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(54) **Automatically focussing binoculars**

(57) Light entering through apertures 6,6' in the front of a binocular housing H is reflected onto a focus detection module 11 to form respective images thereon by means of a fixed reflector 7 and a further reflector 7' which can be angularly oscillated by means of a motor 9. As the reflector 7' is thus moved eyepiece lens assemblies 3,3' are focussed by a further motor 5, and when the said two images coincide the module 11 emits a signal to arrest

operation of both of the motors 5 and 9, such that the binoculars are automatically focussed on an object being viewed. In the event that the object is of such a type that it exceeds the capability of the module 11 to detect a correct focus, the module 11 produces a signal to illuminate a warning lamp 21, the light from the lamp being visible in the viewing optical system by means of an elongate rod-shaped prism 20 having an inclined end surface positioned substantially at the focal point of at least one of the eyepiece assemblies 3,3'.

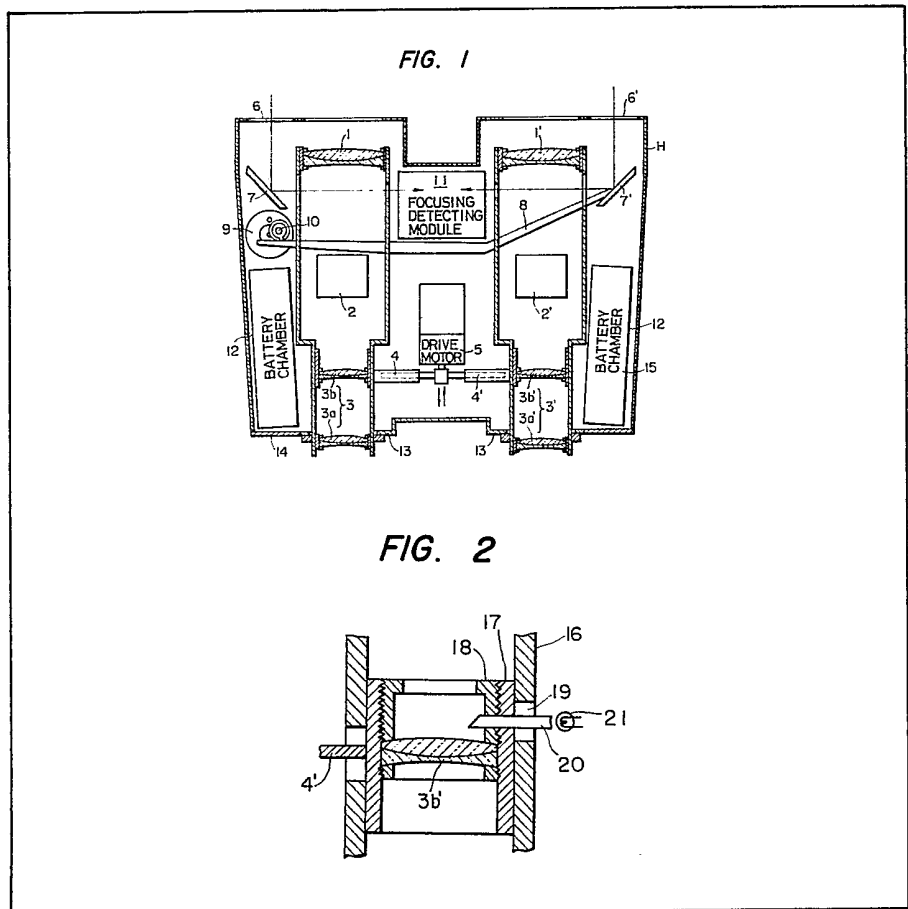


FIG. 1

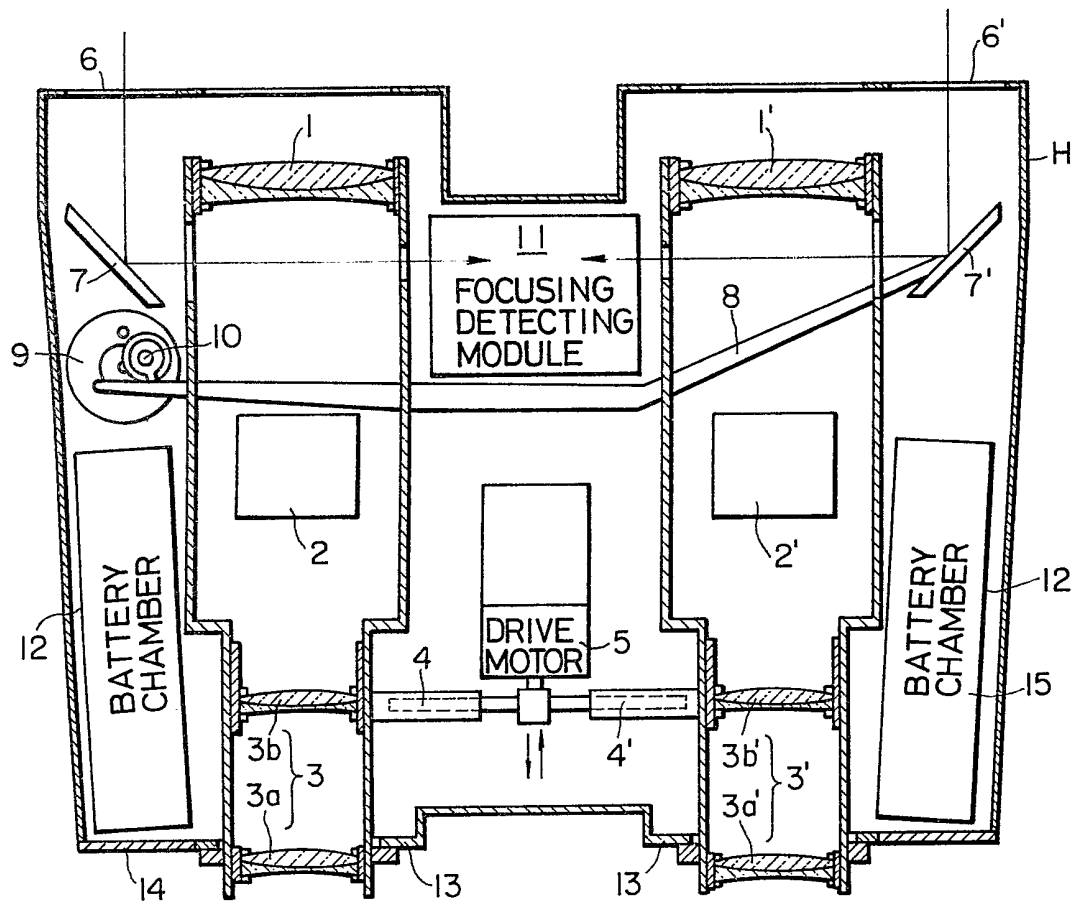


FIG. 2

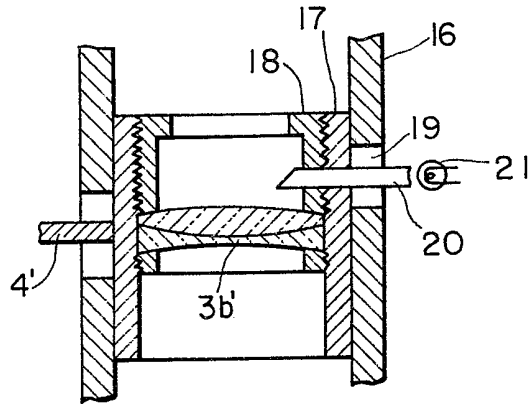


FIG. 3

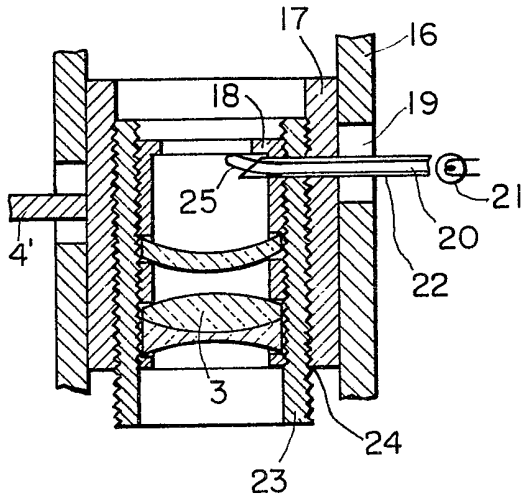
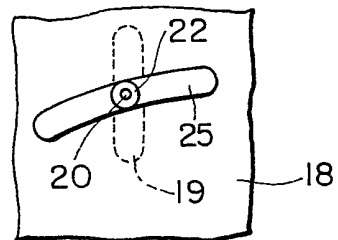


FIG. 4



SPECIFICATION

Automatically focussing binoculars

5 This invention relates to binoculars having an automatic focussing mechanism.

In conventional automatically focussing binoculars, light beams from an object are reflected by a stationary reflector and a movable reflector onto a focus detection module, and at least a part of an eyepiece lens assembly is moved in response to an instruction signal from the module to focus the binoculars automatically on the object. Such automatic focussing will not of course occur if the focussing system becomes out of order or if its component parts become defective. However, it is also possible for the automatic focussing mechanism not to function if the binoculars are used under conditions which exceed the capacity of the module, for example where the object being viewed has an extremely low contrast, where the viewing conditions are very dark, or where the field of view is intricate, being made up of a number of contrasts between light and shadow areas. In conventional binoculars, it is normally impossible to determine whether non-operation of the automatic focussing mechanism is due to the mechanism being defective or whether it is due to the mechanism being used in conditions which exceed its capabilities.

30 It is an object of the present invention to obviate or mitigate this problem.

According to the present invention, there is provided automatically focussing binoculars comprising a viewing optical system including a pair of objective lenses and a pair of eyepiece lens assemblies, a housing in which the viewing optical system is disposed, and a focus detection system including a fixed reflector and a movable reflector disposed so as to receive light entering the housing at spaced points thereon respectively, means operative to effect focus adjustment of the eyepiece lens assemblies in dependence upon movement of the movable reflector, a focus detection unit which receives images reflected by the fixed and movable reflectors and which produces a focus detection signal when the images overlap to a predetermined extent, the focus detection unit also producing an output signal when the viewing conditions are such that the focus detection system cannot operate, and warning means which is actuated by said output signal from the focus detection unit.

The invention thus provides a warning device which can display a signal within the field of view to warn that the capability of the focus detection system has been exceeded. In a preferred example, the warning device includes a warning lamp which is turned on by a signal produced by the focus detection unit when its capacity has been exceeded. Light emitted by this warning lamp is introduced into the field of vision of the binoculars by a rod-shaped prism which is fixed substantially at the focal point of at least one of the eyepiece assemblies, and

within a movable barrel. In the case where the eyepiece assembly is moved in its entirety to effect focus adjustment, a rotatable diopter adjusting ring can be provided. In this connection, the rod-shaped prism can be inserted in a guide pipe which is in turn inserted into an elongage hole which is cut in a lens barrel of the eyepiece assembly. Therefore, even when the diopter adjusting ring is turned for focus adjustment, the prism is maintained at the focal point of the eyepiece assembly, and the user can readily see the light from the warning lamp at all times.

75 The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a sectional plan view of one embodiment of a pair of binoculars according to the present invention;

Figure 2 is an enlarged view of part of the binoculars shown in Figure 1;

Figure 3 is a similar view of Figure 2 but illustrating a second embodiment of the invention; and

85 Figure 4 is a developed view of a diopter adjusting ring which forms part of the binoculars shown in Figure 3.

Referring first to Figure 1, the binoculars shown therein comprise a pair of objective lenses 1 and 1', respective prism groups 2 and 2' disposed behind the objective lenses, and respective eyepiece lens assemblies 3 and 3' disposed behind the prism groups, each eyepiece lens assembly being composed of a fixed component 3a, 3a' which is secured to a housing H of the binoculars and a movable component 3b, 3b' which is axially movable relative to the housing. Each of the lenses 3b and 3b' is coupled by way of a respective drive pin 4, 4' and suitable gearing (not shown) to the output shaft of a motor 5, such that rotation of the motor output shaft causes the lenses 3b and 3b' to move and thereby alter the focal points of the lens assemblies 3 and 3' as a whole.

A pair of apertures 6 and 6' are cut into the housing H at points adjacent the objective lenses 1 and 1' respectively. A fixed reflector 7 is positioned behind the aperture 6 and directs light entering through the latter to a focus detection module 11, while a movable reflector 7' is positioned behind the aperture 6' and similarly directs light entering through the latter to the module 11. A drive lever 8 is coupled at one end thereof to the axis of the movable reflector 7', while its other end is contacted by an eccentric cam 10 which is secured to the output shaft of a motor 9.

115 The focus detection module 11 is disposed between the two reflectors 7 and 7', i.e. between the right- and left-hand optical systems, and as indicated above receives light beams reflected by these reflectors. The focus detection module 11 is the same as that which is used for focus detection in automatically focussing cameras and is well known in the art. In response to the light beams thus received, the module 11 operates the motor 9 to move the reflector 7' angularly and at the same time operates the

motor 5 to adjust the eyepiece assemblies 3 and 3'. Such angular movement of the reflector 7' continues until such time as the light beams from the reflectors 7 and 7' coincide with each other in the module.

- 5 When coincident images are formed in this manner, the module 11 generates a signal to stop the motors 9 and 5.

Also shown in Figure 1 are chambers 12 which receive batteries to power the motors, end plates 13 of the eyepiece assemblies, and covers 14 for the chambers 12.

Figure 2 shows a detail of the eyepiece lens assembly 3', wherein a movable barrel 17 is inserted into a lens barrel 16 for movement in the direction of the optical axis by means of the drive pin 4'. Holes are cut into both the movable barrel 17 and a field-of-vision ring 18 which is fitted in the barrel 17 and which mounts the lens component 3b', and a rod-shaped prism 20 is secured through the holes thus cut. The prism 20 is also inserted through an elongate hole 19 which is cut in the lens barrel 16 in a direction parallel to the optical axis. One end of the prism 20 is inclined and is disposed at the focal point of the eyepiece assembly 3', while the other end of the prism 20 extends to a warning lamp 21 which is disposed beside the lens barrel 16. The prism thus receives light emitted by the warning light 21 and reflects this light into the field of vision of the eyepiece assembly 3'. It will be appreciated that the prism 20 and the warning light 21 may be applied to the eyepiece lens assembly 3 rather than the assembly 3' if desired.

Figure 3 illustrates another embodiment of the binoculars, wherein the eyepiece assemblies 3 and 3' are moved in their entirety to effect focus adjustment. In the illustrated construction, a diopter adjusting ring 23, which is externally threaded at 24, is inserted between a movable barrel 17 and a field-of-vision ring 18. A rod-shaped prism 20, protected by a guide pipe 22, is secured at its middle portion to the movable barrel 17. The prism 20 extends through the diopter adjusting ring 23 and the field-of-vision ring 18 in such a manner that one end is disposed at the focal point of the eyepiece assembly and the other end is disposed adjacent to a warning lamp 21. As shown in Figure 4, in addition to an elongated aperture 19 cut into the lens barrel 16, a curved aperture 25 is cut into the field-of-vision ring 18 and the diopter adjusting ring 23. This aperture 25 coincides with the lead angle of the screw threading 24, and has a length within the stroke of the diopter adjusting ring 28. When a diopter adjustment operation is performed by rotating the ring 23, since the rod-shaped prism 20 is guided by the curved aperture 25, the prism 20 can introduce the light from the warning lamp 21 into the field of vision of the eyepiece assembly irrespective of the movement of the diopter adjusting ring 23.

The operation of the focus detection module 11 will now be described in greater detail. Light beams entering the objective lenses 1 and 1' pass through the prism groups 2 and 2' and form images on the user's eyes with the aid of the eyepiece lens assemblies 3 and 3', respectively. On the other hand, light beams entering the housing H through the apertures

6 and 6' are reflected onto the module 11 by the fixed and movable reflectors 7 and 7', respectively. As the movable reflector 7' is turned in a reciprocating manner by the drive lever 8, the image from the movable reflector 7', as reflected onto the focus detection module 11, is reciprocated or vibrated in such a manner that it overlaps the image from the stationary reflector 7. At the moment when the movable reflector 7' turns through an angle corresponding to the distance between the binoculars and the object being viewed, the two images coincide with each other and the focus detection module 11 produces a focussing signal. In response to this signal, the eyepiece components 3b and 3b' are moved to positions which correspond to the object distance, i.e. the angle of the movable reflector 7' when the two images coincide. The eyepiece assemblies 3 and 3' are thereby set such that their front focal points coincide with the positions of the images which are formed by the objective lenses 1 and 1' such that the viewed image is automatically focussed.

The focus detection module 11 essentially comprises photoelectric converters, integration circuits and a comparator. When the integrations of contrast peaks obtained from the images reflected by the reflectors 7 and 7' coincide with each other, the module 11 produces an output signal of focalization. When the contrast peaks are lower than a pre-selected reference value, the module 11 cannot produce the signal suitably. That is, when the contrast between light and shade is extremely low, or when the field of view is made up of a number of contrasts of light and shade, the contrast peaks are not sufficiently high, and the automatic focussing mechanism cannot produce a proper focussing signal. In this case, the focus detection module provides a signal at a terminal thereof, thereby illuminating the warning lamp 21. Light from the warning lamp 21 is introduced to the interior of the field-of-vision ring 18 through the rod-shaped prism 20, and is then reflected by the inclined surface at the end of the prism 20 so that it can be viewed through the eyepiece assembly 3 or 3'.

The rod-shaped prism 20 is fixedly secured to the movable barrel 17 and is freely movable in the elongate hole 19 which is parallel with the axis of the lens barrel 16. By this arrangement, the prism 20 can co-operate with the eyepiece assembly 3 or 3' in the movable barrel. Thus, even if the eyepiece assembly is moved by the automatic focussing mechanism, the end of the prism 20 is maintained at the front focal point of the eyepiece, enabling the user to see the warning signal clearly. In the case where a diopter adjusting ring 23 is provided as shown in Figure 3, the rod-shaped prism 20 (now covered by the guide pipe 22) is fixedly secured to the movable barrel 17 and is placed in the curved aperture 25 formed in the diopter adjusting ring 23. This enables the prism 20 to be freely movable along the elongated hole 19 in parallel with the axis of the lens barrel 16. Therefore, even when the diopter adjusting ring 23 is turned, no warning signal is produced within the field of vision, and the user can see the warning signal at its predetermined position.

As is apparent from the above description, a signal

is provided at a predetermined position in the field of view of the binoculars, which signal notifies the user that the automatic focussing apparatus has been rendered inoperative due to the lack of light or lack of contrast. This enables the user to determine readily whether the automatic focussing mechanism is not in operation due to the lack of available light, and to distinguish this from the case where the mechanism is not in operation due to a malfunction.

10 CLAIMS

1. Automatically focussing binoculars comprising a viewing optical system including a pair of objective lenses and a pair of eyepiece lens assemblies, a housing in which the viewing optical system is disposed, and a focus detection system including a fixed reflector and a movable reflector disposed so as to receive light entering the housing at spaced points thereon respectively, means operative to effect focus adjustment of the eyepiece lens assemblies in dependence upon movement of the movable reflector, a focus detection unit which receives respective images reflected by the fixed and movable reflectors and which produces a focus detection signal when the images overlap to a predetermined extent, the focus detection unit also producing an output signal when the viewing conditions are such that the focus detection system cannot operate, and warning means which is actuated by said output signal from the focus detection unit.

2. Automatically focussing binoculars as claimed in Claim 1, wherein the warning means includes a lamp which is energised in response to said output signal.

3. Automatically focussing binoculars as claimed in Claim 2, wherein light emitted by said lamp is visible in the viewing optical system.

4. Automatically focussing binoculars as claimed in Claim 3, further comprising light conducting means having one end thereof disposed adjacent to said lamp and the other end thereof positioned substantially at a focal point of at least one of the eyepiece lens assemblies.

5. Automatically focussing binoculars as claimed in Claim 4, wherein the light conducting means comprises an elongate rod-shaped prism which has an inclined surface at said other end thereof.

6. Automatically focussing binoculars comprising a housing, an input lens system including a plurality of focussing apertures, dual eyepiece assemblies disposed behind the input lens system, each assembly including a fixed component and an axially movable component, a stationary reflector disposed directly behind one of the focussing apertures, a movable reflector disposed directly behind the other of the focussing apertures and rotatable about a vertical axis, a focus detection module disposed between the fixed reflector and the movable reflector so as to receive images reflected by the latter, said images being processed and compared with each other and with a reference value of light contrast, and warning means including an illumination source which is actuated by a detection signal produced by the focus detection module to indicate that automatic focussing is impossible.

7. Automatically focussing binoculars as claimed

in Claim 7, further comprising a prism for the introduction of light from the illumination source into the field of vision of the binoculars, one end of the prism being disposed adjacent to the illumination source and the other end thereof being disposed proximate to the focal point of one of the eyepiece assemblies.

8. Automatically focussing binoculars as claimed in Claim 7, wherein the prism is of elongated rod-like shape, and has an inclined surface at said other end thereof.

9. Automatically focussing binoculars as claimed in Claim 6, 7 or 8, further comprising first drive means operable to deflect the movable reflector, and second drive means operable to move the movable components of the eyepiece assemblies in the direction of the optical axis, operation of the first and second drive means being controlled and terminated by a focussing signal as produced by the focus detection module.

10. Automatically focussing binoculars as claimed in Claim 9, wherein the focus detection module produces a drive signal which drives both of the first and second drive means.

11. Automatically focussing binoculars as claimed in Claim 9 or 10, wherein the first drive means deflects the movable reflector in a reciprocating manner.

12. Automatically focussing binoculars as claimed in Claim 9, 10 or 11, wherein the second drive means deflects the movable components of the eyepiece assemblies a distance corresponding to the angle of deflection of the movable reflector.

13. Automatically focussing binoculars as claimed in any one of Claims 6 to 12, wherein the focus detection module comprises photoelectric converters to reduce the reflected images from the fixed and movable reflectors to a series of electrical signals, integration circuits for integrating said electrical signals to produce a series of contrast peaks corresponding to the contrast between light and dark portions of the reflected images, a comparator for comparing the contrast peaks with each other and with a predetermined reference value, and an electronic control circuit for processing output signals from the comparator.

14. Automatically focussing binoculars as claimed in Claim 13, wherein the focus detection module produces a focussing signal when the contrast peaks of the reflected images coincide with each other and are of a greater value than said predetermined reference value.

15. Automatically focussing binoculars as claimed in Claim 14, wherein the focussing signal terminates the operation of both the first and second drive means.

16. Automatically focussing binoculars as claimed in Claim 15, wherein the second drive means terminates movement of the movable components of the eyepiece assemblies at a point wherein the front focal point of each movable component coincides with the position of the images formed by a respective objective lens of the input lens system.

17. Automatically focussing binoculars as claimed in Claim 13, wherein the focus detection

module produces a detection signal when the contrast peaks of the reflected images coincide with each other and are of a lesser value than said predetermined reference value.

5 18. Automatically focussing binoculars as claimed in Claim 17, wherein the detection signal produces a signal which energises the illumination source.

10 19. Automatically focussing binoculars as claimed in Claim 18, wherein light from the illumination source condenses upon said end of the prism disposed adjacent to the illumination source, travels along said prism, and is introduced into at least one of the eyepiece assemblies at said end of the prism proximate to said focal point thereof, thereby being
15 within the field of vision of the user at a predetermined point determined by the location of said end of the prism which is proximate to said focal point.

20 20. Automatically focussing binoculars as claimed in any one of Claims 6 to 19, wherein each eyepiece assembly comprises an outside lens barrel, a diopter adjusting ring disposed inside the outside lens barrel, and a field-of-vision ring disposed inside the diopter adjusting ring, a plurality of eyepiece
25 lens components being attached to the field-of-vision ring.

30 21. Automatically focussing binoculars as claimed in Claim 20, wherein the outside lens barrel possesses an elongated aperture perpendicular to its axis, and both of the diopter adjusting ring and the field-of-vision ring possess a curved aperture parallel to their axes, thereby enabling said prism to maintain its position relative to the eyepiece lens components during a diopter adjusting operation.

35 22. Automatically focussing binoculars substantially as hereinbefore described with reference to Figures 1 and 2 or Figures 3 and 4 of the accompanying drawings.