam pin supporting holes 30, peripheral recesses 32 having a diameter smaller than the diameter of the shaft portions 34, and upper head portions (large diameter portions) 45 which have a diameter larger than that of the shaft portions 34. The head portions 45 are provided on their upper ends with tapered conical peripheral surfaces 31.

In the leaf spring receiving grooves 27 are inserted leaf springs 33 which are deflected or bent upwardly at the rear ends or front ends thereof in their free state. The leaf springs 33 have, at their front ends, engaging portions 38 which are fitted in the side dovetail grooves 29 to be engaged thereby and abutting portions 37 which are connected to the engaging portions 38 and which abut against the rear ends of the leaf spring holding portions 28 to restrict the forward movement of the associated leaf springs 33. The abutting portions 37 have a width larger than that of the leaf spring holding portions 28. The engaging portions 38 have engaging fingers 40 at the center portions to prevent the leaf springs 33 from coming out of the leaf spring receiving grooves 27. The engaging fingers 40 are bent slightly inwardly from the remaining flat portion of the abutting portions 37, so that the engaging fingers 40 can be engaged in corresponding engaging recesses 42 which are formed in the leaf spring receiving grooves 27.

Each of the leaf springs 33 is provided on its opposite end with a cam pin receiving elongated opening 35 having a width which gradually increases toward the rear end thereof. The elongated opening 35 is provided on its rear end with a cam pin holding portion (hole) 36 which has a reduced width, so that the peripheral groove 32 of the associated cam pin 26 can be firmly held in the cam pin holding hole 36. The outer diameter of the head 45 of the cam pin 26 is larger than the largest width of the elongated opening 35, so that when the shaft portion 34 of the cam pin 26 is inserted in the elongated opening 35, the head 45 can not pass the elongated opening 35.

In the lens guide apparatus as constructed above, the attachment of the three cam pins 26 to the associated three cam pin supporting legs 21 is effected as follows.

First, the shaft portions 34 of the cam pins 26 are inserted in the cam pin receiving elongated openings 35 of

the leaf springs 33. In this state, the leaf springs 33 are free from the associated cam pins 26. Then, the shaft portions 34 of the cam pins 26 are moved to come in the cam pin supporting holes 30, so that the cam pins 26 are prevented from coming out of the associated leaf springs 33 by the heads (larger diameter portions) 45 thereof.

After that, the engaging portions 38 of the leaf springs 33 are fitted in the side dovetail grooves 29 until the abutting portions 37 come into contact with the rear ends of the leaf spring holding portions 28. During the fitting, the engaging fingers 40 which slide on the surfaces of the leaf spring receiving grooves 27 are engaged in the corresponding engaging recesses 42 of the leaf spring receiving grooves 27. As a result, the leaf springs 33 are held in the leaf spring receiving grooves 27 so as not to come out therefrom. At the same time, on the rear end sides of the leaf springs 33, since the cam pin receiving elongated openings 35 of the leaf springs 33 are moved along the lower surfaces of the heads 45 of the cam pins 26 in the optical axis direction, the cam pin holding holes 36 finally come into engagement with the peripheral grooves 32 of the cam pins 26. As a result, the cam pins 26 are held by the leaf springs 33 so as not to be disengaged therefrom and are biased outwardly in the radial direction of the rear lens frame 19 by the associated leaf springs 33. The above mentioned operations are performed for the three cam pins 26.

Thereafter, the cam pins 26 are engaged in three corresponding engaging recesses 44 which are formed on the rear end of the lens barrel 12. After that, the three cam pin supporting legs 21 of the rear lens frame 19 are inserted between the key plates 23 of the linear movement guide ring 15, and then, the lens barrel 12 is fitted in the cam ring 13 together with the rear lens frame 19 and the linear movement guide ring 15, placed between the lens barrel 12 and the cam ring 13.

Upon fitting the lens barrel 12 in the cam ring 13, the cam pins 26 are smoothly engaged in the inner cam grooves 17 which open into the front end 13a of the cam ring 13 while sliding the tapered surface 31 of the cam pins 26 on the side surfaces of the associated inner cam grooves 17, as can be seen in Fig. 4. Note that the three cam pins 26 are engaged in the corresponding inner cam grooves 17 at one time. Thereafter, the linear movement guide ring 15 is secured to the camera body through the guide ring securing plate 16.

Thus, the cam pins 26 can be easily assembled to be engaged in the associated inner cam grooves 17 and prevented from coming out of the associated cam pin supporting holes without a special tool or jig for pressing the cam pins. The simplified assembly makes even an automatic assembly possible.

Although the above mentioned embodiment is directed to a lens guide apparatus for guiding the rear lens frame 19, the present invention is not limited thereto and can be generically applied to a guide apparatus for guiding an annular member, such as a light intercepting ring.

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CLAIMS

1. A cam ring guide apparatus comprising a rotatable cam ring having at least one inner cam groove into which at least one cam follower pin engages, said cam follower pin being radially movably provided in a cam pin supporting recess in a movable member and being biased by a leaf spring supported in a leaf spring holding portion assigned to each cam pin supporting recess so as to urge the cam follower pin radially outwardly with respect to the cam ring wherein the leaf spring comprises an elongate opening and a receiving portion of the cam follower pin connected therewith, characterized in that the elongate opening has a width such that said cam follower pin can freely pass through the opening when being inserted into the cam pin supporting recess, and that the receiving portion for the cam follower pin engages with said cam follower pin when the leaf spring is adjusted relative to the leaf spring holding portion.
2. A cam ring guide apparatus according to claim 1, wherein said movable member is a lens holding frame for holding a lens group.
3. A cam ring guide apparatus according to either of claims 1 or 2 wherein said cam pin has a shaft portion adapted to pass through the elongate opening and said receiving portion comprises a peripheral groove having a diameter smaller than that of the shaft portion.
4. A cam ring guide apparatus according to claim 3 wherein the shaft portion comprises a larger diameter portion which can not pass through the elongate opening.
5. A cam ring guide apparatus according to claim 3 or 4 wherein said receiving portion is engaged by the cam pin when the leaf spring is moved relative to the leaf spring holding



portion.

6. A cam ring guide apparatus according to claim 5 wherein said leaf spring has at its one end an engaging portion which engages with the leaf spring holding portion, and an abutting portion which abuts against a rear end of the leaf spring holding portion to restrict a movement of the leaf spring.

7. A cam ring guide apparatus according to any preceding claim wherein said inner cam groove opens at least one end thereof into the end of the cam ring, so that the cam pin which is held by the movable member through the leaf spring can be fitted into the inner cam groove from the open end thereof.

8. A cam ring guide apparatus according to any of claims 4 to 7 wherein said larger diameter portion of the cam pin has at its top a tapered peripheral surface which can be brought into sliding contact with the inner cam groove when the cam pin is inserted in the inner cam groove.

9. A cam ring guide apparatus according to any preceding claim wherein said movable member has a plurality of cam pin supporting legs which project radially outwardly so as to be held by the inner surface of the cam ring and, each of said legs having said elongate opening and said leaf spring holding portion.

10. A cam ring guide apparatus according to claim 9 wherein said supporting legs have leg portions which project in the radial direction of a lens group, and plate portions which are bent substantially at right angles from the associated leg portions to extend in a direction substantially parallel with the optical axis of the lens and which can slide in the cam ring.



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11. A cam ring guide apparatus according to claim 10, wherein said leaf spring holding portions are provided with dovetail grooves which are located at the front ends of the plate portions of the cam pin supporting legs to extend in a direction parallel with the optical axis, so that one end of the leaf springs can be fitted in the dovetail grooves of the associated leaf spring holding portions to be held thereby.

12. A cam ring guide apparatus according to any preceding claim wherein the, or each, said leaf springs have engaging fingers and wherein said leaf spring holding portions have engaging recesses in which the associated engaging fingers can be engaged to prevent the leaf springs from coming out of the associated leaf spring holding portions.

13. A guide apparatus for a rotatable cam ring which has at least one inner cam groove in which at least one cam pin which is provided on a movable member and is biased to project radially of the cam ring, substantially as herein described with reference to the accompanying drawings.

14. A camera comprising a cam ring guide apparatus according to any one of claims 1 to 13.

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