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(54) OPTICAL SYSTEM

(71) We, KARL VOCKENHUBER, of 118 Pötzleinsdorferstrasse, Vienna 18, Austria and RAIMUND HAUSER, of 2 Goldengasse, Vienna 4, Austria, both Austrian Citizens, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an optical zoom lens system which may be designed for use in conjunction with a camera.

According to the present invention, there is provided an optical zoom lens system comprising means for varying the focus plane of the optical system within a normal range; first lens means movable for varying the focal length of the optical system; zoom control means for controlling the movement of said first lens means; second lens means movable from a position in which it is situated during focusing in the said normal range for varying the focus plane of the optical system for close-up images; close-up focusing means for controlling the movement of the second lens means and coupling means for selectively coupling said zoom control means with said close-up focusing means such that by operation of the zoom control means the first lens means may be moved either independently or conjointly with the second lens means.

The invention will now be described in more detail, by way of examples, with reference to the accompanying drawings, in which:—

Figure 1 is a schematic partially exploded view of an optical system as seen from one side;

Figure 2 is a developed surface view of parts of two control tube devices of the system which are capable of being coupled together; and,

Figure 3 is a side view, partially in section and partly broken away of a second construction of optical system.

The optical system of Figure 1 comprises a front element 1, indicated by a single lens adjustable for focusing in the normal operating range, two further optical

elements 2, 3 for adjusting the focal length and disposed in a focal length adjustment or zoom control tube 4, and a base lens indicated by a single lens 5. The base lens 5 is provided for focusing in the macro range and to this end is disposed in an adjustable tube 6. The element 1 can only focus on objects beyond a certain distance which is the lower limit of the normal range. The lens 5 on the other hand can allow nearer objects, said to lie in the macro range, into focus.

As may be seen by reference to Figure 2, the focal length adjusting tube 4 is provided with two cam slits 7, 8 which have a branch 7a or 8a for adjusting the focal length and a further branch 7b, 8b which extends parallel to the direction of rotation of the tube 4 so that the optical elements 2, 3 are stationary with respect to each other or relative to the remaining optical elements 1, 5 as soon as the two cam branches 7b, 8b come into action.

For as long as the cam branches 7a, 8a control the two optical elements 2, 3 the control tube 4 will be freely rotatable without affecting the tube 6. The tubes 4, 6 are however provided with coupling surfaces 9, 10 which face each other and are disposed on stop abutments 11, 12 so that, from a certain range of rotation of the focal length adjustment tube 4 onwards, the two surfaces 9, 10 abut each other and the cam tube 6 for the macro range is coupled for common rotation if the focal length adjustment tube 4 is rotated when the cam slit branches 7b, 8b come into action.

On its image end, the cam tube 6 is provided with an abutment surface 13 by means of which it bears upon a substantially stationary mating abutment 15 under the action of a spring 14 which is diagrammatically indicated. The abutment surfaces 9 to 13 and the abutment 15 are so arranged that the two surfaces 9, 10 touch when the two optical elements 2, 3 are controlled by the transition zones 7c, 8c between the cam branches 7a, 7b or 8a, 8b of the cam slits 7, 8.

The cam branches 7b, 8b assume control of the optical elements 2, 3 as soon as the

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coupling surfaces 9, 10 bear upon each other. Simultaneously the cam tube 6, for adjustment in the macro range, is entrained to co-rotate with the adjusting tube 4 for the focal length adjustment. The cam tube 6 is provided with a cam slot 16 which positions the base lens 5.

Rotation of the adjusting tube 4 for the focal length also entrains the cam tube 6 to reposition the base lens 5 but the optical elements 2, 3 remain stationary due to the orientation of the cam branches 7b, 8b. The positioning of the base lens is effected by sliding along the slanting circumferential cam slot 16 as the tube 6 rotates. This sliding motion permits adjustment in the macro range.

If the adjusting tube 4 for the focal length is subsequently rotated in the opposite direction the cam tube 6 follows the motion under the bias of the spring 14, until the abutment surface 13 again bears upon the stop abutment 15. This achieves a fading effect of the optical system as it enables the front element 1 to be pre-adjusted to a distant object whereupon the system can be focused onto a near object, for example a title, by means of the adjusting element 5 for the macro range, followed by focusing on to the distant, preset object by rotation of the adjusting tube 4 for the focal length until the surface 13 once again abuts on the stop abutment 15.

The optical system described hereinabove is completely functional by itself and already offers the advantage of simplified handling because only a single operating element is required for adjusting the focal length and for obtaining adjustment in the macro range.

It is sometimes desirable for an adjustment of focal length to be made in the macro range. Figure 1 shows how this may be achieved. A ratchet device is provided to retain the tube 6 against the action of the spring 14. The ratchet device comprises a ratchet ring 17 on which the stop abutment 15 is also formed. The ratchet 17 is non-rotational but axially slidable along pins 18 and its end face is provided with ratchet teeth 19 which are disposed opposite mating ratchet teeth 20 which are provided on the opposite end face of the cam tube 6. Axial adjustment of the ratchet ring 17 permits engagement between the ratchet teeth 19, 20 so that the cam tube 6 is secured against rotation.

A common operating tube 21, of which Figure 1 shows a circumferential segment partially in section and partially in perspective, is provided for turning the tube 4 for adjusting the focal length and for axially sliding the ratchet ring 17. The operating tube 21 is thus not only rotatable but also axially slidable and has an indexing device

in the form of shallow grooves 22 which co-operate with ball ratchets 23. The ratchet ring 17 can therefore be retained in its appropriate position. To enable the tube 4 and the ring 17 to be operated the ring 17 and the tube 4 are provided with operating pins 24, 25 of which the pin 24 is disposed in a groove 27 inside the operating tube 21 and extending parallel to the optical axis 26 of the optical system but the pin 25 engages in a radial groove 28. The operating tube 21 is therefore co-rotationally coupled with the tube 4 for adjusting the focal length but is axially slidable. The operating tube 21 on the other hand is rotatable with respect to the ratchet ring 17 but cannot slide axially with respect thereto.

With the illustrated embodiment it is possible to obtain a fading effect and to adjust the focal length in the macro range. If additional fading is to be applied after adjusting the focal length it is merely necessary to detach the ratchet teeth 19, 20 from each other whereupon the cam tube 6 returns into its starting position under the action of the spring 14 so that focusing of the optical system is achieved simply by adjustment of the front element 1.

The need for subsequent refocusing after adjustment of the focal length in the macro range can in some circumstances be a disadvantage. This is so if the optical system is to be used as a camera lens. This disadvantage can however be avoided if the optical element associated with the macro range is disposed on the object side and not on the image side with respect to the optical elements 2, 3 which adjust the focal length. However, it is different to construct such an arrangement because the distances required for adjustment on this side are long. Fundamentally, however, the problem can be solved in this way.

Figure 3 shows an embodiment which is similar in many respects to that described above. Parts which have a like function have the same reference symbols and the description of them is not repeated to the extent of re-describing their functions. In the embodiment of Figure 3 the tube 6 is disposed in front of the tube 4 i.e. on the object side, for adjusting the focal length. The front element is divided into two lens components of which one is axially slidable over the normal adjusting range for focusing in conventional manner by means of a distance adjusting ring 29. The other lens component is adjusted by the cam tube 6. The ratchet ring 17 is disposed between the adjusting ring 29 and the cam tube 6. The individual tubes are supported in a tubular support 30 which is attached to the camera and is provided with screw-threading 31 for connection purposes. On

the image side end the support 30 also supports the base lens (not shown). The pin 24 extends through a slit 32 in the support 30 and into the axially extending groove 27 of the operating tube 21. A separate ring 34, whose external circumference is provided with grooves or flutes, is screwed onto the operating tube by screwthreading 33 which has a relatively steep pitch, the ring 34 being provided with the groove 28 for accommodating the pin 25 of the ratchet ring 17.

Although the two cam tubes 4, 6 could be coupled to each other by the same coupling arrangement as that shown in Figure 1, a different form of coupling is shown in Figure 3. A pawl 36, which can latch onto sprocket pins 37 projecting radially from the cam tube 6 is pivotable on a spindle 35 which is fixed on the tube 4 for adjusting the focal length. Other elements can be provided in place of the pins 37 for engagement of the pawl 36. By providing a large number of pins 37 it is possible to couple the two cam tubes 4, 6 to each other in virtually any desired position of the tube 4 for adjusting the focal length. For the coupling operation, the pawl 36 is provided with a pin 38 which extends perpendicularly from its principal plane, the pin 38 extending in the same way as the pin 24 through a slit in the support tube 30 to engage in a groove inside the operating tube 21. Sliding the operating tube 21 in the axial orientation therefore not only slides the ratchet ring 17 along the guide pins 18 but the pawl 36 is also pivoted about its spindle 35 so that it engages with or disengages from the pins 37. Depending on the position of the ring 34 on the operating tube 21, the adjustment can be made so that disengagement of the coupling pawl 36 from the pins 37 is accompanied by engagement of the ratchet teeth 19 with their mating teeth 20 so that the cam tube 6 is immediately retained. However, if it is desired to allow the return spring 14 to come into operation it is merely necessary to slightly unscrew the ring 34 so that the teeth 19, 20 disengage.

Numerous different embodiments are possible within the scope of the invention: since the pins 37 must in any case be guided in a groove of the support tube 30 it is possible for one ratchet pin to co-operate with a boundary wall of the groove which extends transversely to the direction of rotation of the tube 6 as a stop abutment, so that the stop abutments 13, 15 can be dispensed with. Furthermore, the pin 24 is not absolutely necessary if a coupling operating pin 38 is provided. The pin 38 may in some cases perform both functions. Should the arrangement of the optical element associated with the macro range give rise to

difficulties on the object side of the adjusting elements for the focal length it is also feasible to modify the embodiment according to Figure 1 so that an optical element is provided in the zone of the base lens 5 to perform a compensating motion dependent on the motion of the tube 4 for adjusting the focal length in order to maintain a constant image position.

WHAT WE CLAIM IS:—

1. An optical zoom lens system comprising means for varying the focus plane of the optical system within a normal range; first lens means movable for varying the focal length of the optical system; zoom control means for controlling the movement of said first lens means; second lens means movable from a position in which it is situated during focusing in the said normal range for varying the focus plane of the optical system for close-up images; close-up focusing means for controlling the movement of the second lens means and coupling means for selectively coupling said zoom control means with said close-up focusing means such that by operation of the zoom control means the first lens means may be moved within independently or conjointly with the second lens means.
2. An optical system as claimed in claim 1, further comprising biasing means for urging said second lens means towards the normal range position.
3. An optical system as claimed in claim 1 or 2, wherein such coupling means comprise a first coupling surface on said zoom control means and a second coupling surface on said close-up focusing means.
4. An optical system as claimed in claims 2 and 3, wherein said first coupling surface forms an abutting surface on said zoom control means and said second coupling surface forms a counter-abutting surface on said close-up focusing means, said zoom control means being movable within the first range of movement for varying the focal length until the abutting surface abuts the counter-abutting surface of the close-up focusing means and being further movable within a second range of movement with both abutting surfaces in engagement to move the close-up focusing means against the urging force of said biasing means for varying the focus plane for close-up images.
5. An optical system as claimed in Claim 4, wherein the coupling means further comprise locking means movable into an operative position and into an inoperative position, in operative position the locking means arresting said second lens means to prevent a movement under the urging force of said biasing means, and in inoperative position the locking means allowing free movement of said second lens means.

the image side end the support 30 also supports the base lens (not shown). The pin 24 extends through a slit 32 in the support 30 and into the axially extending groove 27 of the operating tube 21. A separate ring 34, whose external circumference is provided with grooves or flutes, is screwed onto the operating tube by screwthreading 33 which has a relatively steep pitch, the ring 34 being provided with the groove 28 for accommodating the pin 25 of the ratchet ring 17.

Although the two cam tubes 4, 6 could be coupled to each other by the same coupling arrangement as that shown in Figure 1, a different form of coupling is shown in Figure 3. A pawl 36, which can latch onto sprocket pins 37 projecting radially from the cam tube 6 is pivotable on a spindle 35 which is fixed on the tube 4 for adjusting the focal length. Other elements can be provided in place of the pins 37 for engagement of the pawl 36. By providing a large number of pins 37 it is possible to couple the two cam tubes 4, 6 to each other in virtually any desired position of the tube 4 for adjusting the focal length. For the coupling operation, the pawl 36 is provided with a pin 38 which extends perpendicularly from its principal plane, the pin 38 extending in the same way as the pin 24 through a slit in the support tube 30 to engage in a groove inside the operating tube 21. Sliding the operating tube 21 in the axial orientation therefore not only slides the ratchet ring 17 along the guide pins 18 but the pawl 36 is also pivoted about its spindle 35 so that it engages with or disengages from the pins 37. Depending on the position of the ring 34 on the operating tube 21, the adjustment can be made so that disengagement of the coupling pawl 36 from the pins 37 is accompanied by engagement of the ratchet teeth 19 with their mating teeth 20 so that the cam tube 6 is immediately retained. However, if it is desired to allow the return spring 14 to come into operation it is merely necessary to slightly unscrew the ring 34 so that the teeth 19, 20 disengage.

Numerous different embodiments are possible within the scope of the invention: since the pins 37 must in any case be guided in a groove of the support tube 30 it is possible for one ratchet pin to co-operate with a boundary wall of the groove which extends transversely to the direction of rotation of the tube 6 as a stop abutment, so that the stop abutments 13, 15 can be dispensed with. Furthermore, the pin 24 is not absolutely necessary if a coupling operating pin 38 is provided. The pin 38 may in some cases perform both functions. Should the arrangement of the optical element associated with the macro range give rise to

difficulties on the object side of the adjusting elements for the focal length it is also feasible to modify the embodiment according to Figure 1 so that an optical element is provided in the zone of the base lens 5 to perform a compensating motion dependent on the motion of the tube 4 for adjusting the focal length in order to maintain a constant image position.

WHAT WE CLAIM IS:—

1. An optical zoom lens system comprising means for varying the focus plane of the optical system within a normal range; first lens means movable for varying the focal length of the optical system; zoom control means for controlling the movement of said first lens means; second lens means movable from a position in which it is situated during focusing in the said normal range for varying the focus plane of the optical system for close-up images; close-up focusing means for controlling the movement of the second lens means and coupling means for selectively coupling said zoom control means with said close-up focusing means such that by operation of the zoom control means the first lens means may be moved within independently or conjointly with the second lens means.
2. An optical system as claimed in claim 1, further comprising biasing means for urging said second lens means towards the normal range position.
3. An optical system as claimed in claim 1 or 2, wherein such coupling means comprise a first coupling surface on said zoom control means and a second coupling surface on said close-up focusing means.
4. An optical system as claimed in claims 2 and 3, wherein said first coupling surface forms an abutting surface on said zoom control means and said second coupling surface forms a counter-abutting surface on said close-up focusing means, said zoom control means being movable within the first range of movement for varying the focal length until the abutting surface abuts the counter-abutting surface of the close-up focusing means and being further movable within a second range of movement with both abutting surfaces in engagement to move the close-up focusing means against the urging force of said biasing means for varying the focus plane for close-up images.
5. An optical system as claimed in Claim 4, wherein the coupling means further comprise locking means movable into an operative position and into an inoperative position, in operative position the locking means arresting said second lens means to prevent a movement under the urging force of said biasing means, and in inoperative position the locking means allowing free movement of said second lens means.



6. An optical system as claimed in Claim 5, wherein the biasing means are connected to the close-up focusing means for providing the urging force for the second lens means via the close-up focusing means, said locking means comprising a detent surface being only movable transversely to the direction of the adjusting movement of said close-up focusing means, and said close-up focusing means having a counter-detent surface facing said detent surface, in operative position of said locking means said detent and counter-detent surfaces engaging each other, and in inoperative position the detent and counter-detent surfaces being disengaged from each other.

7. An optical system as claimed in Claim 6, further comprising adjusting means connected to said locking means, the connection between the adjusting means and the locking means allowing free movement of the adjusting means in the direction of the adjusting movement of the zoom control means but providing common movement of the adjusting means and the locking means in transverse direction to the adjusting movement of the zoom control means.

8. An optical system as claimed in Claim 6, further comprising adjusting means connected to said zoom control means, the connection between the adjusting means and the zoom control means allowing free move-

ment of the adjusting means in a direction transverse to the adjusting movement of the zoom control means but providing common movement of the adjusting means and the zoom control means in the direction of said adjusting movement.

9. An optical system as claimed in Claim 5, further comprising arresting means for securing said locking means in at least one of the operative and inoperative positions.

10. An optical system as claimed in Claim 1, wherein the second lens means are arranged in front of said first lens means.

11. An optical zoom lens system as claimed in Claim 1, arranged and adapted to operate substantially as herein described with reference to and as illustrated in Figures 1 and 2 of the accompanying drawings.

12. An optical system as claimed in Claim 11, modified substantially as herein described with reference to Figure 3 of the accompanying drawings.

13. A camera fitted with an optical zoom lens system as claimed in any preceding claim.

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