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(54) IMAGE STABILIZATION APPARATUS

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(57) ABSTRACT

An image stabilization apparatus comprises a housing accommodating an optical system in the interior thereof. A part of optical members that compose the optical system is held to allow angular displacement relative to the housing, and the position of the part of the optical members is maintained in a predetermined state. The part of the optical members is driven to restore the position angularly displaced. A driving amount is controlled based on information of the angular displacement. A mode for controlling the housing that is suitable for vibration applied to the housing is determined, and the mode is informed to a user.

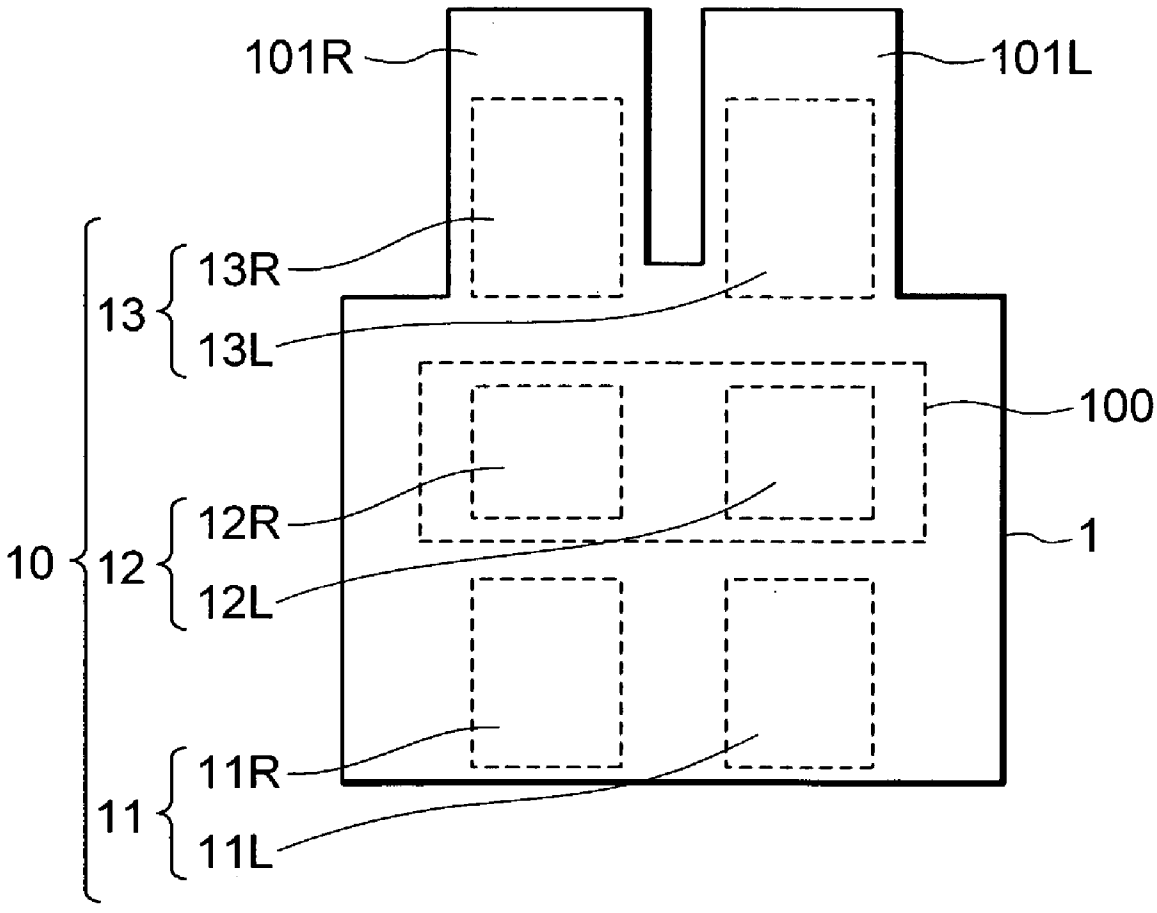

FIG. 1

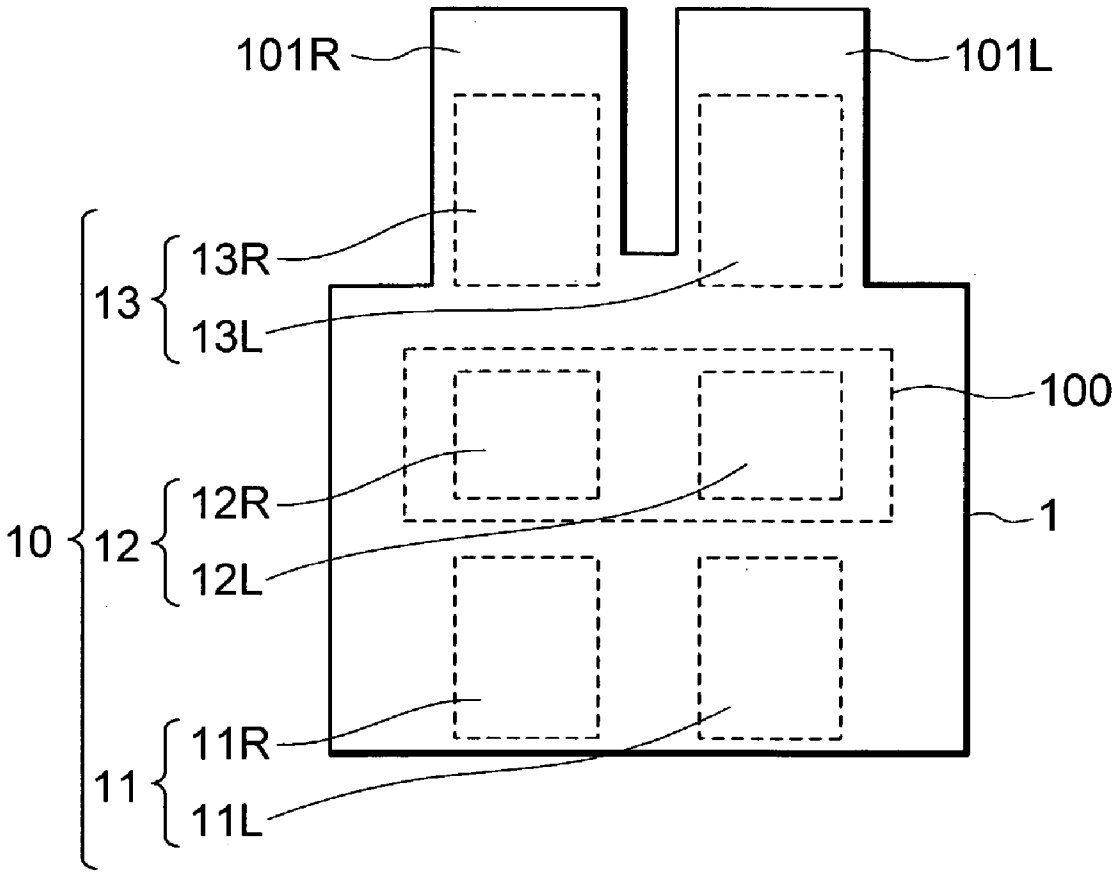

FIG. 2A

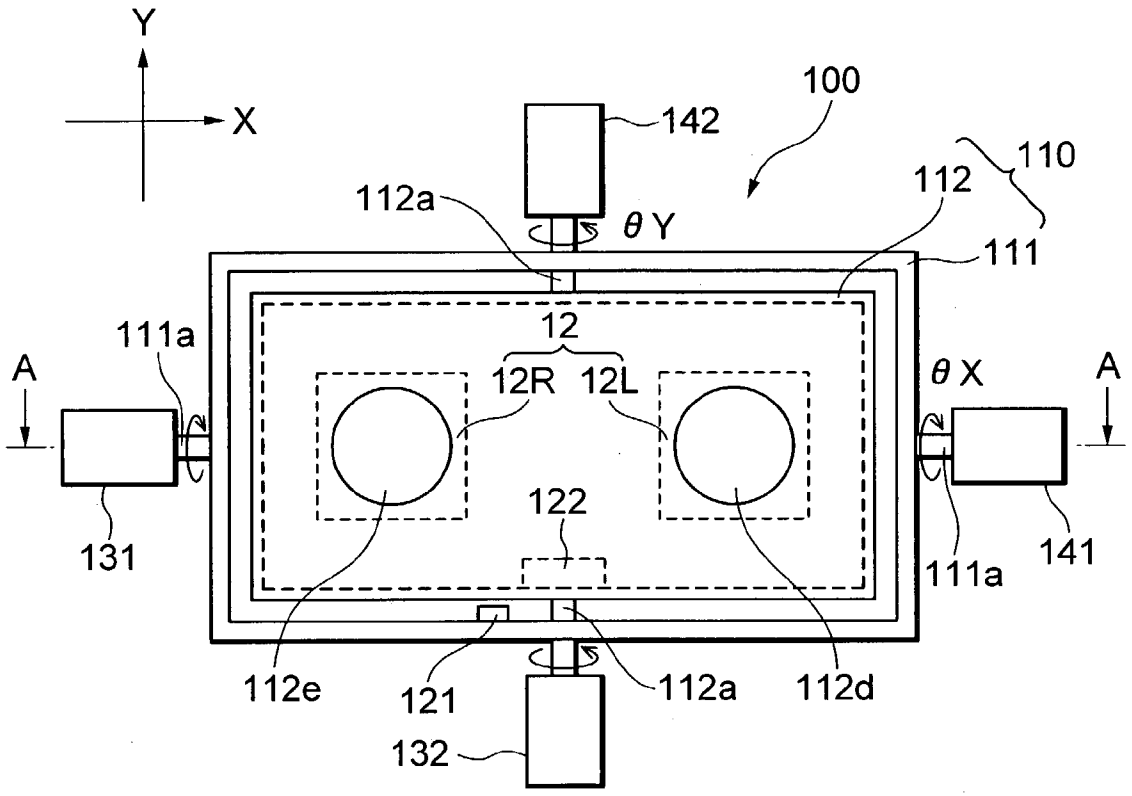
Y
X
100
142
110
112
112a
θ Y
111
12
111a
12R
12L
θ X
A
A
122
131
141
111a
112e
121
112a
112d
132

FIG. 2B

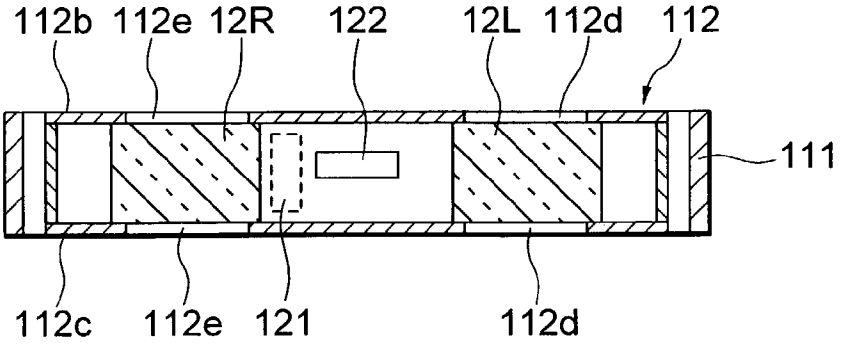
112b
112e
12R
122
12L
112d
112
111
112c
112e
121
112d

FIG. 3

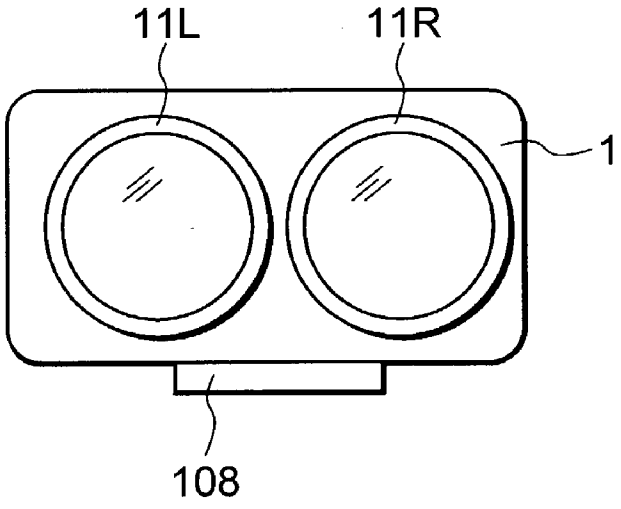

FIG. 4

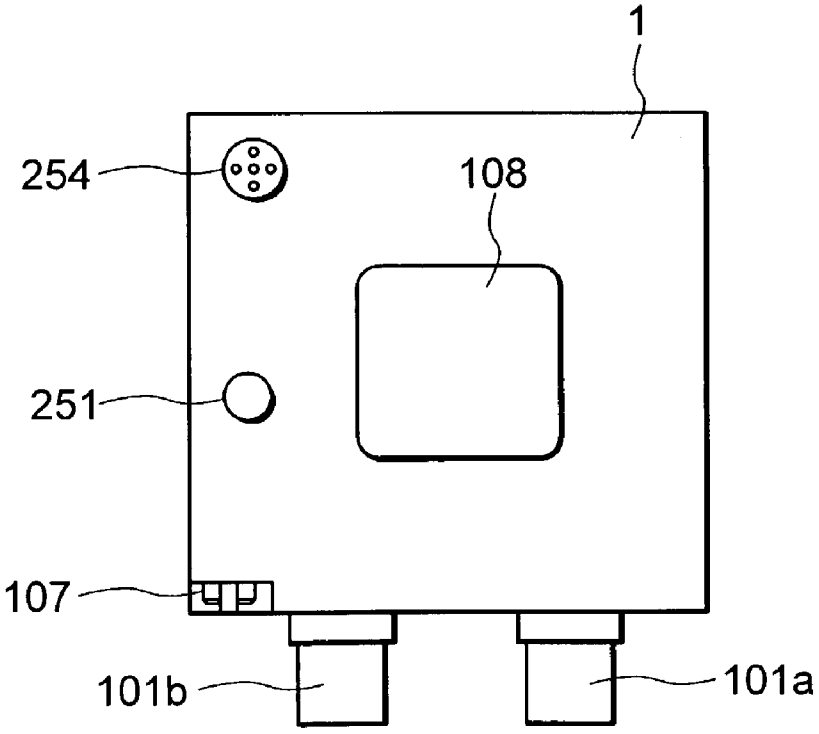

FIG. 5

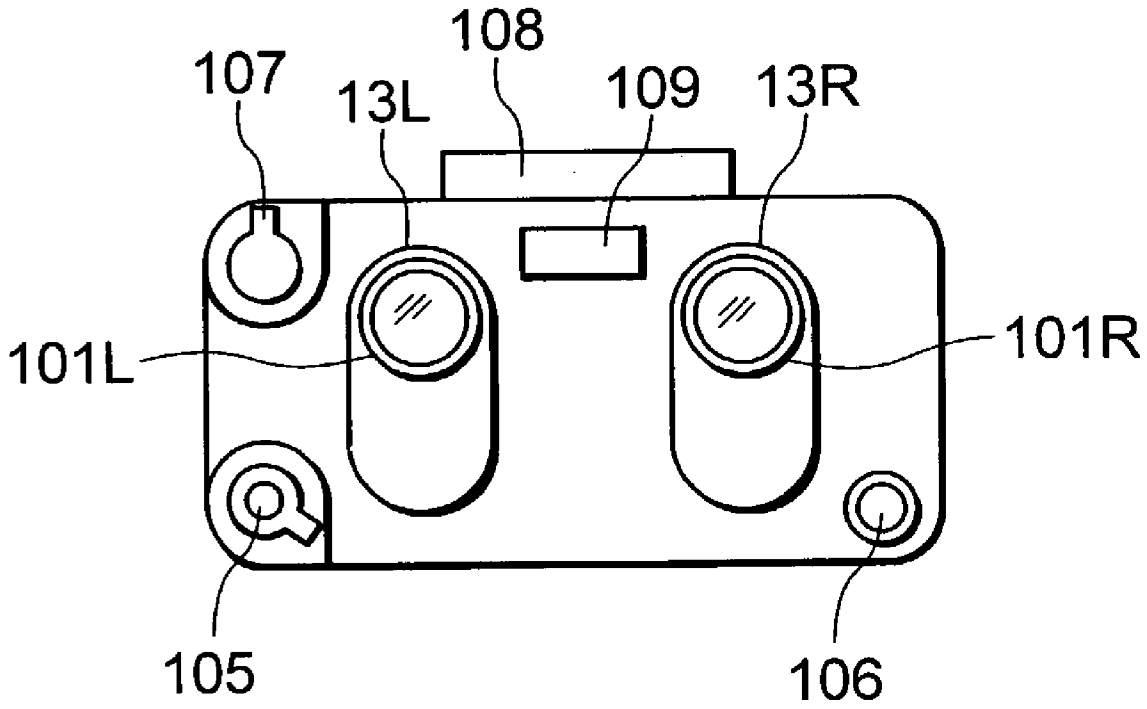

FIG. 6

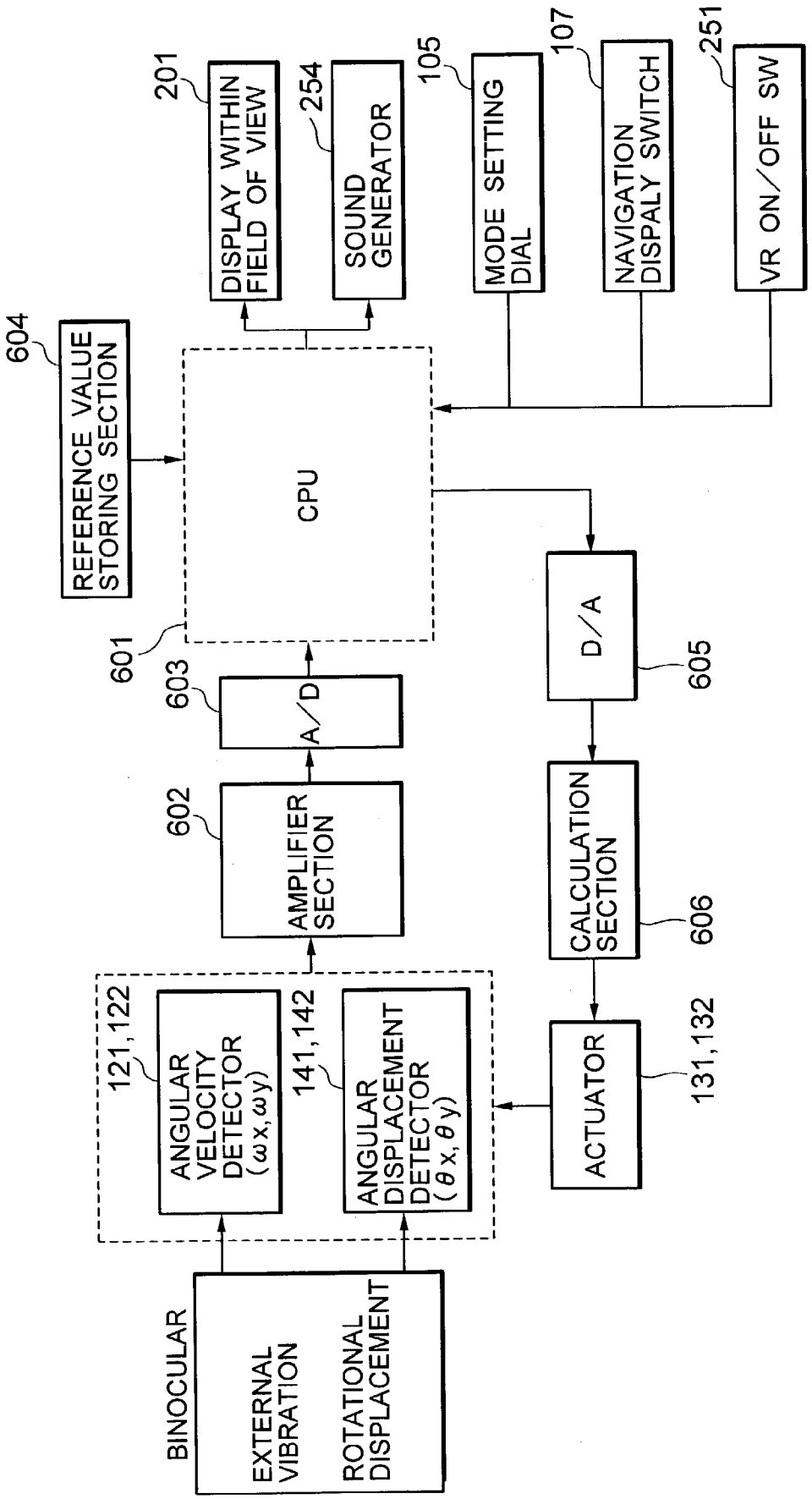
BINOCULAR
EXTERNAL VIBRATION
ROTATIONAL DISPLACEMENT
121,122
ANGULAR VELOCITY DETECTOR (ωx, ωy)
141,142
ANGULAR DISPLACEMENT DETECTOR (θx, θy)
602
AMPLIFIER SECTION
603
A/D
601
CPU
604
REFERENCE VALUE STORING SECTION
201
DISPLAY WITHIN FIELD OF VIEW
254
SOUND GENERATOR
105
MODE SETTING DIAL
107
NAVIGATION DISPALY SWITCH
251
VR ON/OFF SW
D/A
605
CALCULATION SECTION
606
ACTUATOR
131,132

FIG. 7

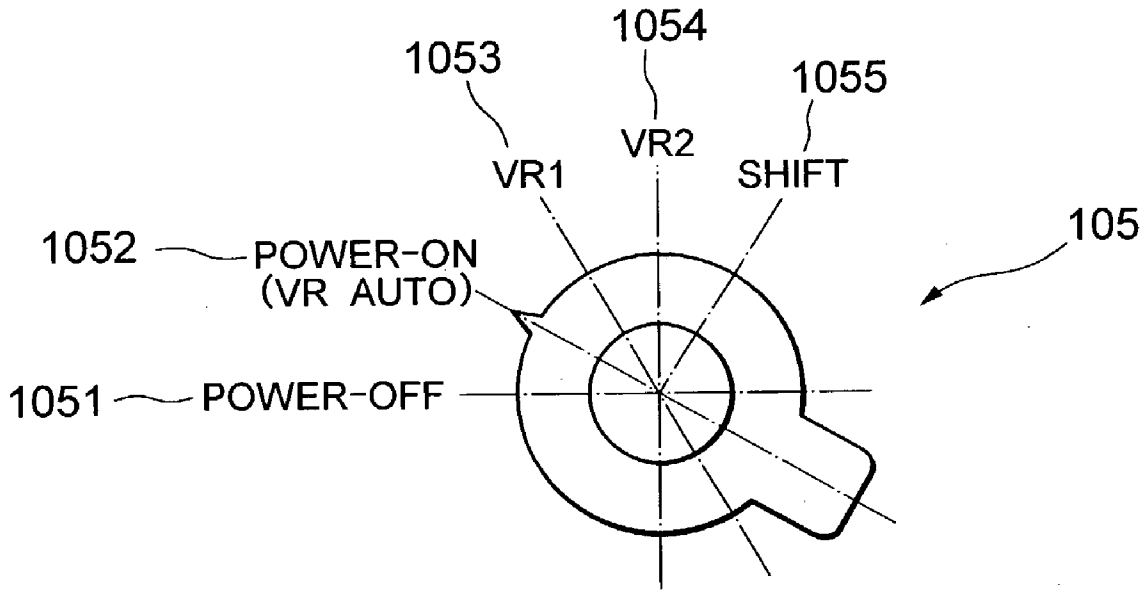
1053
1054
1055
VR1
VR2
SHIFT
105
1052
POWER-ON
(VR AUTO)
1051
POWER-OFF

FIG. 8

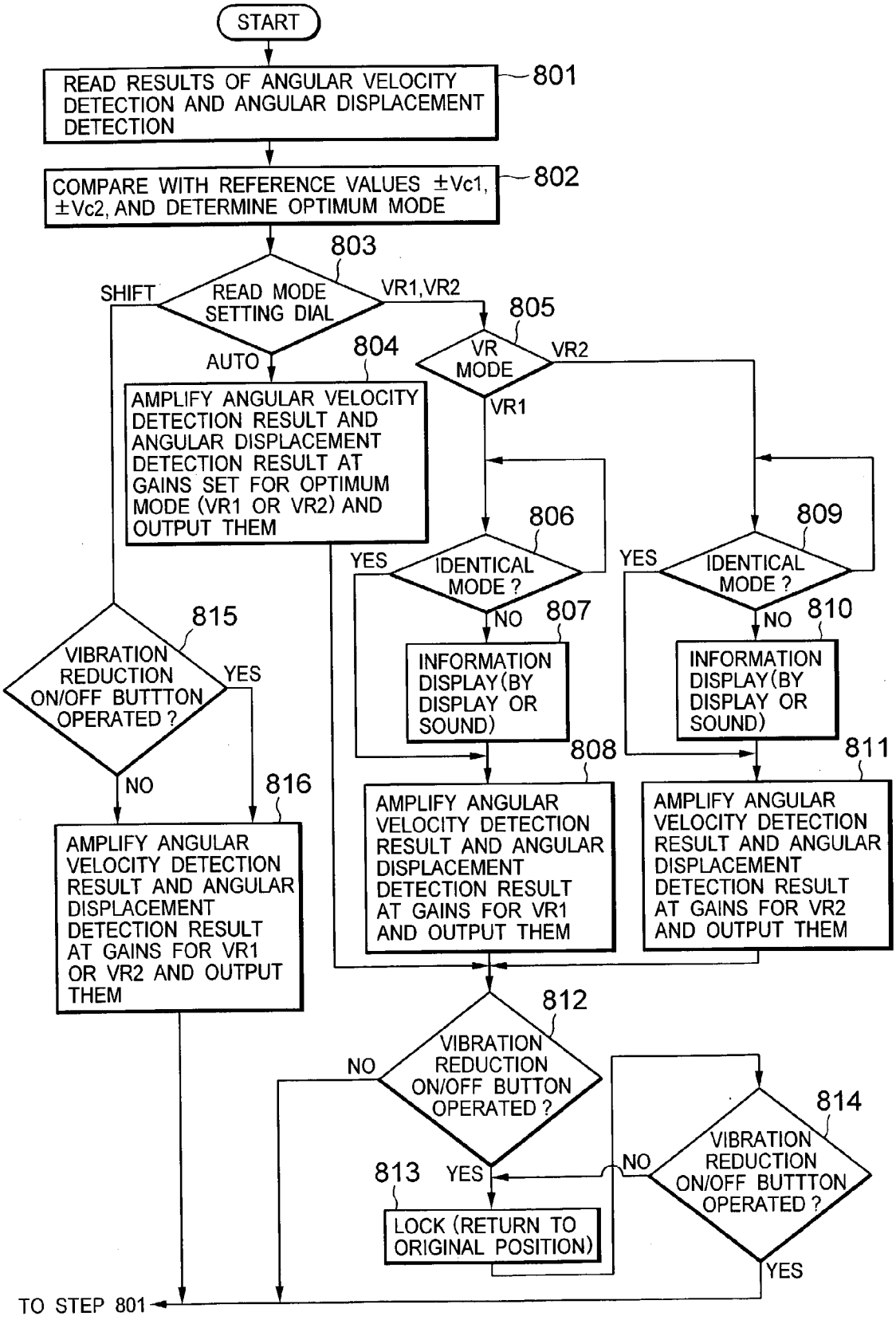
START
READ RESULTS OF ANGULAR VELOCITY DETECTION AND ANGULAR DISPLACEMENT DETECTION
801
COMPARE WITH REFERENCE VALUES ±Vc1, ±Vc2, AND DETERMINE OPTIMUM MODE
802
803
READ MODE SETTING DIAL
SHIFT
VR1,VR2
AUTO
804
AMPLIFY ANGULAR VELOCITY DETECTION RESULT AND ANGULAR DISPLACEMENT DETECTION RESULT AT GAINS SET FOR OPTIMUM MODE (VR1 OR VR2) AND OUTPUT THEM
805
VR MODE
VR2
VR1
806
IDENTICAL MODE ?
YES
NO
807
INFORMATION DISPLAY (BY DISPLAY OR SOUND)
809
IDENTICAL MODE ?
YES
NO
810
INFORMATION DISPLAY (BY DISPLAY OR SOUND)
815
VIBRATION REDUCTION ON/OFF BUTTTON OPERATED ?
YES
NO
816
AMPLIFY ANGULAR VELOCITY DETECTION RESULT AND ANGULAR DISPLACEMENT DETECTION RESULT AT GAINS FOR VR1 OR VR2 AND OUTPUT THEM
808
AMPLIFY ANGULAR VELOCITY DETECTION RESULT AND ANGULAR DISPLACEMENT DETECTION RESULT AT GAINS FOR VR1 AND OUTPUT THEM
811
AMPLIFY ANGULAR VELOCITY DETECTION RESULT AND ANGULAR DISPLACEMENT DETECTION RESULT AT GAINS FOR VR2 AND OUTPUT THEM
812
VIBRATION REDUCTION ON/OFF BUTTON OPERATED ?
NO
814
VIBRATION REDUCTION ON/OFF BUTTTON OPERATED ?
NO
YES
813
YES
LOCK (RETURN TO ORIGINAL POSITION)
TO STEP 801

FIG. 9

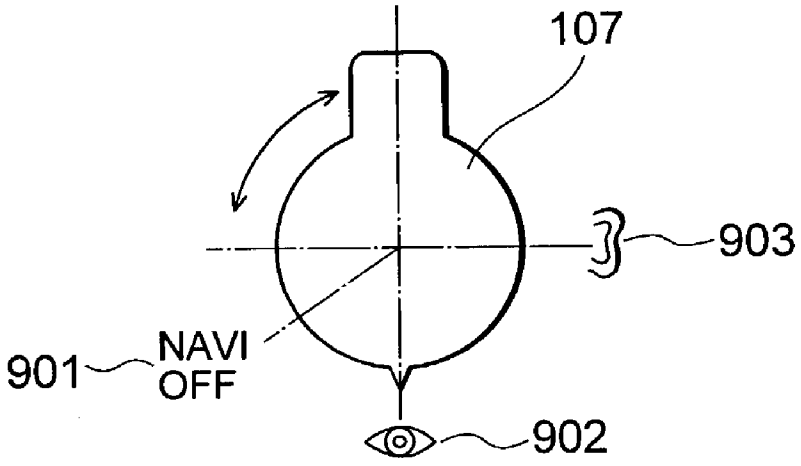

FIG. 10

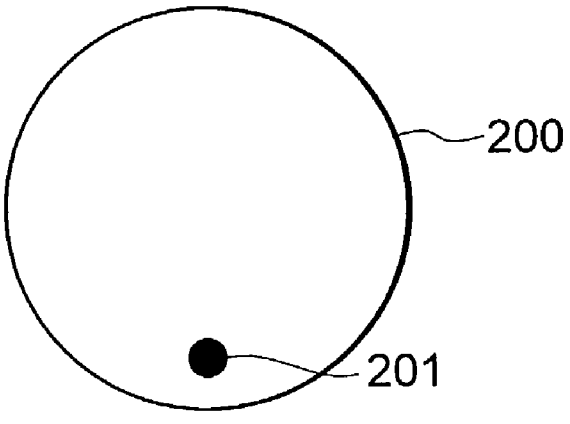

FIG. 11

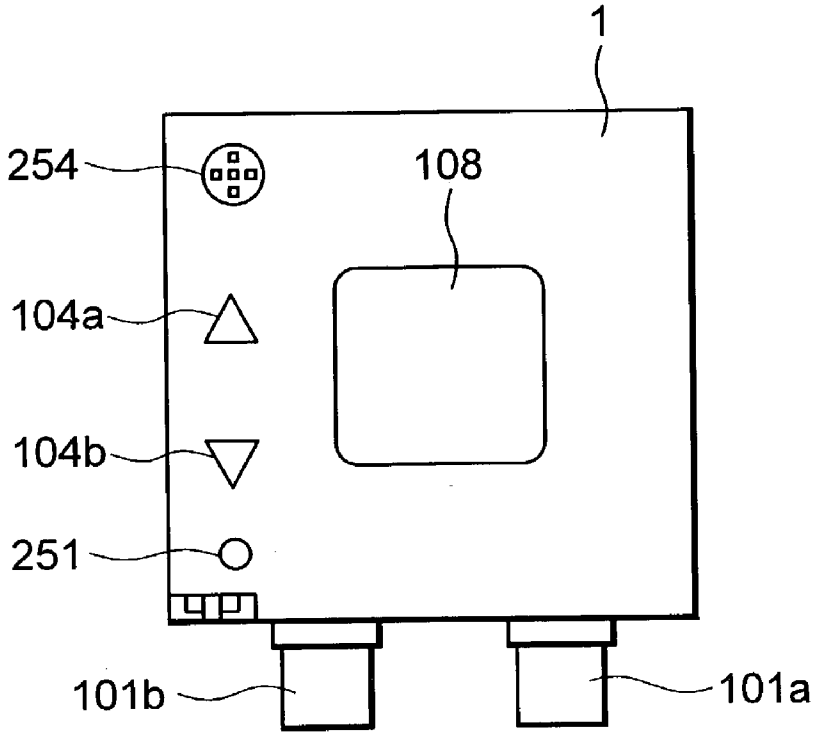

FIG. 12

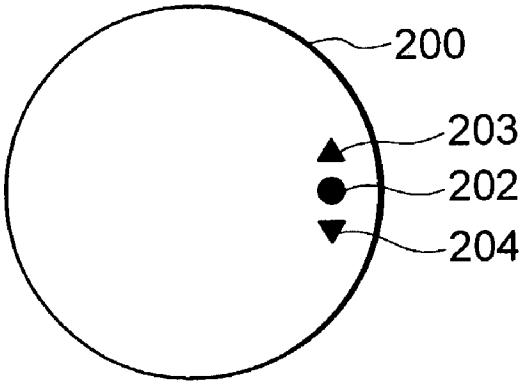

FIG. 13A

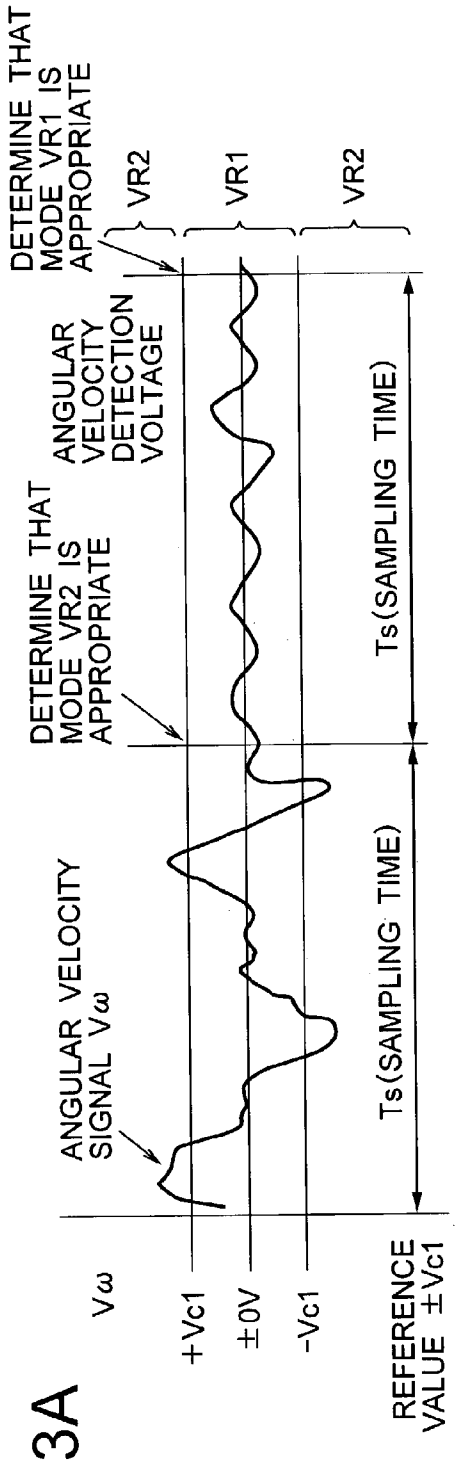

FIG. 13B

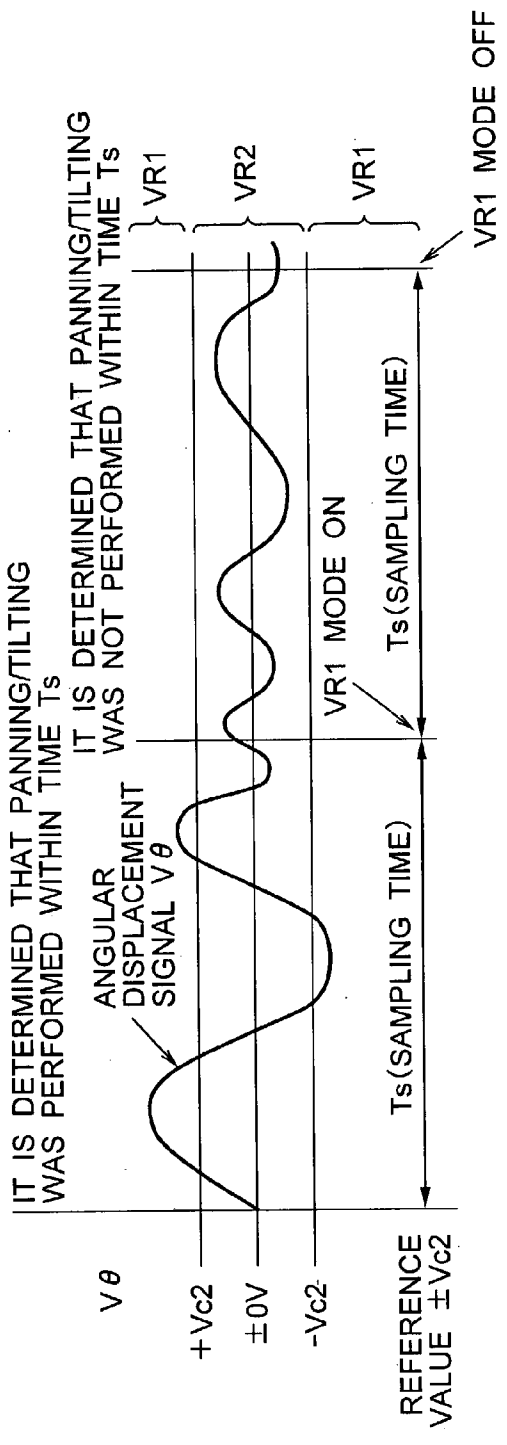

IMAGE STABILIZATION APPARATUS

[0001] This application claims the benefit of Japanese Patent application No. 2002-173031 which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an image stabilization apparatus to be equipped in various optical apparatus such as a binocular or monocular.

[0004] 2. Related Background Art

[0005] Reference is made here, by way of example, to Japanese Patent Application Laid-Open No. 10-104681, which discloses an image stabilization apparatus. A prior art image stabilization apparatus disclosed in this Japanese Patent Application Laid-Open No. 10-104681 is provided with an erecting prism, a gimbaled member to which the erecting prism is attached, position feedback control means and angular velocity feedback control means for controlling the position or posture of the gimbaled member. The angular velocity feedback control means is a feedback loop that detects an angular velocity of the gimbaled member that is created due to hand shake or other causes and enhances following-up ability of the gimbaled member to the optical axis of the objective lens based on a detection result. A position feedback loop is a feedback loop that detects an angular displacement of the gimbaled member that is created due to hand shake or other causes and enhances following-up ability of the gimbaled member to the optical axis of the objective lens based on a detection result. With the above-described structure, Japanese Patent Application Laid-open No. 10-104681 teaches a technology to change a gain of the position feedback control means in response to a user's switching operation of a mode switch to realize a mode for reducing vibration created by hand shake and a mode for providing a high following-up performance to panning and tilting operations.

[0006] Another patent document Japanese Patent Application Laid-Open No. 2001-100106 discloses an image stabilization apparatus in which a vibration reduction mode and a panning/tilting mode are switched automatically.

[0007] Specifically, in this prior art, the apparatus detects the angular velocity and an angular displacement of a gimbaled member and determines whether or not the detected values are larger (or alternatively, smaller) than predetermined values. Then, the apparatus determines an appropriate mode to automatically set this appropriate mode.

[0008] In addition, in the technology disclosed in Japanese Patent Application Laid-Open No. 2001-100106, a user can freely switch the mode at his or her will by a manual operation. Even during observation under a mode that has been set manually, the apparatus detects the angular velocity and the angular positional displacement of the gimbaled member, determines the appropriate mode, and when it is determined that the appropriate mode is different from the manually selected mode, the mode is automatically switched to the appropriate mode determined by the apparatus.

[0009] In the above-described technology disclosed in Japanese Patent Application Laid-Open No. **10-104681**, the mode is manually selected on user's own discretion, and therefore it would be difficult for an unskilled user to determine the optimum mode definitely. Therefore, in some cases, a mode other than that selected by the user may be the optimum mode. In such cases, the performance of the apparatus would not brought out fully.

[0010] On the other hand, in the technology disclosed in Japanese Patent Application Laid-Open No. 2001-100106, the switching of the vibration reduction mode is effected automatically in accordance with the degree of the vibration of the apparatus. However, if the mode is thus switched automatically, the mode determined by the apparatus as the appropriate mode sometimes differs from the mode that the user has selected in accordance with his or her intention. In that case, the user sometimes feels it undesirable to observe under the mode automatically switched based on the determination by the apparatus.

SUMMARY OF THE INVENTION

[0011] An object of the present invention is to provide an image stabilization apparatus that has a good usability.

[0012] In order to attain the above object, according to one aspect of the present invention, there is provided an image stabilization apparatus comprising:

[0013] a housing accommodating an optical system in the interior thereof;

[0014] holding means for holding a part of optical members that compose the optical system in such a way as to allow angular displacement of said part of the optical members relative to the housing, in order to maintain the position of said part of the optical members in a predetermined state;

[0015] driving means for angularly displacing said part of the optical members in the direction for restoring the position of said part of the optical members that have been angularly displaced by the holding member;

[0016] control means for controlling a driving amount of the driving means, the control means including detection means for detecting information on angular displacement of said part of the optical members caused by the holding means and determination means for determining, based on the information detected by the detection means, a mode for controlling the housing that is suitable for vibration applied to the housing; and

[0017] an informing section that informs a user of the control method determined by the determination means.

[0018] In the image stabilization apparatus according to the present invention, the angular displacement information may comprise information on angular velocity of the holding means and/or information on angular displacement amount of the holding means.

[0019] In the image stabilization apparatus according to the present invention, the determination by the determination means may be made based on a comparison of a predetermined reference value and the angular displacement information.

[0020] In the image stabilization apparatus according to the present invention, the reference value may comprise a reference value for the angular velocity and/or a reference value for the angular displacement amount.

[0021] In the image stabilization apparatus according to the present invention, the determination by the determination means may be made based on a comparison of the reference value and the angular displacement information obtained within a predetermined sampling time, and based on the number of times the angular displacement information becomes larger than and/or smaller than the reference value.

[0022] In the image stabilization apparatus according to the present invention, the control mode determined by the determination means may be selected for at least two vibration reduction modes.

[0023] In the image stabilization apparatus according to the present invention, the apparatus may be so adapted that the user can select an automatic switching mode in which the control mode is automatically switched to the mode determined by the determination means based on the angular displacement information detected by the detection means or a user setting mode in which the user is allowed to select the control mode.

[0024] In addition, in this image stabilization apparatus, when the selected mode is the user setting mode, the informing section may be adapted to provide information on whether the mode selected under the user setting mode and the mode determined by the determination means are different or identical.

[0025] In the image stabilization apparatus according to the present invention, the informing section may be adapted to provide information on the control mode determined by the determination means.

[0026] In the image stabilization apparatus according to the present invention, the apparatus may be so adapted that the user can select and set any mode based on the control mode of which the user is informed by the informing section.

[0027] The image stabilization apparatus according to the present invention may further comprises first calculation means for performing calculation on a detection result of the detection means based on a first predetermined calculation method to determine the driving amount, second calculation means for performing calculation on a detection result of the detection means based on a second predetermined calculation method to determine the driving amount, and decision means for determining calculation means, from among the first and second calculation means, that is suitable for vibration applied to the housing.

[0028] In this image stabilization apparatus, the decision means may make the determination by comparing the detection result of the detection means with a predetermined reference value.

[0029] This image stabilization apparatus may further comprise an automatic mode switching means for causing the driving means to operate by the driving amount determined by the calculation means that is determined from among the first and second calculation means by the decision means.

[0030] In this image stabilization apparatus, when an angular displacement amount based on the information on angular displacement deviates from a predetermined range a predetermined number of times or more within a predetermined sampling time, the decision means may be adapted to determine that panning or tilting of the housing is occurring and select calculation means that is suitable for the panning or tilting from among the first and second calculation means.

[0031] In this image stabilization apparatus, when the angular velocity deviates from the predetermined range said number of times or more than said number of times within the predetermined sampling time, the decision means may be adapted to determine that the user is on a conveyance so as to select calculation means that is suitable for vibration caused by the conveyance from among the first and second calculation means.

[0032] The image stabilizing apparatus according to the present invention may further comprise an observation optical system, and the informing section may include a display provided within a field of view of the observation optical system.

[0033] In the image stabilization apparatus according to the present invention, the informing section may include a sound generator with which the informing section provides information using a sound.

[0034] According to another aspect of the present invention, there is provided a binocular comprising:

[0035] a pair of eyepiece optical systems;

[0036] a pair of objective optical systems;

[0037] an intermediate optical system provided on an optical axis between the eyepiece optical systems and objective optical systems;

[0038] a housing accommodating the eyepiece optical systems, the objective optical systems and the intermediate optical system;

[0039] holding means for holding a part of optical members that compose the intermediate optical system in such a way as to allow angular displacement of said part of the optical members relative to the housing, in order to maintain the position of said part of the optical members in a predetermined state;

[0040] driving means for angularly displacing said part of the optical members in the direction for restoring the position of said part of the optical members that have been angularly displaced by the holding member;

[0041] control means for controlling a driving amount of the driving means, the control means including detection means for detecting information on angular displacement of said part of the optical members caused by the holding means and determination means for determining, based on the information detected by the detection means, a mode for controlling the housing that is suitable for vibration applied to the housing; and

[0042] an informing section that informs a user of the control method determined by the determination means.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] **FIG. 1** is a drawing schematically showing the internal structure of a binocular as an embodiment of the present invention.

[0044] **FIG. 2A** is a front view showing the structure of an image stabilization apparatus **100** in the embodiment of the present invention.

[0045] **FIG. 2B** is a cross sectional view taken on line A-A in **FIG. 2A**.

[0046] **FIG. 3** is a rear view of the binocular according to the first embodiment of the present invention.

[0047] **FIG. 4** is a top view of the binocular according to the first embodiment of the present invention.

[0048] **FIG. 5** is a front view of the binocular according to the first embodiment of the present invention.

[0049] **FIG. 6** is a block diagram showing the structure of the image stabilization apparatus **100** in the binocular according to the first embodiment of the present invention.

[0050] **FIG. 7** is a top view showing the structure of a mode setting dial **105** of the image stabilization apparatus **100** in the binocular according to the first embodiment of the present invention.

[0051] **FIG. 8** is a flow chart showing a control process performed by a CPU **601** of the image stabilization apparatus **100** in the binocular according to the first embodiment of the present invention.

[0052] **FIG. 9** is a top view showing the structure of a navigation display changing switch **107** of the image stabilization apparatus **100** in the binocular according to the first embodiment of the present invention.

[0053] **FIG. 10** is a drawing illustrating a display **201** within the field of view **200** of the binocular according to the first embodiment of the present invention.

[0054] **FIG. 11** is a top view of a binocular according to the second embodiment of the present invention.

[0055] **FIG. 12** is a drawing illustrating displays **202**, **203** and **204** within the field of view **200** of the binocular according to the second embodiment of the present invention.

[0056] **FIGS. 13A and 13B** are diagrams for illustrating comparison of reference values and signals in a process for determining vibration reduction mode performed by the CPU **601** of the image stabilization apparatus **100** according to the first embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0057] In the following, embodiments of the present invention will be described. In the following embodiments, descriptions will be made with reference to an image stabilization apparatus equipped in a binocular. However, it should be understood that the present invention may also be applied to other optical apparatus. For example, the invention may be applied to a monocular apparatus such as a telescope etc.

[0058] First, a description will be made of a binocular equipped with an image stabilization apparatus as a first embodiment of the present invention.

[0059] Referring to **FIG. 1** and **FIG. 2A**, The binocular equipped with an image stabilization apparatus according to the embodiment has a binocular optical system **10**, a housing **1** accommodating the binocular optical system, and an image stabilization apparatus **100**. The image stabilization apparatus **100** is adapted to detect vibration generated during use of the binocular, such as vibration applied to the housing **1** due to hand shake, and to suppress such vibration.

[0060] As shown in **FIG. 1**, the binocular optical system **10** includes an objective optical system **11**, an eyepiece optical system **13**, an intermediate optical system **12** disposed between the objective optical system **11** and the eyepiece optical system **13**. As illustrated in **FIGS. 1 and 3**, the objective optical system **11** includes objective lenses **11**R and **11**L. As shown in **FIGS. 1, 4** and **5**, the eyepiece optical system **13** includes an eyepiece barrels **101**R and **101**L and eyepiece lenses **13**R and **13**L. The intermediate optical system **12** functions to direct a light flux from the objective optical system **11** to the eyepiece optical system **13**. The intermediate optical system **12** is provided for performing, when vibration occurs in the binocular, optical compensation to prevent an object from disappearing out of the field of view. In this embodiment, the intermediate optical system **12** includes erecting prisms **12**R and **12**L.

[0061] The image stabilization apparatus **100** has a gimbal mechanism **110**. The gimbal mechanism **110** includes an outer gimbaled member **111** having a rotation axis parallel to X-axis and an inner gimbaled member **112** having a rotation axis parallel to Y-axis. The inner gimbaled member **112** is supported by rotation shaft **112***a* in such a way as to be rotatable relative to the outer gimbaled member **111**. The outer gimbaled member **111** is supported by rotation shaft **111***a* in such a way as to be rotatable relative to the housing **1**. The inner gimbaled member **112** holds the erecting prisms **12**R and **12**L between two plate members **112***b* and **112***c*. The plate members **112***b* and **112***c* have openings **112***d* and **112***e* respectively at the positions of the left and right optical paths. With the above-described structure, when vibration or panning/tilting of the housing **1** occurs, the gimbaled members **111** and **112** are rotated relative to the housing respectively by inertial force so that the direction of the optical axes of the erecting prisms **12**R and **12**L would be kept unchanged with respect to the inertial system (i.e. with respect to the earth).

[0062] On the outer gimbaled member **111**, there is mounted an angular velocity detector **121** for detecting the angular velocity ωx of the rotational movement about the rotation axis **111***a* parallel to X-axis. On the inner gimbaled member **112**, there is mounted an angular velocity detector **122** for detecting the angular velocity ωy of the rotational movement about the rotation axis **112***a* parallel to X-axis. Each of the angular velocity detectors **121** and **122** may be composed, for example, of a piezoelectric vibration gyro sensor.

[0063] In addition, an angular displacement detector **141** for detecting an angular displacement (i.e. a change in the angular position) θx caused by the rotation is attached to the rotation shaft **111***a* for rotation about the axis parallel to X-axis. Furthermore, an actuator **131** for rotationally driving

the rotation shaft **111***a* that has been rotationally displaced in the rotational direction for returning back the rotation axis **111***a* is also attached to the rotation shaft **111***a*. Similarly, to the rotation axis **112***a* for rotation about the axis parallel to Y-axis, there is attached an angular displacement detector **142** for detecting an angular displacement θy caused by the rotation and an actuator **132** for rotationally driving the rotation shaft **112***a* that has been rotationally displaced in the rotational direction for returning back the rotation axis **112***a*. Thus, the angular displacement of the rotation of the outer and inner gimbaled members **111** and **112** about axes parallel to X-axis and Y-axis can be detected based on outputs of the angular displacement detectors **141** and **142**. The directions of rotational drive by the actuators **131** and **132** are such directions with which the optical axis of the erecting prism **12**R and **12**L mounted on the gimbaled member **111** and **112** that have been rotated by inertial force would be restored to the original position (i.e. the optical axis of the objective optical system **11**). Each of the actuators **131** and **132** may include, for example, a servo mechanism. Each of the angular displacement detectors **141** and **142** may include a rotary encoder.

[**0064**] As shown in **FIG. 4**, the image stabilization apparatus **100** is further provided with a button **251** for turning on/off the vibration reduction function disposed on the top surface of the housing **1**, a sound generator **254** and a battery box **108**. In addition, as shown in **FIG. 5**, the image stabilization apparatus **100** is provided with a switch **107** for switching a navigation display disposed on the front surface of the housing **1** and a mode setting dial **105**. Furthermore, referring to **FIG. 6**, the image stabilization apparatus **100** has a CPU (central processing unit) **601**, an amplifier section **602**, an A/D converter **603**, a reference value storing section **604**, a D/A converter **605** and a calculator section **606**. The control system as described above is accommodated in the interior of the housing **1**. The image stabilization apparatus **100** is further provided with a display within the field of view **201** disposed within the field of view of either one of the eyepiece lenses **13**R and **13**L. In addition, a display **109** and a focus knob **106** are also provided on the front side surface of the housing **1**.

[**0065**] The mode setting dial **105** is a dial type switch used for selecting the vibration reduction mode of the image stabilization apparatus **100**. The apparatus according to this embodiment has two vibration reduction modes (mode VR**1** and mode VR**2**) and an automatic mode for switching the mode VR**1** and the mode VR**2** automatically. While the apparatus according to this embodiment is described to have two modes VR**1** and VR**2** by way of example, the apparatus may be adapted to have more than two modes to be switched. The mode VR**1** is a mode that is suitable for stabilizing the image at the occasion of performing observation on a steady ground or observation which involves frequent panning and tilting operations (e.g. at the time of bird watching). On the other hand, the mode VR**2** is a mode suitable for stabilizing the image at the occasion of performing observation on a swinging or wavering board of a conveyance (e.g. a ship, a vehicle, an airplane or a helicopter etc.). The mode setting dial **105** has five positions to be switched, that is, "POWER-OFF" position **1051**, "POWER-ON (VR AUTO: auto vibration reduction)" position **1052**, "VR1" position **1053**, "VR2" position **1054** and "SHIFT" position **1055**. When the mode setting dial **105** is set to the "POWER-OFF" position **1051**, power supply from the battery box **108** to each section of the image stabilization apparatus **100** is turned off and disabled, so that the gimbal mechanism **110** is placed into a locked state in which the gimbal mechanism **110** is maintained at the position of the center of the optical axis without angular displacement. Under this state, the binocular behaves as an ordinary binocular that is not provided with a vibration reduction function. When the mode setting dial **105** is set to the "POWER-ON (VR AUTO)" position **1052**, the image stabilization apparatus **100** is turned on, and the vibration reduction mode is set to the automatic switching mode. When the mode setting dial **105** is set to the "VR1" position **1053** or the "VR2" position **1054**, the vibration reduction mode is set to the vibration reduction mode VR**1** or VR**2** respectively. The operation under the dial setting to the "SHIFT" position **1055** will be described later.

[**0066**] In the following, functions characterizing the present invention will be specifically described. As shown in **FIG. 10**, the display within the field of view **201** is composed, for example, of an LED or other elements, and it is disposed in the field of view **200** of either one of the eyepiece lenses **13**R and **13**L. Under the state in which a vibration reduction mode is selected by setting of the mode setting dial **105** to the "VR1" position **1053** or the "VR2" position, if it is determined, based on the level or degree of the external vibration actually applied to the housing **1**, that the selected mode is not the optimal mode, the display in the field of view **201** indicates with red light. This prompts the user to change the mode selected by the mode setting dial **105** to another mode. Such a prompting function for changing the mode is referred to in this embodiment as a vibration reduction mode navigation function.

[**0067**] Referring to **FIG. 9, a** navigation display changing switch **107** has multiple positions to be switched, namely, a "NAVI-OFF" position **901**, an eye-mark position **902** and an ear-mark position **903**. When the navigation display changing switch **107** is set to the eye-mark position **902**, the prompt for changing the vibration reduction mode is performed by means of the display within the field of view **201**. On the other hand, when the navigation display changing switch **107** is set to the ear-mark position **903**, the indication by the display within the field of view **201** is not performed, but prompt for changing the vibration reduction mode is performed by beep sound or voice sound for prompting mode change generated by the sound generator **254**. When the beep sound is used, its sound duration time or its frequency may be modulated in accordance with the vibration reduction mode. When the navigation display changing switch is set to the "NAVI OFF" position **901**, the vibration reduction mode navigation function is disabled.

[**0068**] The vibration reduction on/off button **251** is enabled when the mode setting dial **105** is set to either one of the "POWER-ON (VR AUTO)" position **1052**, the "VR1" position **1053**, the "VR2" position **1054** or the "SHIFT" position **1055**. When the mode setting dial **105** is set to either one of the "POWER-ON (VR AUTO)" position **1052**, the "VR1" position **1053** or the "VR2" position **1054**, the state in which the vibration reduction mode is disabled and the state in which the vibration reduction mode is enabled are alternately switched by manipulation of the vibration reduction on/off button. Under the state in which the vibration reduction mode is disabled, the gimbal mechanism **110** is placed in the locked state in which the gimbal

mechanism is positioned at the original position without angular displacement. Under the state in which the vibration reduction mode is enabled, the vibration reduction mode corresponding to the setting of the mode setting dial **105** (i.e. either one of the auto switching mode, the VR1 mode or the VR2 mode) is enabled. Therefore, during observation under the vibration reduction mode (i.e. either one of the auto switching mode, the VR1 mode or the VR2 mode), the vibration reduction on/off button is useful for the user, when the user wants to disable the vibration reduction mode to lock the gimbal mechanism instantaneously for power saving or other reasons.

[0069] On the other hand, when the mode setting dial **105** is set to the "SHIFT" position **1055**, the vibration reduction mode is alternately switched between VR1 and VR2 by manipulation of the vibration reduction on/off button **251**. Therefore, during observation under the mode VR2, the mode setting dial **105** may be set to the "SHIFT" position in preparation for panning and tilting operation for following up an object such as a bird or an airplane that may possibly comes within the field of view, so that the vibration reduction mode can be changed to the mode VR2 by manipulating (or pressing) the vibration reduction of/off button **251**. In connection with this, when the mode setting dial **105** is set to the "SHIFT" position **1055**, the automatic vibration reduction mode change and the information by the display within the field of view **201** will not be enabled.

[0070] The above-described navigation function is so adapted to prompt the user to change the vibration reduction mode selected by the mode setting dial **105** into another mode. However, it may be modified to inform the user of the optimal mode determined by the external vibration level actually applied to the housing **1**. If the function is so modified, the user can know the optimal mode determined by the apparatus, and therefore the user can be aware of the difference between the optimal mode and the mode selected by the user. In addition, if the mode selected by the user is also displayed together with the optimal mode determined by the apparatus, the user can recognize the difference in the modes easily.

[0071] Next, in the following, control operations by the CPU **601** of the image stabilization apparatus will be described.

[0072] The CPU **601** reads a program stored in the reference value storing section **604** upon turning-on of the power supply and executes the program to operate in the manner described in the flow chart presented in **FIG. 8**. First, in step **801**, the CPU **601** receives, via the A/D converter **603**, signals Vωx and Vωy that have been obtained by amplifying angular velocity ωx and ωy detected by the angular velocity detector **121** and **122** by a predetermined gain in the amplifier section **602**. In addition, the CPU **601** also receives via the A/D converter **603**, signals Vθx and Vθy that have been obtained by amplifying angular displacement θx and θy detected by the angular velocity detector **141** and **142** by a predetermined gain by the amplifier section **602**.

[0073] Next in step **802**, the CPU **601** compares the received angular velocity signals Vωx and Vωy with reference angular velocity values ±Vc1 stored in the reference value storing section **604** in advance respectively. In addition, the CPU **601** compares the received angular displacement signals Vθx and Vθy with reference angular displacement values ±Vc2 stored in the reference value storing section **604** in advance respectively. Based on the above-mentioned comparison, the CPU **601** determines whether the optimal mode is the mode VR1 or the mode VR2.

[0074] In the apparatus according to this embodiment, the angular velocity signals Vωx and Vωy are used as information for detecting vibration caused by conveyance. Specifically, as will be seen from **FIG. 13**A, if at least one of the angular velocity signals Vωx and Vωy becomes larger than ±Vc1 or smaller than −Vc1, it is determined that the user is on a conveyance and so the mode VR2 is appropriate. In addition, in order not to mistakenly interpret angular velocity signals Vωx and Vωy corresponding to an user's unintentional action as those corresponding to vibration of a conveyance, a sampling time Ts is set in the apparatus according to this embodiment as shown in **FIG. 13A**. If the state in which at least one of the angular velocity signals Vωx and Vωy becomes larger than +Vc1 or smaller than −Vc1 occurs more than once during the sampling time Ts, it is determined that the optimal mode is the mode VR2.

[0075] On the other hand, the angular displacement signals Vωx and Vωy are used as information for detecting panning and tilting operations. Specifically, as will be seen from **FIG. 13**B, if at least one of the angular displacement signals Vωx and Vωy becomes larger than +Vc2 or smaller than −Vc2, it is determined that the user is performing a panning or tilting operation and so the mode VR1 is appropriate. As in the case of the angular velocity signals, in order to prevent erroneous interpretation of output corresponding to an user's unintentional action, if the state in which at least one of the angular displacement signals Vθx and Vθy becomes larger than +Vc1 or smaller than −Vc2 occurs more than once during the sampling time Ts, it is determined that the optimal mode is the mode VR1.

[0076] In the case in which the determination of the optimal mode conflicts between VR1 and VR2 (for example, when a user on a conveyance is performing panning or tilting operation), in other words, in the case in which at least one of Vωx and Vωy becomes larger than +Vc1 or smaller than −Vc1 more than once within the sampling time Ts and at least one of Vωx and Vωy becomes larger than +Vc2 or smaller than −Vc2 more than once within the sampling time Ts, it is determined in the apparatus according to this embodiment that the mode VR1 for panning/tilting is the optimal mode.

[0077] The above-described criteria in step **802** are summarized as follows:

[0078] (1) When during the sampling time Ts, both Vωx and Vωy are within the range larger than −Vc1 and smaller than +Vc1 (or deviate from this range only once) and at least one of Vθx and Vθy becomes smaller than −Vc2 or larger than +Vc2 more than once, it is determined that the optimal mode is the mode VR1;

[0079] (2) When during the sampling time Ts, both Vωx and Vωy are within the range larger than −Vc1 and smaller than +Vc1 (or deviate from this range only once) and both Vθx and Vθy are within the range larger than −Vc2 and smaller than +Vc2 (or deviate from this range only once), it is determined that the optimal mode is the mode VR2;

[0080] (3) When during the sampling time Ts, at least one of Vωx and Vωy becomes smaller than −Vc1 or larger than +Vc1 more than once and at least one of V θx and Vθy becomes smaller than −Vc2 or larger than +Vc2 more than once, it is determined that the optimal mode is the mode VR1; and

[0081] (4) When during the sampling time Ts, at least one of Vωx and Vωy becomes smaller than −Vc1 or larger than +Vc1 more than once and both Vωx and Vωy are within the range larger than −Vc2 and smaller than +Vc2 (or deviate from this range only once), it is determined that the optimal mode is the mode VR2 As per the above, in step **802**, it is possible to determine the vibration reduction mode VR1 or VR2 that is optimal to the vibration level applied to the binocular, by comparing the angular velocity signals Vωx and Vωy and angular displacement signals Vθx and Vθy with the reference values ±Vc1 and ±Vc2 respectively.

[0082] Next in step **803**, the CPU **601** reads to which position **1052** to **1055** the mode setting dial **105** is set. When the mode setting dial **105** is set to the "POWER-ON (VR AUTO)" position **1052**, which means that automatic switching of the vibration reduction mode is selected, the process proceeds to step **804**. In step **804**, the CPU **601** controls to create outputs for causing the actuators **131** and **132** to rotationally drive the rotation shafts **111***a* and **111***b* of the gimbal mechanism **110** in accordance with the optimal vibration mode VR1 or VR2 determined in step **802**.

[0083] Specifically, in step **804**, if the vibration mode determined in step **802** is the mode VR1, the CPU **601** controls to amplify the angular velocity signals Vωx and Vωy at a predetermined gain α1 and to amplify the angular displacement signals Vθx and Vθy at a predetermined gain β1 and to output them. The output signals α1×Vωx, α1×Vωy, β1×Vθx and β1×Vθy are converted by the D/A converter **605** into analog signals and then input to the calculation section **606**. The calculation section **606** performs predetermined calculation processing such as addition or integration on the output α1×Vωx and the output β1×Vθx and outputs the results to the actuator **131** for rotationally driving the rotation shaft **111***a* about X-axis. Thus, the actuator **131** rotationally drives the rotation shaft **111***a* with a driving voltage reflecting the outputs of the angular velocity signal Vωx and the angular displacement signal Vθx so as to rotate the outer gimbaled member **111** in the direction for bringing the optical axis of the erecting prism **12**R and **12**L closer to the original position (i.e. the optical axis of the objective optical system **11**). In addition, the calculation section **606** also performs calculation processing such as addition or integration on the output α1×Vωy and the output β1×Vθy and outputs the results to the actuator **132** for rotationally driving the rotation shaft **112***a* about Y-axis. Thus, the actuator **132** rotationally drives the rotation shaft **112***a* with a driving voltage reflecting the outputs of the angular velocity signal Vωy and the angular displacement signal Vθy so as to rotate the inner gimbaled member **112** in the direction for bringing the optical axis of the erecting prism **12**R and **12**L closer to the original position (i.e. the optical axis of the objective optical system **11**).

[0084] On the other hand, in the case in which the vibration reduction mode determined in step **802** is VR2, the CPU **601** also controls in step **804** to amplify the angular velocity signals Vωx and Vωy and the angular displacement signals Vθx and Vθy so as to output them, but the amplification is performed at gains α2 and β2 respectively. While gains α1 and β1 are predetermined values for realizing the vibration mode VR1 that is suitable for panning and tilting operations, gains α2 and β2 are predetermined values for realizing the vibration reduction mode VR2 that is suitable for the vibration of a conveyance. The gains α1 and β1 in the mode VR1 are set in such a way that the gimbal mechanism **110** is restrained to the original position more strongly than in the mode VR2. In other words, the gains α1 and β1 for the mode VR1 are so set that the field of view follows the movement of the housing upon panning and tilting operations. On the other hand, the gains α2 and β2 in the mode VR2 are set in such a way that the restraint of the gimbal mechanism **110** to the original position is weaker than in the mode VR1. In other words, the gains α2 and β2 in the mode VR2 are so set that the field of view is kept as constant (or steady) as possible relative to the inertial system (i.e. relative to the earth) even if the binocular vibrates due to vibration of a conveyance. Specifically, the ratio of the gain α1 for the angular velocity signal to the gain β1 for the angular displacement signal in the mode VR1 is made larger than the ratio of the gain α2 for the angular velocity signal to the gain β2 for the angular displacement signal in the mode VR2.

[0085] As per the above, the automatic switching of the vibration reduction mode between VR1 and VR2 is realized in step **804**.

[0086] On the other hand, when it is turned out in step **803** that the mode setting dial **105** is set to the "VR1" position **1053** or the "VR2" position **1054**, the process proceeds to step **805**. In step **805**, it is further determined whether the mode setting dial **105** is in the "VR1" position **1053** or in the "VR2" position **1054**. When it is determined that the mode setting dial **105** is in the "VR1" position **1053**, the process proceeds to step **806**. In step **806**, it is determined whether or not the optimal vibration reduction mode determined in step **802** is identical to the mode VR1 set by the mode setting dial **105**. If they are not identical, the process proceeds to step **807**, in which information for prompting mode change is presented to the user, since the currently set vibration reduction mode is not appropriate. The way of informing the user is pursuant to the setting by the navigation information changing switch **107**. Specifically, when the eye-mark position **902** is selected, the LED in the display within the field of view **201** is turned on in red, while when the ear-mark position **903** is selected, a beep sound or a voice sound is generated from the sound generator **254**, and then the process proceeds to step **808**. In connection with this, when the navigation information changing switch **107** is set to the "NAVI OFF" position **901**, the information is not presented and the process proceeds to step **808**.

[0087] In the process shown in the flow chart of **FIG. 8**, it is determined in step **806** whether or not the optimal vibration reduction mode determined in step **802** is identical to the mode set by the user, which is determined in step **805**. However, as described before, in the present invention the process may be modified in such a way as to inform the user of the optimal vibration reduction mode determined in step **802**. In that case, step **806** for determining whether or not the optimal vibration reduction mode determined in step **802** is identical to the mode set by the user is not necessary (i.e. can

be omitted). Therefore, the information made in step **807** will be information on the optimal vibration reduction mode determined in step **802**.

[**0088**] In step **808**, in order to realize the mode VR**1**, the CPU **601** controls to amplify the angular velocity signals Vωx and Vωy at a predetermined gain α1 and to amplify the angular displacement signals Vθx and Vθy at a predetermined gain β1 and to output them in like manner as in step **804**. Thus, the actuators **131** and **132** rotationally drive the rotation shafts **111***a* and **112***a* respectively with driving voltages reflecting the outputs of the angular velocity signals and the angular displacement signals so as to realize the vibration reduction mode VR**1**.

[**0089**] In step **808**, the vibration reduction mode is switched to the optimal vibration reduction mode determined in step **802** automatically. However, in the present invention, whether or not the mode suggested by the information in step **807** is to be selected may be left to user's discretion. In that case, step **808** is not necessary (i.e. can be omitted). Therefore, if the user considers that observation under the mode selected by himself or herself is satisfactory, the user can continue the observation while maintaining the current mode without following the information. In addition, even if the user considers that observation under the current mode selected by himself or herself is satisfactory, the user can change the mode once when a mode different from the currently selected mode is suggested by the information and if the suggested mode provides better observation, the user would observe with the suggested mode. If the user finds, after changing the mode to the suggested mode, that observation under the mode selected by himself or herself is more preferable for him or her than observation under the suggested mode, the user would change the mode from the suggested mode to the mode previously selected by the user again.

[**0090**] As per the above, the present invention can provide an apparatus that reflects user's intention or taste to a greater degree.

[**0091**] After the above-described steps, the process proceeds to step **812**, in which the CPU **601** detects whether or not the vibration reduction on/off button **251** has been manipulated within a predetermined time. When it is detected that the vibration reduction of/off button has been manipulated, the process proceeds to step **813**, in which the CPU **601** outputs a signal for commanding the actuators **131** and **132** to return the rotation shafts **111***a* and **112***a* to the original positions and to maintain (or lock) them at that state. That signal is sent to the actuators **131** and **132** via the D/A converter **605**, the calculation section **606**, and the actuators **131** and **132** return the rotation shafts **111***a* and **112***a* to their original positions to maintain (or lock) them in that state. Thus, the gimbal mechanism **110** of the image stabilization apparatus **100** will not rotate from the original position, and therefore the binocular behaves as an ordinary binocular that does not have a vibration reduction function. The locking of the rotation shafts **111***a* and **112***a* is maintained until it is detected that the vibration reduction on/off button **251** is manipulated (or pressed) again. If it is determined in step **814** that the vibration reduction on/off button **251** is pressed again and the locking is released, or if it is determined in step **812** that the vibration reduction on/off button **251** has not been manipulated, the process returns to step **801**.

[**0092**] Referring back to step **805**, if it is determined in step **805** that the mode setting dial **105** is in the "VR2" position **1054**, the process proceeds to step **809**. In step **809**, it is determined whether or not the optimal vibration reduction mode determined in step **802** is identical to the mode VR**2** set by the mode setting dial **105**. If they are not identical, the process proceeds to step **810**, in which information for prompting mode change is presented to the user in like manner as in step **807**, since the currently set vibration reduction mode is not appropriate.

[**0093**] As described before, the process may be modified in such a way as to inform the user of the optimal vibration reduction mode that is determined in step **802**. In that case, step **809** for determining whether or not the optimal vibration reduction mode determined in step **802** is identical to the mode set by the user determined in step **805** is not necessary (i.e. can be omitted). Therefore, step **809** and step **810** are not necessary, and information of the optimal vibration reduction mode determined in step **802** is made only in step **807**.

[**0094**] Then the process proceeds to step **811**. In step **811**, in order to realize the mode VR**2**, the CPU **601** controls to amplify the angular velocity signals Vωx and Vωy at a predetermined gain α2 and to amplify the angular displacement signals Vθx and Vθy at a predetermined gain β2 and to output them in like manner as in step **804**. Thus, the actuators **131** and **132** rotationally drive the rotation shafts **111***a* and **112***a* respectively with driving voltages reflecting the outputs of the angular velocity signals and the angular displacement signals so as to realize the vibration reduction mode VR**2**. After that, the process proceeds to step **812**.

[**0095**] As described before, whether or not the mode suggested by the information in step **810** is to be selected may be left to user's discretion. In that case, step **810** is not necessary (i.e. can be omitted).

[**0096**] Referring back to step **803**, if the mode setting dial **105** is set to the "SHIFT" position **1055**, the process proceeds to step **815**. In step **815**, it is determined whether the vibration reduction on/off button **251** has been manipulated (or pressed) within a predetermined time. In the state in which the mode setting dial **105** is set to the "SHIFT" position, the vibration reduction mode is switched between VR**1** and VR**2** automatically. Therefore, if it is determined in step **815** that the vibration reduction on/off button **251** has not been pressed, the process proceeds to step **816**, and in order to realize the vibration reduction mode same as the previously set mode, which is assumed here to be the mode VR**1** for example, if the mode set in the latest step **816** is VR**1**, the CPU **601** controls to amplify the angular velocity signals Vωx and Vωy at a predetermined gain α1 and to amplify the angular displacement signals Vθx and Vθy at a predetermined, gain β1 and to output them. On the other hand, if it is determined in step **815** that the vibration reduction on/off button **251** has been pressed, the process proceeds to step **816**, and in order to realize the vibration reduction mode different from the previously set mode (i.e. in order to realize the mode VR**2**, if the mode set in the latest step **816** is VR**1**,), the CPU **601** controls to amplify the angular velocity signals Vωx and Vωy at a predetermined gain α2 and to amplify the angular displacement signals Vθx and Vθy at a predetermined gain β2 and to output them. Thus, the actuators **131** and **132** rotationally drive the

rotation shafts **111***a* and **112***a* so as to realize vibration reduction mode VR1 or VR2.

[**0097**] As per the above, in the binocular having the image stabilization apparatus **100** according to this embodiment, it is possible to realize a mode with which vibration reduction mode is automatically switched in accordance with the level or degree of vibration of the binocular. Under this automatic mode, it is possible, by setting a sampling time Ts, to distinguish movement of the binocular caused unintentionally by the user from intentional panning/tilting operations or vibration caused by conveyance. In addition, even if there is a time lag between detection of the angular velocity of the gimbal mechanism and detection of the angular displacement of the gimbal mechanism, it is possible to determine the optimal vibration reduction mode.

[**0098**] In addition, when a vibration reduction mode is set by a user at his or her will, the apparatus can inform the user whether that mode is the optimal vibration reduction mode or not, based on the above-described determination of the optimal vibration reduction mode, to prompt the user to change the vibration reduction mode to the optimal mode. In this way, the user can notice whether or not the vibration reduction mode selected by him or her is appropriate, and even inexperienced user can appropriately select the mode. Therefore, it is possible to bring out the performance of the image stabilization apparatus fully.

[**0099**] In the apparatus according to the above-described embodiment, the optimal vibration reduction mode is determined based on whether the angular velocity signal or the angular displacement signal deviates from a reference range more than once within the sampling time Ts. However, the frequency criterion is not limited to "more than once", but it may also be "more than twice" or other desirable frequency.

[**0100**] In steps **804**, **808**, **811** and **816** in **FIG. 8**, the gains are varied in accordance with the vibration reduction mode in order to realize modes VR1 and Vr2. But the apparatus may be modified in such a way that the modes VR1 and VR2 are realized not only by varying the gains but by performing calculation or other processing that is predetermined for each mode.

[**0101**] Next, as a second embodiment, an apparatus in which a modification is made to the displayed mark that appears, in accordance with the informing process of steps **807** and **810**, in the display **201** within the field of view **200** in the apparatus according to the first embodiment is modified.

[**0102**] In the second embodiment, as shown in **FIG. 12, a** display within the field of view **200** includes a display **203** indicating an upward red triangle mark, a display **204** indicating a downward red triangle mark and a display **202** disposed between these displays indicating a green circular mark. These displays can be realized by LEDs or other devices. On the upper surface of a housing **1** of the binocular, as shown in **FIG. 11**, there is provided vibration reduction mode changing buttons **104***a* and **104***b* having the shapes corresponding to the shapes of the marks of the displays **203** and **204**. The button **104***a* is to be operated upon changing the vibration reduction mode to mode VR2 when the currently set mode is mode VR1, while the button **104***b* is to be operated upon changing the vibration reduction mode to mode VR1 when the currently set mode is mode VR2.

[**0103**] When in step **807** (in the process shown in the flow chart of **FIG. 8**) the currently set mode VR1 is not the optimal mode, the CPU **601** causes the upward triangle mark of the display within the field of view **203** to be turned on in red. If the user presses the changing button **104***a* of the same shape in response to the turned-on mark, the CPU **601** causes the circular mark of the display within the field of view **202** to be turned on in green, and the process proceeds to step **811**, in which the process for the vibration reduction mode VR2 (that is the mode set after the mode change) is performed. On the other hand, if the user does not press the changing button **104***a* of the same shape in step **807**, the process proceeds to step **808**, in which the process for the vibration reduction mode VR1 is continued without a mode change. Similarly, when in step **810** the currently set mode VR2 is not the optimal mode, the CPU **601** causes the downward triangle mark of the display within the field of view **204** to be turned on in red. If the user presses the changing button **104***b* of the same shape in response to the turned-on mark, the CPU **601** causes the circular mark of the display within the field of view **202** to be turned on in green, and the process proceeds to step **808**, in which the process for the vibration reduction mode VR1 (that is the mode set after the mode change) is performed. On the other hand, if the user does not press the changing button **104***b* of the same shape in step **810**, the process proceeds to step **811**, in which the process for the vibration reduction mode VR2 is continued without a mode change.

[**0104**] The binocular provided with the image stabilization apparatus according to the second embodiment having the above-described structure realizes an advantageous effect that the user can change the vibration reduction mode to select the optimal mode by operating the button **104***a* or **104***b* by a finger in accordance with a figure indicated in the display within the field of view during observation without detaching the eyes from the eyepiece lenses **13**R and **13**L.

[**0105**] In the process of providing information on the optimal mode determined in step **802**, the information may be provided by visual displays or sounds specific to the respective modes that are different from each other. It is preferable that the mode selected by user be indicated in the field of view to inform the user of the mode. When both the mode selected by the user and the optimal mode determined in step **802** are displayed, the user can conveniently recognize the difference between those modes at sight.

[**0106**] The displays within the field of view **203** and **204** may be composed of LEDs or other elements that can emit a color light selected from more than two color lights. In that case, the comparison of the angular velocity signal and the angular displacement signal with the reference ranges may be arranged in such a way that the degrees of deviations of those signals from the respective reference ranges are classified into two or more levels. Thus, in the process of informing the user in steps **807** and **810**, those levels (or degrees) of the deviation are represented by corresponding colors of light. For example, when the degree of the deviation is relatively low, the displays within the field of view **203** and **204** are caused to emit yellow light, while when the degree of the deviation is relatively high, the displays **203** and **204** are caused to emit red light. Thus, the user can make a decision on the vibration reduction mode in a customized way in accordance with his or her intention, for example, in such a way as to change the vibration reduction mode only

when the degree of the deviation is high. Therefore, it is possible to enlarge the variety of use for user of the binocular.

[0107] The apparatus according to the above-described embodiment has two vibration reduction modes (VR1, VR2), but the present invention is also applicable to more than two vibration reduction modes (VR1, VR2, VR3, . . . , VRn).

[0108] The apparatus according to the above-described embodiment is provided with a gimbaled member on which prisms are mounted, angular velocity feedback control means and position feedback control means for controlling the position of the gimbaled member. However, the present invention is also applicable to other types of optical elements.

[0109] For example, the present invention can be applied to an apparatus that uses a variable-angle prism for vibration reduction, which is composed of two glass plates and liquid having a high refractive index included between the glass plates in a sealed manner. (The variable-angle prism itself has been already known, and described for example in Japanese Patent Application Laid-Open Nos. 10-319325 and 2000-10143.) In that case, the present invention can be applied to an apparatus that has a variable-angle prism position detector that detects an inclination angle of one of the glass plates and a driving device such as a motor for driving that glass plate in a direction for correcting an inclination of the optical system based on the detection result.

[0110] The present invention can be applied to various apparatus in which an inclination of the optical axis of an observation optical system having an erecting prism or other element is detected and the inclination is corrected based on a detection result.

[0111] The apparatus according to the present invention may be provided with a mode selecting switch with which a user can select automatic mode switching and manual mode switching that allows the user to select desired mode. In this case, the user can select a desired mode at his or her will depending on circumstances and the user's operation skill.

[0112] As per the above, the present invention can provide an image stabilization apparatus having a good usability.

What is claimed is:

1. An image stabilization apparatus comprising:

a housing accommodating an optical system in the interior thereof;

holding means for holding a part of optical members that compose said optical system in such a way as to allow angular displacement of said part of the optical members relative to said housing, in order to maintain the position of said part of the optical members in a predetermined state;

driving means for angularly displacing said part of the optical members in the direction for restoring the position of said part of the optical members that have been angularly displaced by said holding member;

control means for controlling a driving amount of said driving means, said control means including detection means for detecting information on angular displacement of said part of the optical members caused by said holding means and determination means for determining, based on the information detected by said detection means, a mode for controlling said housing that is suitable for vibration applied to said housing; and

an informing section that informs a user of said control method determined by said determination means.

2. An image stabilization apparatus according to claim 1, wherein said angular displacement information comprises information on angular velocity of said holding means and/or information on angular displacement amount of said holding means.

3. An image stabilization apparatus according to claim 1, wherein the determination by said determination means is made based on a comparison of a predetermined reference value and said angular displacement information.

4. An image stabilization apparatus according to claim 3, wherein said reference value comprises a reference value for the angular velocity and/or a reference value for the angular displacement amount.

5. An image stabilization apparatus according to claim 3, wherein determination by said determination means is made based on a comparison of said reference value and said angular displacement information obtained within a predetermined sampling time, and based on the number of times said angular displacement information becomes larger than and/or smaller than said reference value.

6. An image stabilization apparatus according to claim 1, wherein the control mode determined by said determination means is selected for at least two vibration reduction modes.

7. An image stabilization apparatus according to claim 1, wherein the apparatus is so adapted that the user can select an automatic switching mode in which the control mode is automatically switched to the mode determined by said determination means based on the angular displacement information detected by said detection means or a user setting mode in which the user is allowed to select the control mode.

8. An image stabilization apparatus according to claim 1, wherein said informing section provides information on the control mode determined by said determination means.

9. An image stabilization apparatus according to claim 7, wherein when the selected mode is said user setting mode, said informing section provides information on whether the mode selected under said user setting mode and the mode determined by said determination means are different or identical.

10. An image stabilization apparatus according to claim 1, wherein the apparatus is so adapted that the user can select and set any mode based on the control mode of which the user is informed by said informing section.

11. An image stabilization apparatus according to claim 10, further comprising an observation optical system, wherein said informing section includes a display section disposed within a view field of said observation optical system;

the apparatus is provided with a mode selecting section for changing over the mode, the mode selecting section including a button for selecting any one of said modes and said display section displaying a mark which has a same shape as that of said button.

12. An image stabilization apparatus according to claim 1 further comprising first calculation means for performing calculation on a detection result of said detection means based on a first predetermined calculation method to determine said driving amount, second calculation means for performing calculation on a detection result of said detection means based on a second predetermined calculation method to determine said driving amount, and decision means for determining calculation means, from among said first and second calculation means, that is suitable for vibration applied to said housing.

13. An image stabilization apparatus according to claim 12, wherein said decision means makes said determination by comparing the detection result of said detection means with a predetermined reference value.

14. An image stabilization apparatus according to claim 12 further comprising an automatic mode switching means for causing said driving means to operate by said driving amount determined by the calculation means that is determined from among said first and second calculation means by said decision means.

15. An image stabilization apparatus according to claim 12, wherein when a displacement amount based on said information on angular displacement deviates from a predetermined range a predetermined number of times or more within a predetermined sampling time, said decision means determines that panning or tilting of said housing is occurring and selects calculation means that is suitable for the panning or tilting from among said first and second calculation means.

16. An image stabilization apparatus according to claim 12, wherein when said angular velocity deviates from said predetermined range said number of times or more than said number of times within said predetermined sampling time, said decision means determines that the user is on a conveyance so as to select calculation means that is suitable for vibration caused by said conveyance from among said first and second calculation means.

17. An image stabilizing apparatus according to claim 1 further comprising an observation optical system, wherein said informing section includes a display provided within a field of view of said observation optical system.

18. An image stabilization apparatus according to claim 1, wherein said informing section includes a sound generator with which said informing section provides information using a sound.

19. A binocular comprising:

a pair of eyepiece optical systems;

a pair of objective optical systems;

an intermediate optical system provided on an optical axis between said eyepiece optical systems and objective optical systems;

a housing accommodating said eyepiece optical systems, said objective optical systems and said intermediate optical system;

holding means for holding a part of optical members that compose said intermediate optical system in such a way as to allow angular displacement of said part of the optical members relative to said housing, in order to maintain the position of said part of the optical members in a predetermined state;

driving means for angularly displacing said part of the optical members in the direction for restoring the position of said part of the optical members that have been angularly displaced by said holding member;

control means for controlling a driving amount of said driving means, said control means including detection means for detecting information on angular displacement of said part of the optical members caused by said holding means and determination means for determining, based on the information detected by said detection means, a mode for controlling said housing that is suitable for vibration applied to said housing; and

an informing section that informs a user of said control method determined by said determination means.

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