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(54) IMPROVEMENTS IN OR RELATING TO INTERCHANGEABLE LENS MOUNTING SYSTEMS

(71) We, CANON KABUSHIKI KAISHA, a Japanese Company, of No. 3-30-2, Shimomaruko, Ohta-ku, Tokyo, Japan, 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 interchangeable lens for a camera, and in particular but not exclusively to an interchangeable objective lens for a single lens reflex camera, which lens incorporates a lens system and a diaphragm device.

There are several methods of coupling an interchangeable lens, such as a standard, wide angle, telephoto or zoom lens, to a camera body. The conventional types of coupling devices may be classified into three main categories, one of which is known as a "multi-turn screw coupling". This device utilises a male screw thread formed at the rear of a main support tube of the lens, there being a female screw thread formed within a bore provided in a wall defining the front panel of the camera body. When the interchangeable lens is to be mounted on the camera body, the male thread is offered to the female thread and the tube is turned until a radial shoulder on the tube abuts the camera body front panel. The helix angle of the threads tightens the shoulder against the panel until the frictional force between the surfaces is equal to the torque applied to the lens tube. The coupling requires an accurate correspondence between the male and female threads, and is therefore troublesome to manufacture. Also, interengaging the threads can be awkward and because the tube needs to be rotated through several full turns, the

coupling is time-consuming. An additional serious disadvantage is that the final angular position of the tube relative to the camera body varies depending upon the torque applied to the tube.

The second category is known as a "bayonet coupling". This device utilises male and female bayonet members provided respectively on the lens tube and the camera housing. During the coupling operation, the male bayonet member is slidably inserted into the female bayonet member and is then turned by rotating the tube about the optical axis of the lens, while the camera housing is maintained stationary. An advantage of this coupling device is that the final angular position of the tube relative to the camera housing can be determined with high accuracy by an abutment pin provided on the tube or the camera housing. The arrangement thus permits the provision either of mechanical or of electrical interconnections between the lens and camera body, for instance to transfer a manually preset value of diaphragm aperture from the tube into the camera body, and automatically to close down the diaphragm under control from the camera body.

When the tube is coupled to the camera body by rotating the tube, transmission members co-operable with corresponding members within the camera body and which project from the tube also move within the space inside the camera body. Accordingly, the camera body specified for use with the lens must be designed to leave a clear path for the movement of the transmission members. Thus, such camera bodies and lenses therefore cannot be freely interchanged, and this prejudices the usefulness of the inter-

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changeable objectives. Another disadvantage which arises if there is a plurality of transmission members is that, as it is virtually impossible to give an entirely clear space for the movement of the transmission members during the coupling operation, the control members for the camera transmission members must be provided with buffering means, to avoid mechanical interference which otherwise would be encountered between the transmission members and the control members.

The third category has been designed to overcome the drawbacks of the second category and is typically disclosed in U.S. Patent No. 3,906,534, in which one of the two complementary bayonet members is made movable with reference to its carrier—that is, the tube or the camera body. In the case of the movable member being provided on the lens, that member is constructed in the form of a ring arranged to be journaled around an adapter shell which constitutes the rear part of the lens tube. After the adapter shell of the tube has been slidably fitted into the bore in the camera body, the aforesaid movable ring is brought into angular alignment with the corresponding and complementary coupling member, and then turned to tighten the lens to the camera body, while the adapter shell remains stationary.

This type of coupling device assists in achieving an accurate and reliable establishment of operative connection between the diaphragm value transmission device and the diaphragm control device respectively in the lens and camera body, regardless of the number of transmission members there are. Also, the common disadvantage of the first and second categories of coupling devices (that is, wear giving rise to deviations of the required axial position of the lens and to lack of flatness of the abutment surfaces of the adapter shell and the camera housing) can be eliminated. But there is instead the disadvantage that the coupling ring must be located at a point within a relatively small axial space in the vicinity of the abutment surface of the adapter shell, and the accessibility and ease of use of the coupling ring are not particularly good. Especially in the case of 'instant' cameras, the diaphragm ring, focusing ring and other actuating members have to be arranged on a relatively short common support tube and this does not leave a sufficiently large space for a coupling ring having a structure suitable for allowing the fingers of an operator to exert the required torque thereto.

Attempts have been made to obviate all the above-mentioned drawbacks of the described coupling devices, for instance by imparting relative motion to the main support tube and the adapter shell so that an operator may rotate the coupling ring by

grasping the tube, while the adapter shell remains stationary. As the diaphragm mechanism is mounted in the main support tube, however, provision must be made for assuring the transmission members associated with the diaphragm are accurately and reliably maintained in the required positions both before and after the tube is attached to and detached from the camera body; otherwise it is impossible properly to establish an operative connection between a diaphragm pre-setting transmission member and a control device therefor within the camera body, as the control device assumes a predetermined position which is located either in coincidence with or slightly beyond the terminal end position of the lens transmission member.

It is an object of the present invention to provide an interchangeable lens for a camera, which lens includes a diaphragm device and a transmission member associated therewith, the transmission member being co-operable with a device within a camera body to which the lens is to be attached, the lens being arranged to be relatively easy to handle and yet capable of achieving an accurate and reliable connection between the transmission members respectively of the lens and of the camera body.

Accordingly, this invention provides an interchangeable lens for a camera, comprising:

a) a lens barrel in which are mounted a lens system for forming an image of an object to be photographed and a diaphragm device for controlling light passing through the lens;

b) diaphragm setting means having a diaphragm aperture scale and an index therefore and being manually operable to allow setting of a required diaphragm aperture value;

c) diaphragm pre-setting means arranged for co-operation with the diaphragm device and the diaphragm setting means, and having operating means for pre-setting the diaphragm device to an aperture corresponding to a set aperture value on the diaphragm setting means, and transmission means for transmitting the set aperture value to a camera body on which the lens is mounted or for setting the diaphragm device to an aperture corresponding to a diaphragm pre-setting signal from the camera body depending upon the selected mode of operation;

d) attachment means having a coupling member mounted on the lens barrel and adapted to be engageable with a complementary coupling member on the camera body whereby the lens may releasably be mounted on the body; and

e) an adapter member rotatably mounted on the lens barrel and restrained against axial movement with respect thereto, the adapter member having an abutment

surface for engaging a reference mounting surface of the camera body and having an opening through which a member of the transmission means projects, the transmission means member in operation being movable within the opening, and the adapter member being arranged to remain stationary, with respect to a camera on which the lens is being mounted, during the mounting operation.

Preferably, there is provided adapter member locking means comprising holes provided in the adapter member and the lens barrel and which holes are in registration when the lens is removed from a camera body, and a lock member biased by a spring to extend through the two holes when in registration but movable against the spring bias to release the lock on offering the lens up to a camera body for mounting thereon. Moreover, there may be provided releasable locking means to prevent releasing rotation of the lens once mounted on a camera body, said means having a lock operation member supported in the lens barrel and engageable with a recess formed in the adapter member when the lens barrel has been rotated relative to the adapter member on mounting the lens on a camera body, the lock operating member partially projecting out of the lens barrel to allow releasing thereof.

For an arrangement in which the coupling member is fixed to the lens barrel, it may be advantageous to provide a tightening ring formed so as to rotate in unison with the lens barrel and having an outer peripheral surface of greater diameter than the outer peripheral surface of the lens barrel, whereby the attachment of the lens to the camera body may be performed by grasping the outer peripheral surface of the tightening ring.

By way of illustration only, certain specific embodiments of this invention will now be described, reference being made to the accompanying drawings, in which:—

Figure 1 is a side view, partly cut away, of a first embodiment of interchangeable objective lens arranged in accordance with this invention;

Figure 2 is a rear elevation of the lens of Figure 1, as detached from a camera body;

Figure 3 is an exploded perspective view of the diaphragm pre-setting and closing-down mechanism mounted in the lens of Figures 1 and 2, shown with the parts in their positions when the lens is detached from a camera body and certain parts being cut away to show the structure of an adapter shell locking device;

Figure 4A shows the initial state of operative connection between the diaphragm transmission members and the control device therefor, when the lens of Figures 1 to 3 is mounted on a camera body,

Figure 4B is sectional detail of a part of

Figure 4A, but on a greater scale;

Figure 5 is a rear elevation of the lens shown in Figure 4, when fully tightened on the camera body;

Figure 6 is a view similar to that of Figure 3, but with the parts shown in their positions when the lens is fully tightened on a camera body;

Figure 7 is a part-sectional view of the interchangeable lens similar to that shown in Figure 1, but showing the construction of the lens barrel locking device;

Figure 8 is an end view, partly cut away, of the lens of Figure 7;

Figure 9 is an exploded perspective view of the locking device used in the lens shown in Figures 7 and 8;

Figure 10 is a fragmentary partly perspective, partly sectional view of another embodiment of lens of this invention;

Figure 11 is a fragmentary partly perspective, partly sectional view of still another embodiment of lens of this invention, incorporating a locking mechanism for the coupling device;

Figure 12 is an exploded perspective view of yet another embodiment of the invention, wherein the range of movement of the diaphragm transmission member is larger than that of the coupling device; and

Figures 13 to 15 show still another embodiment of interchangeable lens of the invention, Figure 13 being a side view, partly in section, of the lens, Figure 14 being a rear view of the lens, and Figure 15 being an exploded perspective view of part of the internal structure of the lens.

Referring to Figures 1 to 6, there is shown a first embodiment of an interchangeable lens for a single lens reflex camera, the lens including an optical lens system and a diaphragm mechanism. The lens comprises a main support tube or lens barrel 1 at the front of which is rotatably mounted a focus adjusting ring 2 the rear end of which is in the form of a thin tubular wall having distance scales marked thereon which are co-operative with an index mark 1a provided on the outer surface of the tube 1. The tubular wall overlaps the front end of the tube 1 and the focus adjusting ring 2 is fixed to an intermediate sleeve 2' having threaded on its outer and inner surfaces, the threads engaging corresponding threads formed respectively on the inner diameter of an enlarged bore in the front end of the main support tube 1 and the outer diameter of a movable member 3 in which the focusing lens elements are mounted. Rotation of the focus adjusting ring 2 with respect to the tube 1 thus translates the member 3 along the optical axis to effect focussing.

A collet 4 is affixed to the rear of the main support tube 4, which collet has an increased inner diameter to afford a space in which is

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provided a bayonet member 6 and a front radial flange of an adapter shell 8. The bayonet member 6 is fixed to the collet 4 by screws 7, while the adapter shell 8 is free to turn within the front bore of the bayonet member 6 and is seated against a radial shoulder of the collet 4. The adapter shell 8 carries an adapter flange 9 having a rear shoulder which serves as a reference surface for abutment against the front panel of a camera body (see Figure 4A). The adapter shell also carries a position control pin 10 which is in radial alignment with an engraving 4a formed on the outer surface of the collet 4, before the lens is attached to a camera body and after the lens has been detached therefrom.

As shown in Figure 2, the bayonet member 6 is formed with three inturned radial lugs 6b, 6c and 6d angularly spaced from each other by about 120 degrees to provide three arcuate recesses which are aligned with and generally correspond to radial lugs 25a, 25b and 25c of a mating bayonet member 25 (see Figures 4 and 5) provided on the front panel of the camera body around its bore for receiving the adapter shell 8. With the lens from the camera body, the pin 10 is located in radial alignment with the centre of the top recess between the lugs 6b and 6d.

Projecting parallel to the axis into a space within the recess between the lugs 6b and 6c is an actuating pin 13 for an adapter shell locking mechanism the details of which are shown in Figure 3. This mechanism further includes a lock pin 14 slidable fitted in an axial hole 4b formed in the inturned radial flange of the collet 4 and biased by a compression spring 15 to project into a hole 8c formed through the wall of the radial flange of the adapter shell 8, when the actuating pin 13 also freely slidable in this hole 8c is not depressed. When the adapter shell 8 is fully inserted into the bore of the camera housing, the interface between the actuator pin 13 and the lock pin 14 is moved to coincide with that between the adapter shell 8 and the collet 4, whereafter the operator may turn the collet 4 with the bayonet member 6 about the axis of the objective in a tightening direction by grasping the main support tube 1. The adapter shell 8 is maintained stationary relative to the camera housing during such rotation, as the pin 10 is received in a corresponding slot 25a' formed in lug 25a of the camera bayonet member 25, as shown in Figures 4B and 5.

Referring again to Figure 3, there is shown a diaphragm pre-setting mechanism which includes an actuating member or diaphragm ring 5 rotatably mounted on the main support tube within a recess adjacent the front end of the collet 4. The ring 5 has a diaphragm value scale marked thereon which scale is co-operative with the common

index mark 1a of the distance scale. A cam ring 17 is movably mounted in the tube 1 and is shaped to provide a cam surface 17a on the inner surface thereof, there being a driving spring 19 connected between the tube 1 and an extension 17b' of the cam ring 17. The extension 17b' is also in the path of a projection 5a of the diaphragm ring 5 which projection extends through a circumferential slot in the tube 1, whereby the cam ring 17 tends to follow movement of the ring 5 by virtue of the action of spring 19. In this way, any diaphragm value selected on the scale by turning the diaphragm ring 5 to place that value in alignment with the index mark 1a is transferred to the cam ring 17.

A diaphragm closing down mechanism is provided, which includes a driving ring 12 rotatably mounted in the main support tube 1 and having a rearwardly-extending member 12a which projects through and beyond an arcuate slot 9b provided through the flange 9 of the adapter shell 8. The member 12a is urged towards an initial point near the left-hand of the slot 9b (as viewed in Figures 2 and 3) by a first retaining spring 26. When the camera shutter is released, this ring 12 is automatically driven against the force of the spring 26 by means of an association member C2 in the camera body engaging the member 12a and moving it through almost the full length of the slot 9b. After the completion of an exposure, the spring returns the member 12a to the initial position, as illustrated in Figure 3. The ring 12 has an arm 12b which normally is engaged by a tab 20a of a C-shaped lever 20 linked to a diaphragm blade control ring 21 by leg 21a formed integrally with the ring, drive spring 21A serving to keep tab 20a engaged with the arm 12b. In the illustrated position (Figure 3) the diaphragm is fully open, and in the first part of an exposure sequence, member 12a is driven round its slot 9b, tab 20a following movement of arm 12b, by virtue of spring 21A, until cam follower pin 20b engages the cam surface 17a of the cam ring 17. The point at which this occurs depends upon the position of that ring 17, which is controlled by the pre-set value on the diaphragm ring 5.

A mechanism is provided to allow a manually pre-set aperture to be introduced to an automatic exposure device within the camera body, or to allow that device to close the diaphragm to an aperture assessed by the device, for exposures in an automatic mode, respectively with diaphragm priority or shutter priority. This mechanism comprises an intermediate ring 11 having a transmission member 11a projecting through an arcuate slot 9a provided in the adapter flange 9 of the shell 8, said slot 9a being concentric with the slot 9b and being angularly spaced therefrom by about 90 degrees measured at the initial ends. A tension spring 18 is connected

between an extension 17b' of the cam ring 17 and a lug 11b of the intermediate ring 11, whereby the extension 17b' and the lug 11b are urged into operative engagement with each other when the lens is mounted on a camera body, at the end of tightening rotational motion, that is, at the position illustrated in Figure 6.

In order to retain the transmission member 11a in its initial position when the lens has been detached from a camera body while permitting the diaphragm ring 5 to remain at any set position up to the fully open position, there is provided a drive member 23 fixed on the radial flange of the collet 4 by screws 24 which is moved into engagement with an arm 17b of the cam ring 17 on dismounting the lens, and moves the cam ring 17 round to an initial position beyond that for a fully open aperture against the action of spring 19. Ring 11 is turned with ring 17, by virtue of spring 18, until member 11a reaches its initial position at the end of the slot 9a; any further movement of ring 17 caused by drive member 23 is accommodated by spring 18. The smaller the preselected aperture value on ring 5, the earlier in the dismounting operation that the drive member picks up the arm 17b, to restore member 11a to its initial position.

In Figures 7 to 9, there is shown a mechanism for locking the lens in the fully tightened position on a camera, in which position entire effective range of movement of the intermediate ring 11 can be assured because the drive member 23 is removed from arm 17b. This mechanism comprises an actuating button 101 slidably fitted in a radial slot 4A formed in the thickened front part of the collet 4 adjacent the front shoulder of a flange on the adapter shell 8, a bias spring 102 urging the actuating button 101 to project out of the slot 4A. A recess 8A is formed in the flange of the adapter shell 8, which recess comes into registration with the slot 4A, when the lens is fully tightened on a camera and thus at that position can receive a rearwardly extending projection 101A of the actuating member 101. This locking mechanism hence serves as a mechanism from preventing accidental disengagement of the unit from the camera body. It should be noted that the lens of Figures 7 to 9 is not identical to that shown in Figures 1 to 6 insofar as the locking mechanism is shown provided at different angular positions; otherwise the lenses are identical.

The operation of a lens as described above is as follows. The operator offers the lens to a camera body with the engraving 4a aligned with a corresponding mark (not shown) on the front panel of the camera body, and then inserts the rear outer diameter 8a of the adapter shell into the bore in the camera body by grasping the main support tube 1. In

this way, the bayonet members 6 and 25 are placed in mating relation to each other, and as the radial shoulder of the adapter shell 8 comes to abut the front surface of the camera body, the position control pin 10 enters the slot 25a' (see Figure 4B). Also, the actuating pin 13 is pushed against the force of spring 15 so that the lock pin 14 moves out of the hole 8c, to allow the operator to perform a tightening operation.

The tightening operation is performed by turning the main support tube 1 about the axis of the objective lens in a clockwise direction, as viewed from the front, together with the diaphragm pre-setting mechanism as supported by the tube 1. The adapter shell 8 is meanwhile maintained stationary together with the intermediate ring 11 and the ring 12 as the relative angular displacements between the ring 11 and the cam ring 17 and between the ring 12 and the tube 1 being absorbed by the respective springs 18 and 26. When tightened, the tube 1 has moved through about 60 degrees from the initial position of Figure 3, and the locking mechanism for the tube 1 operates so that the projection 101A drops into the recess 8A under the action of the spring 102, causing the release actuating button 101 to project outwardly beyond the outer diameter of the collet 4, as shown in Figure 8. The bayonet member 6 is provided with three circumferential slits 6a of equal angular extent formed in the tubular section thereof corresponding to the positions of the respective lugs 6b, 6c and 6d, resilient characteristics are thereby imparted to the lugs, allowing a sufficiently sturdy connection between the unit and the camera body to be established in the locked position of Figure 8.

If the diaphragm ring 5 is initially taken to be at the aperture fully open position, in this instance, F/1.4, it is at the beginning of the tightening rotation of the tube 1 that the drive member 23 leaves the arm 17b allowing the extension 17b' to move into engagement with the lug 11b, as shown in Figure 6. If the diaphragm ring 5 is set at the smallest aperture, it is at the end of the tightening rotation that the drive member 23 leaves the arm 17b, member 11a moving around slot 9a until the extension 17b' comes into engagement with the projection 5a. Thus, the angular extent of the operating range of the intermediate ring 11 has to be smaller than the angular movement of the tube 1 to complete tightening.

Provided the diaphragm ring 5 is in the illustrated position for the largest diaphragm aperture, namely 1.4, the transmission member 11a remains at its initial position in the slot 9a during the tightening operation, and thus no stress is applied to the association member C1 within the camera body. In the diaphragm pre-selection automatic exposure

mode, therefore, the set value of diaphragm aperture (on the ring 5) is introduced through the cam ring 17 and the intermediate ring 11 to the association member C1 in the camera body. An exposure value can be derived to control the period of actuation of the camera shutter depending upon the pre-selected diaphragm value, object brightness as sensed by a TTL type light metering arrangement operating at the full open aperture, and the sensitivity of the film being used. When the camera shutter release button (not shown) is depressed, the association member C2 is actuated to move to the right as viewed in Figure 2, causing the diaphragm to close down until the cam follower pin 20b strikes the cam surface 17a at a point dependent upon the set value of diaphragm aperture. After an exposure has been completed, association member C2 moves back to its initial position, allowing association member 12a to be returned under the action of the spring 26, whereby the diaphragm blades 22 are fully opened again.

In the shutter speed pre-selection automatic exposure mode, the diaphragm ring 5 is turned to a point beyond the minimum diaphragm aperture on the scale, and the camera automatic exposure device moves the transmission member 11a to the required position for a proper exposure on movement of member 12a.

If the operator wishes to interchange the lens with another, he or she may first depress the lock release button 101, then turn the tube 1 relative to the camera body in the opposite direction to the tightening one until the engraving 4a is aligned with the corresponding mark on the camera body. The tube 1 is then pulled from the camera body, and the adapter shell 8 is automatically locked by the pin 14 to the collet 4. During this dismounting operation, if the diaphragm ring 5 is left to set any value of aperture smaller than the largest aperture (i.e. F/1.4), then the drive member 23 is brought into driving engagement with the arm 17b at a corresponding point in the range of movement of the member 23 to push the arm 17b against the force of the drive spring 19. At the end of the dismounting, the position of the transmission member 11a is at the end of the slot 9a. Thus, the detached lens is ready for use when next required, and it is easy to establish an operative connection between the diaphragm in the lens and the control device therefor in the camera body. The term "operative connection" as just used does not necessarily mean in intimate contact, but any spatial relationship which assures an operative connection between the lens and the camera body. Such a connection need not be direct, but could for instance be through an intermediary such as mechanical switches, variable resistors and electrical contacts.

As is evident from the above, all the operator need take care of so as to establish an accurate and reliable co-operation between the diaphragm in the lens and the control device therefor in the camera body is to achieve a correct angular alignment between the lens and the camera body. Furthermore, because there is no friction between the adapter shell 8 and the camera body during the coupling operation, no wear takes place which otherwise would lead to mechanical and optical errors between the lens and camera body, because of the damage which results from abrasion and scratching at the relatively moving surfaces. Also, because the collet 4 is fixed to the main support tube 1 rather than constructed in the form of a movable coupling member the operator merely has to grasp the tube 1 when performing a coupling or decoupling operation. The accessibility to the coupling device is thus greatly improved without sacrificing the accuracy and reliability of diaphragm control in the complete camera.

The mechanical mounting for the coupling device which has been described above can of course be changed in many ways. For example, instead of a pair of mating bayonet members 6 and 25, it is possible to use male and female screw threads. In this case, it is recommended that the helix angle be such a value that the required tightening motion of the lens relative to the stationary camera body does not exceed one revolution. Instead of a position control pin 10, it is possible to utilise one of association members C1 and C2 to define the angular position of the adapter shell relative to the camera body. In this case, provision must be made for assuring the adapter shell is restored to its initial angular position relative to the main support tube when the lens is detached from a camera body. Instead of a main support tube 1, it is possible to utilise the diaphragm ring 5 to drive a bayonet or screw thread coupling member for rotation to bring the lens into tightened engagement with the camera body. The latter possibility is exemplified in Figure 10, wherein parts similar to those of the first-described embodiment are given like reference characters and will not be described in detail again.

In Figure 10, whilst the collet 4 remains fixed to the main support tube as in the above embodiment, the bayonet member 6 is made rotatable relative not only to the adapter shell 8 but also to the collet 4. The bayonet member 6 is supported by a rotatable sleeve 61 which is fitted within the inner surface of the collet 4 and which is appropriately restrained against axial movement. The support sleeve 61 has an arm 62 projecting forwardly into the paths of movement of two radial projections 5A and 5B of the diaphragm ring 5, so that when the diaphragm

ring 5 is turned beyond its setting for the smallest aperture, projection 5A is brought into driving engagement with the arm 62 to rotate the bayonet member 6 in a tightening direction, once the lock mechanism 13, 14 and 15 is in its released position. When the diaphragm ring 5 is turned beyond its setting for the largest aperture, projection 5B is brought into driving engagement with the arm 62 to rotate the bayonet member 6 in an unfastening direction, opposite to the tightening direction. So long as the diaphragm ring 5 has any one of the diaphragm values marked thereon in alignment with the stationary index mark 1a, an operative engagement between a lug 5C of the diaphragm ring 5 and an arm 201 of a cam ring 200 is established. Here, parts 5C, 200 and 201 correspond to parts 5a, 17 and 17b of Figures 3 and 6.

In order to permit the tightening and unfastening movement of the diaphragm ring 5 relative to the cam ring 200, there are provided two tension springs S1 and S2 connected respectively between the projections 5A and 5B and the cam ring 200. The spring S2 also serves to ensure the aforesaid operative engagement between the lug 5C and the arm 201.

As the lens housing comprising the main support tube 1 and the collet 4 is rotatable with respect to the adapter shell 8 and therefore to the camera body through an angular extent of about 60 degrees or more, depending upon the structure of the intermediate ring 11, cam ring 17 and drive member 23, a somewhat strong click-mechanism should be provided between the lens housing and the adapter shell, for otherwise the operation of the focusing ring 2 and the diaphragm ring 5 may be difficult to perform, as the body of the complete camera is usually held, rather than the tube 1. The free rotation of the lens housing with respect to the camera body gives rise to the advantage that the attitude of the camera may be either vertical or horizontal, but the index mark 1a of the lens can be maintained uppermost, making it easy to view the distance and diaphragm indicia.

Instead of utilising the diaphragm ring 5 as an actuating member for the bayonet member 6, it is possible to provide an independent actuating member, as shown in Figure 11. This actuating member 300 is in the form of a ring provided around the lens tube at a forward part thereof, so as to be rotatable thereabout. The actuating member 300 is fixed to the sleeve 61 by means of a pair of arms 301 and 302.

If desired, a lock mechanism having the same function as that shown in connection with the Figures 7 to 9 may be employed, not only on the unit of Figure 11 but also on that of Figure 10. This lock mechanism may

comprise a pawl 63 fixed on the adapter shell 8 and engageable in a hole 301a in arm 301, when the bayonet member 6 has been fully tightened, to hold the member 300 against rotation with respect to the shell 8. The pawl 63 may however be released by an actuating member 301c biased by a plate spring 301b fixed at one end to the arm 301 and arranged to be in alignment with the hole 301a. Depression of the member 301c effects disengagement of the pawl 63 from the hole 301a.

Referring to Figure 12, there is shown another embodiment of the present invention, in the form of a lens wherein the angular extent of the tightening movement relative to a camera body is smaller than the permissible angular movement of the transmission member 11a. In this connection, it should be explained that the smaller the angular extent of the tightening movement, the easier and quicker is the coupling operation to perform, while the larger the angular range of movement of the diaphragm control transmission member 11, the better the accuracy of the diaphragm control. A problem arising with a lens arranged in this way is that it is not always possible to ensure the transmission member 11a is returned to its initial position as the lens is detached from a camera body. This embodiment of the invention is adapted to obviate such a problem.

To achieve this, there is provided an accelerating device for moving the diaphragm transmission member 11a through a greater angle than the movement of the main support tube 1. This device includes a cam member 51 fixed on the axially inner surface 8d of the adapter shell 8 and having a cam surface 51a formed on the radially inner side edge thereof, configured such that the distance between the axis of the tube 1 and a point at which a radius from that axis intersects the profile of the cam surface 51a increases with an increasing angle, as measured in a counter-clockwise direction as viewed in Figure 12. This device further includes a lever 52 fulcrumed on a pin 52a mounted on the main support tube 1, and a longitudinally-elongate cam follower pin 53 fixed on the lever 52 near to the pivot pin 52a than the distance between the cam follower pin 53 and those points on the edge of the lever 52 which are abutted by the transmission member 11a, while that member slides thereover on dismounting the lens from a camera body.

If the diaphragm ring 5 is turned to select the largest diaphragm aperture (in this instance, F/1.4), when the tube 1 is turned in a counter-clockwise direction as indicated by an arrow from the illustrated position to a fully tightened position, the extension 17c of the diaphragm cam ring 17 is moved to engage the lug 11b of the ring 11, which is maintained stationary by the action of the

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spring 18 retaining the member 11a in the illustrated initial position. During this tightening operation, the accelerating device is moved away from the transmission member 11a, with a simultaneous occurrence of clockwise movement of the lever 52 about the pivot pin 52a. As long as the diaphragm ring 5 is set initially during mounting of the lens at the maximum aperture, (i.e. F/1.4) or is turned from that setting by not more than the angular tightening movement of the tube 1, the aforesaid problem does not arise.

Now assuming that the diaphragm ring 5 is left either at the minimum possible aperture setting or in the "EE" position therebeyond, when the tube 1 is turned to unfasten the lens from the camera body, the lever 52 is brought into driving engagement with the member 11a and moves the latter at a faster angular rate than that of the tube 1, because the lever 52 driving the member 11a is turned in a counter-clockwise direction (indicated by an arrow) by the cam follower pin 53 acting on the stationary cam member 51. By the time the lens has been dismounted from the camera body, the member 11a has arrived at its initial position, and the tube 1 is locked to the adapter shell 8 by the lock pin 14, to prevent the accelerating device being driven by the arm 11a under the force of the charged spring 19. This force is directly applied to the accelerating device because of the displacement of the lug 11b from the extension 17c.

Figures 13 to 15 show another embodiment of an interchangeable lens of this invention, and again parts similar to those of the first-described embodiment are given like reference characters and will not be described in detail.

In the lens of this embodiment, when in the initial position shown in Figure 14, the member 12a is located adjacent an association member C2 therefor within the camera body, whereas the transmission arm 11a is spaced from its association member C1, for a purpose to be described later. The transmission arm 11a is formed integrally with ring 11, which has a lug 11b projecting in the opposite direction to fit within a slot formed by a fork 117b upstanding from a pre-setting control cam ring 117. A drive spring 113 is connected between the lug 11b and the adapter shell 8, extendible over the entire range of movement of the ring 11, together with the cam ring 117. The fork 117b is positioned so that the projection 5a of the diaphragm ring 5 may pass thereover. An intermediate ring 114 is rotatably supported within the lens barrel, between the ring 11 and the diaphragm ring 5, which ring has an internal radial lug 114a arranged adjacent the lug 11b so that when the lens is detached, the transmission member 11a is retained in the initial position by interengagement of the

lugs 11b and 114a. With the diaphragm ring 5 set in the "A" position, beyond the range of diaphragm aperture values marked on the peripheral surface thereof, (in other words, when the "A" symbol is aligned with the index mark 1a) should the lens barrel 1 be turned about the axis thereof in the direction indicated by arrows in Figure 15 to tighten fully the lens from the lug 11b, to permit automatic adjustment of the cam ring 117 in position.

The intermediate ring 114 may be locked to the ring 5 by means of an anchor in the form of a pin 115 having a round head 115a formed at one end thereof the head being urged by a spring 116 to engage the end face of the adapter shell 8. The shell has a V-shaped groove 8e into which the head 115a may enter, when the pin 115 is aligned therewith. The pin is carried in a hole 114c in the ring 114 and projects towards the ring 5 to an extent sufficient to engage in slot 5b in the projection 5a of the ring 5. Thus, from the initial position and presuming the head 115a is entered in the groove 8e as illustrated, when the lens is turned in the tightening direction, the projection 5a first abuts the lug 114b of the intermediate ring 114, at which position the pin 115 is aligned with the slot 5b in the projection 5a. Further rotation of the lens barrel, relative to the stationary adapter shell 8, causes the intermediate ring and diaphragm ring 5 to turn simultaneously, and as the head 115a rides out of the groove 8e the free end 115b of the pin 115 enters the slot 5b to connect together the rings 5 and 114. This action requires there to be a click-mechanism between the diaphragm ring 5 and the lens barrel to exert a sufficiently strong resistance to relative movement therebetween.

The diaphragm closing down mechanism, including the ring 12 and transmission member 12a, has a retaining tension spring 123 connected between an arm 12b of the ring 12 and the adapter shell 8, to maintain a diaphragm blade control ring 121 normally stationary with the diaphragm blades 124 fully open by the interengagement of the arm 12b with a projection 121a of the control ring 121. A diaphragm drive spring 122 of lesser force than tension spring 123 tends to move the diaphragm blade control ring 121 in a closing down direction. A bell-crank 120 is pivoted on the barrel 1 and has a cam follower pin 120a engaged with a cam surface 117a of the pre-setting control cam ring 117, thereby to control arrestment of the ring 121 at an angular position depending upon the setting of the cam ring 117, by means of a pin 120b which is fixed on the bell crank 120 and projects into a recess 121b formed in the ring 121.

In operating the lens described above, to mount the lens the operator first aligns the

engraving 4a provided on the outer periphery of the collect 4 with a corresponding mark (not shown) provided on the camera body and then inserts the rear outer diameter 8a of the adapter shell 8 into the camera body bore until the abutment surface 8b contacts the bearing surface of the camera body, pin 10 simultaneously entering a fitted hole provided on the camera body and the actuating pin 13 also being actuated to release the adapter shell 8 from its locked connection to the lens barrel 1. Then the operator turns the barrel 1 about the axis of the lens, with respect to the stationary camera body. During this tightening operation, the adapter shell 8 is maintained stationary relative to the camera body.

Now assuming that the diaphragm ring 5 is initially set in an extreme position for the maximum diaphragm aperture (i.e., F/1.4) as shown in Figure 15, when the lens barrel 1 nears the end of its tightening movement, the projection 5a abuts the lug 114b. Upon further movement of the lens barrel 1 through an arc of length equal to or slightly larger than the above-noted distance between the member 11a and the association member C1 shown in Figure 14, the pin head 115a rides out of the groove 8e on to the end face of the adapter shell 8, bringing the member 11a into operative engagement with the control member C1. At the termination of such additional tightening movement, the lens barrel 1 is stopped from further rotation by means such as those shown in Figures 7 to 9. After that, the diaphragm ring 5 may be turned to place a desired diaphragm value in registry with the index 1a, causing the ring 11 to follow the intermediate ring 114 under the action of the spring 113, the ring 114 being connected to the ring 5 by virtue of the end 115b of the pin 115 engaged in the slot 5b. When the complete camera is switched to a shutter priority automatic photography mode by turning the diaphragm ring 5 to place the symbol "A" in registry with the index 1a, the member 11a is displaced to the end of the slot 9a opposed to the end of the slot at which the member 11a is at initially, so that the cam ring 117 can be adjusted by a control device in the camera automatically, from a position of the ring 117 corresponding to a fully closed aperture in an opening-up direction.

When the shutter release button is depressed, the association member C2 is actuated to move in a counter-clockwise direction as viewed in Figure 14, and such movement of the member C2 is transmitted through the ring 12 to the diaphragm blade control ring 121. The ring 121 is driven by the spring 122 to follow the ring 12 because spring 122, which is weaker than the spring 123, pulls the projection 121a to follow arm 12b. After an exposure has been completed, the association

member C2 returns to the initial position, and thus permits the diaphragm blades to move to the full open position under the action of the spring 123, which overcomes the force of the spring 122.

If the operator wishes to interchange the lens for another one of different rating, he or she need only push the button 101 (see Figures 7 to 9) and then turn the lens barrel in the unfastening direction, without the necessity of being aware of the setting of the diaphragm ring 5. With the diaphragm ring 5 in the "A" position, turning movement of the barrel 1 from the fully tightened position through an angular extent equal to that of the effective operating range of the diaphragm ring 5 from the graduation "1.4" to the symbol "A", causes the association member C1 to follow but then the member C1 stops and upon further unfastening movement, through the angular extent noted above, the head 115a of the pin 115 drops into the groove 8e under the action of the spring 116, thereby causing the transmission member 11a to be retained at its initial position against the force of spring 113. After that, the lens barrel 1 may be further turned in the unfastening direction up to whatever extent is necessary to disengage the bayonet member 6 from the mating member of the camera. Thus, the lens can easily be interchanged with another one of different focal length. Another advantage is that the design flexibility of the coupling device is increased, allowing an angular extent of tightening movement of the unit to be increased as desired without overstressing the diaphragm transmission mechanism.

Reference is directed to our co-pending Application No. 4365/78 (Serial No. 1600891), in which are described and claimed various mounting arrangements for mounting accessories on a camera body, certain of the described accessories being interchangeable lenses as described hereinbefore.

WHAT WE CLAIM IS:—

1. An interchangeable lens for a camera, comprising:
 - a) a lens barrel in which are mounted a lens system for forming an image of an object to be photographed and a diaphragm device for controlling light passing through the lens;
 - b) diaphragm setting means having a diaphragm aperture scale and an index therefore and being manually operable to allow setting of a required diaphragm aperture value;
 - c) diaphragm pre-setting means arranged for co-operation with the diaphragm device and the diaphragm setting means, and having operating means for pre-setting the diaphragm device to an aperture corresponding to a set aperture value on the diaphragm



engraving 4a provided on the outer periphery of the collect 4 with a corresponding mark (not shown) provided on the camera body and then inserts the rear outer diameter 8a of the adapter shell 8 into the camera body bore until the abutment surface 8b contacts the bearing surface of the camera body, pin 10 simultaneously entering a fitted hole provided on the camera body and the actuating pin 13 also being actuated to release the adapter shell 8 from its locked connection to the lens barrel 1. Then the operator turns the barrel 1 about the axis of the lens, with respect to the stationary camera body. During this tightening operation, the adapter shell 8 is maintained stationary relative to the camera body.

Now assuming that the diaphragm ring 5 is initially set in an extreme position for the maximum diaphragm aperture (i.e., F/1.4) as shown in Figure 15, when the lens barrel 1 nears the end of its tightening movement, the projection 5a abuts the lug 114b. Upon further movement of the lens barrel 1 through an arc of length equal to or slightly larger than the above-noted distance between the member 11a and the association member C1 shown in Figure 14, the pin head 115a rides out of the groove 8e on to the end face of the adapter shell 8, bringing the member 11a into operative engagement with the control member C1. At the termination of such additional tightening movement, the lens barrel 1 is stopped from further rotation by means such as those shown in Figures 7 to 9. After that, the diaphragm ring 5 may be turned to place a desired diaphragm value in registry with the index 1a, causing the ring 11 to follow the intermediate ring 114 under the action of the spring 113, the ring 114 being connected to the ring 5 by virtue of the end 115b of the pin 115 engaged in the slot 5b. When the complete camera is switched to a shutter priority automatic photography mode by turning the diaphragm ring 5 to place the symbol "A" in registry with the index 1a, the member 11a is displaced to the end of the slot 9a opposed to the end of the slot at which the member 11a is at initially, so that the cam ring 117 can be adjusted by a control device in the camera automatically, from a position of the ring 117 corresponding to a fully closed aperture in an opening-up direction.

When the shutter release button is depressed, the association member C2 is actuated to move in a counter-clockwise direction as viewed in Figure 14, and such movement of the member C2 is transmitted through the ring 12 to the diaphragm blade control ring 121. The ring 121 is driven by the spring 122 to follow the ring 12 because spring 122, which is weaker than the spring 123, pulls the projection 121a to follow arm 12b. After an exposure has been completed, the association

member C2 returns to the initial position, and thus permits the diaphragm blades to move to the full open position under the action of the spring 123, which overcomes the force of the spring 122.

If the operator wishes to interchange the lens for another one of different rating, he or she need only push the button 101 (see Figures 7 to 9) and then turn the lens barrel in the unfastening direction, without the necessity of being aware of the setting of the diaphragm ring 5. With the diaphragm ring 5 in the "A" position, turning movement of the barrel 1 from the fully tightened position through an angular extent equal to that of the effective operating range of the diaphragm ring 5 from the graduation "1.4" to the symbol "A", causes the association member C1 to follow but then the member C1 stops and upon further unfastening movement, through the angular extent noted above, the head 115a of the pin 115 drops into the groove 8e under the action of the spring 116, thereby causing the transmission member 11a to be retained at its initial position against the force of spring 113. After that, the lens barrel 1 may be further turned in the unfastening direction up to whatever extent is necessary to disengage the bayonet member 6 from the mating member of the camera. Thus, the lens can easily be interchanged with another one of different focal length. Another advantage is that the design flexibility of the coupling device is increased, allowing an angular extent of tightening movement of the unit to be increased as desired without overstressing the diaphragm transmission mechanism.

Reference is directed to our co-pending Application No. 4365/78 (Serial No. 1600891), in which are described and claimed various mounting arrangements for mounting accessories on a camera body, certain of the described accessories being interchangeable lenses as described hereinbefore.

WHAT WE CLAIM IS:—

1. An interchangeable lens for a camera, comprising:

a) a lens barrel in which are mounted a lens system for forming an image of an object to be photographed and a diaphragm device for controlling light passing through the lens;

b) diaphragm setting means having a diaphragm aperture scale and an index therefore and being manually operable to allow setting of a required diaphragm aperture value;

c) diaphragm pre-setting means arranged for co-operation with the diaphragm device and the diaphragm setting means, and having operating means for pre-setting the diaphragm device to an aperture corresponding to a set aperture value on the diaphragm



setting means, and transmission means for transmitting the set aperture value to a camera body on which the lens is mounted or for setting the diaphragm device to an aperture corresponding to a diaphragm pre-setting signal from the camera body depending upon the selected mode of operation;

d) attachment means having a coupling member mounted on the lens barrel and adapted to be engageable with a complementary coupling member on the camera body whereby the lens may releasably be mounted on the body; and

e) an adapter member rotatably mounted on the lens barrel and restrained against axial movement with respect thereto, the adapter member having an abutment surface for engaging a reference mounting surface of the camera body and having an opening through which a member of the transmission means projects, the transmission means member in operation being movable within the opening, and the adapter member being adapted to remain stationary, with respect to a camera on which the lens is being mounted, during the mounting operation.

2. An interchangeable lens for a camera, as claimed in claim 1, wherein there is provided adapter member locking means comprising holes provided in the adapter member and the lens barrel and which holes are in registration when the lens is removed from a camera body, and a lock member biased by a spring to extend through the two holes when in registration but movable against the spring bias to release the lock on offering the lens up to a camera body for mounting thereon.

3. An interchangeable lens for a camera as claimed in claim 1 or claim 2, wherein there is adapter member position defining means comprising a projection mounted on the adapter member and arranged on attachment of the lens to a camera body to be received in a recess provided in a part of the camera body thereby to restrain the adapter member against rotation during the mounting of the lens.

4. An interchangeable lens for a camera as claimed in any of claims 1 to 3, wherein the diaphragm pre-setting means further comprises an intermediate member rotatably arranged within the lens barrel and being drivable by the diaphragm setting means to transfer a set diaphragm aperture to the diaphragm device, the transmission means includes an output member movable in response to movement of the intermediate member for transmitting an aperture value set on the diaphragm setting means to the camera body, and the output member further serving to transmit the camera body diaphragm pre-setting signal to the lens, and there is provided a diaphragm device actuat-

ing means which is arranged to cause actuation of the diaphragm device to an aperture value corresponding to the set value on the diaphragm setting means or to the value of the camera body pre-setting signal.

5. An interchangeable lens for a camera as claimed in claim 4, and wherein there is provided charge means having a charge member mounted on the lens barrel and arranged to be engageable with a part of the intermediate member when the lens barrel is turned thereby to dismount the lens from a camera body, the charge member thereby serving to move the transmission means output member to an initial position as the lens is dismounted by turning the lens barrel, by acting through the intermediate member.

6. An interchangeable lens for a camera as claimed in any of claims 1 to 5, wherein there is provided releasable locking means to prevent releasing rotation of the lens once mounted on a camera body, said means having a lock operating member supported in the lens barrel and engageable with a recess formed in the adapter member when the lens barrel has been rotated relative to the adapter member on mounting the lens on a camera body, the lock operating member partially projecting out of the lens barrel to allow releasing thereof.

7. An interchangeable lens as claimed in claim 6, wherein the releasable locking means includes means biasing the lock operating member to a position in which said member is engaged with the recess in the adapter member.

8. An interchangeable lens for a camera as claimed in any of claims 1 to 7, wherein there is provided a tightening ring formed so as to rotate in unison with the lens barrel and having an outer peripheral surface of greater diameter than the outer peripheral surface of the lens barrel, whereby the attachment of the lens to the camera body may be performed by grasping the outer peripheral surface of the tightening ring.

9. An interchangeable lens for a camera as claimed in any of the preceding claims, wherein the diaphragm setting means is in the form of a ring mounted on and rotatable about the lens barrel, the ring having a diaphragm scale marked thereon which scale is co-operative with an index on the lens barrel.

10. An interchangeable lens for a camera as claimed in claim 9, wherein the diaphragm setting ring has two projections which are engageable with means connected to the coupling member at the two ends respectively of the range of angular movement of the ring, whereby the coupling member may be turned to effect mounting and dismounting of the lens by grasping the diaphragm setting ring and effecting moving movement thereof in the required sense.



11. An interchangeable lens for a camera as claimed in any of claims 1 to 3, wherein the transmission means includes an output member which projects from the rear of the lens in the camera body when the lens is mounted thereon, and there is provided compensating means which is arranged to engage with the output member on rotation of the lens barrel to disengage the lens from a camera and to move the output member to an initial position, the compensating means being adapted to move the output member to said initial position irrespective of the position of the member at the start of lens dismounting rotation by compensating between the dismounting angular movement and the required movement of the output member.

12. An interchangeable lens for a camera as claimed in claim 11, wherein the compensating means comprises a compensation member pivotally mounted on the lens barrel, and a cam mounted on the adapter member and having a cam surface for engagement with the output member, whereby when the lens barrel is detached from the camera body, the compensation member is moved in engagement with the cam surface of the cam and at the same time pushes the transmission output member thereby returning the output member to its initial position.

13. An interchangeable lens for a camera as claimed in any of claims 1 to 3, wherein there is provided interconnection means for interconnecting the diaphragm setting means and the transmission means in response to relative rotation between the lens barrel and the adapter member in the sense for mounting the lens on a camera body, the interconnection means serving to allow the transmission output member to be moved dependent upon a diaphragm aperture value set on the diaphragm setting means once the lens has been mounted on a camera.

14. An interchangeable lens for a camera as claimed in claim 13, wherein the interconnection has a rotary member rotatable relative to the lens barrel and engageable with the transmission means, and an interconnection member slidable within a hole provided in the wall of the rotary member and biased by a spring member so that the interconnection member is engageable with the diaphragm setting means and/or the adapter member when the lens barrel is turned to mount the lens on a camera body.

15. An interchangeable lens for a camera substantially as hereinbefore described with reference to and as illustrated in any of Figures 1 to 6, 7 to 9, 10, 11, 12 and 13 to 15 of the accompanying drawings.

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