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Imaging device and shake suppression method

Abstract

An imaging device that includes a shutter unit including a shutter adjusting an amount of subject light incident on an image sensor through an imaging optical system. The shutter unit being mounted on a frame. The at least three or more elastic members are disposed on an outer periphery of a contour of the shutter unit in a front view and press the shutter unit from the frame to support the shutter unit, each of the at least three or more elastic members is elastically deformed in a first direction that is a direction in which each of the at least three or more elastic members presses the shutter unit from the frame and a second direction that is a direction perpendicular to the first direction, and the first directions of the at least three or more elastic members intersect with each other at a specific spot inside the contour.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation application of International Application No. PCT/JP2021/030229, filed Aug. 18, 2021, the disclosure of which is incorporated herein by reference in its entirety. Further, this application claims priority under 35 USC 119 from Japanese Patent Application No. 2020-162677 filed Sep. 28, 2020, the disclosure of which is incorporated by reference herein.

BACKGROUND
1. Technical Field
(1) The present disclosure relates to an imaging device and a shake suppression method.
2. Related Art
(2) A shake correction camera disclosed in JP2011-107439A comprises an imaging optical system, an imaging element, a shake correction unit, an imaging controller, an imaging body part that includes a shutter button and a shutter spring, a frame that supports the imaging body part to allow the imaging body part to move rotationally, and a support spring that is held by the frame and supports the imaging body part.
(3) An imaging device disclosed in WO2020/021956A comprises an imaging element that is provided in a device body and comprises an imaging surface orthogonal to an optical axis of light forming an optical image, and a shutter unit that adjusts the amount of light incident on the imaging element. The shutter unit includes a support member and a shutter member that is provided in the device body. The shutter member is supported by the support member and is moved in a direction orthogonal to the optical axis together with the support member. The imaging device disclosed in WO2020/021956A further comprises a camera shake correction unit that is provided in a device body and moves an imaging element in a direction orthogonal to the optical axis to correct the amount of camera shake, and a plurality of elastic members that are disposed on at least one side and the other side of imaginary straight line passing through a centroid of the shutter unit and orthogonal to the optical axis as viewed in the direction of an optical axis and that is in contact with the device body and the support member.
SUMMARY
(4) An embodiment according to a technique of the present disclosure provides an imaging device and a shake suppression method that can achieve both the suppression of vibration caused by the operation of a shutter and the holding of the position of a shutter unit with high accuracy.
(5) An imaging device according to a first aspect of the technique of the present disclosure includes a shutter unit including a shutter adjusting an amount of subject light incident on an image sensor through an imaging optical system, and the shutter unit being mounted on a frame. The imaging device comprises at least three or more elastic members. The at least three or more elastic members are disposed on an outer periphery of a contour of the shutter unit in a front view and press the shutter unit from the frame to support the shutter unit, each of the at least three or more elastic members is elastically deformed in a first direction that is a direction in which each of the at least three or more elastic members presses the shutter unit from the frame and a second direction that is a direction perpendicular to the first direction, and the first directions of the at least three or more elastic members intersect with each other at a specific spot inside the contour.
(6) According to a second aspect of the technique of the present disclosure, in the imaging device according to a first aspect, the at least three or more elastic members are disposed at spots that form a polygon of which vertices correspond to respective positions of the at least three or more elastic members, and the specific spot is positioned inside the polygon.
(7) According to a third aspect of the technique of the present disclosure, in the imaging device according to the second aspect, an interval between adjacent vertices of the polygon is an interval

less than 180° in a circumferential direction around the specific spot in the front view.
(8) According to a fourth aspect of the technique of the present disclosure, the imaging device according to any one of the first to third aspects further comprises a shake correction mechanism that moves the image sensor in a plane perpendicular to an optical axis of the imaging optical system to correct a shake, and the shake correction mechanism is mounted on the frame.
(9) According to a fifth aspect of the technique of the present disclosure, in the imaging device according to any one of the first to fourth aspects, the imaging optical system is capable of being mounted on the frame, and the imaging optical system includes a vibration-proof lens that is moved in a plane perpendicular to an optical axis of the imaging optical system to correct a shake.
(10) According to a sixth aspect of the technique of the present disclosure, in the imaging device according to any one of the first to fifth aspects, elastic forces of the at least three or more elastic members in the first direction are larger than elastic forces of the at least three or more elastic members in the second direction.
(11) According to a seventh aspect of the technique of the present disclosure, in the imaging device according to any one of the first to sixth aspects, the shutter unit is supported from a side of the outer periphery by the at least three or more elastic members in a state where the shutter unit is oscillatable against elastic forces of the at least three or more elastic members.
(12) According to an eighth aspect of the technique of the present disclosure, in the imaging device according to any one of the first to seventh aspects, the specific spot is one spot inside the contour.
(13) According to a ninth aspect of the technique of the present disclosure, in the imaging device according to the eighth aspect, the one spot is a spot that coincides with a centroid of the shutter unit in the front view.
(14) According to a tenth aspect of the technique of the present disclosure, in the imaging device according to the eighth aspect, the one spot is a centroid of the shutter unit.
(15) According to an eleventh aspect of the technique of the present disclosure, in the imaging device according to any one of the first to tenth aspects, the first direction of at least one elastic member of the at least three or more elastic members coincides with a vertical direction in a case where the imaging device picks up an image in a standard posture.
(16) According to a twelfth aspect of the technique of the present disclosure, in the imaging device according to any one of the first to eleventh aspects, the at least three or more elastic members are disposed between the frame and the shutter unit on the outer periphery in a state where the at least three or more elastic members are compressed in the first direction in a case where a position of the shutter unit is a reference position, and an amount of elastic deformation of the at least three or more elastic members in a case where the position of the shutter unit is the reference position is equal to or larger than a movable distance of the shutter unit.
(17) According to a thirteenth aspect of the technique of the present disclosure, in the imaging device according to the twelfth aspect, a moving distance of the shutter unit in a vertical direction in a case where the imaging device picks up an image in a standard posture is equal to or less than the movable distance of the shutter unit.
(18) According to a fourteenth aspect of the technique of the present disclosure, in the imaging device according to any one of the first to thirteenth aspects, the shutter unit includes a rotating member, the rotating member is connected to the shutter and is rotated to open and close the shutter, a rotational force caused by rotation of the rotating member is applied to the shutter unit, so that the shutter unit oscillates in the second direction, and elastic forces of the at least three or more elastic members are set to elastic forces that allow an oscillation amplitude of the shutter unit in the second direction to be less than a maximum oscillation amplitude of the shutter unit in the second direction.
(19) According to a fifteenth aspect of the technique of the present disclosure, in the imaging device according to any one of the first to fourteenth aspects, the shutter is a focal plane shutter.
(20) According to a sixteenth aspect of the technique of the present disclosure, in the imaging

device according to any one of the first to fifteenth aspects, at least one of the at least three or more elastic members is a compression coil spring.
(21) According to a seventeenth aspect of the technique of the present disclosure, the imaging device according to any one of the first to sixteenth aspects further comprises a holding mechanism that holds positions of end portions of the elastic members.
(22) According to an eighteenth aspect of the technique of the present disclosure, in the imaging device according to the seventeenth aspect, the holding mechanism includes a first fastener and a first engaging member to be engaged with the first fastener, one of the first fastener and the first engaging member is provided on one of the frame and a first end portion of the elastic member, and the other of the first fastener and the first engaging member is provided on the other of the frame and the first end portion.
(23) According to a nineteenth aspect of the technique of the present disclosure, in the imaging device according to the seventeenth or eighteenth aspect, the holding mechanism includes a second fastener and a second engaging member to be engaged with the second fastener, one of the second fastener and the second engaging member is provided on one of the shutter unit and a second end portion of the elastic member, and the other of the second fastener and the second engaging member is provided on the other of the shutter unit and the second end portion.
(24) According to a twentieth aspect of the technique of the present disclosure, the imaging device according to any one of the first to nineteenth aspects further comprises a friction material that is interposed between the frame and the shutter unit and regulates misregistration between the frame and the shutter unit with a friction force.
(25) According to a twenty-first aspect of the technique of the present disclosure, in the imaging device according to any one of the first to twentieth aspects, the specific spot is a predetermined range inside the contour, and the predetermined range is a range in which damping performance equivalent to damping performance of the at least three or more elastic members against the shutter unit, in a case where the specific spot is a centroid, is exhibited by adjustment of a modulus of elasticity of at least one elastic member of the at least three or more elastic members.
(26) A shake suppression method according to a twenty-second aspect of the technique of the present disclosure is applied to an imaging device that includes a shutter unit including a shutter adjusting an amount of subject light incident on an image sensor through an imaging optical system, and at least three or more elastic members. The shutter unit being mounted on a frame. The shake suppression method comprises: disposing the at least three or more elastic members on an outer periphery of a contour of the shutter unit in a front view; causing the at least three or more elastic members to press the shutter unit from the frame to support the shutter unit; causing each of the at least three or more elastic members to be elastically deformed in a first direction that is a direction in which each of the at least three or more elastic members presses the shutter unit from the frame and a second direction that is a direction perpendicular to the first direction; and causing the first directions of the at least three or more elastic members to intersect with each other at a specific spot inside the contour.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Exemplary embodiments of the technology of the disclosure will be described in detail based on the following figures, wherein:
(2) FIG. **1** is a schematic front view showing an example of an appearance in a case where a camera body, a shutter unit, and an image sensor are viewed from a front side of a digital camera;
(3) FIG. **2** is a conceptual diagram showing an example of the hardware configuration of an optical system and an electrical system of the digital camera;

(4) FIG. **3** is a schematic perspective view showing an example of the back configuration of a front frame and a shutter unit;
(5) FIG. **4** is a schematic back view showing an example of the configuration of the shutter unit in a case where the shutter unit is viewed from the back side of the digital camera;
(6) FIG. **5** is a schematic bottom view showing an example of the configuration of the front frame and the shutter unit in a case where an aspect in which the shutter unit is mounted on the front frame is viewed from the bottom side of the digital camera;
(7) FIG. **6** is a schematic back view showing an example of the configuration of the front frame and the shutter unit in a case where an aspect in which the shutter unit is mounted on the front frame is viewed from the back side of the digital camera;
(8) FIG. **7** is a schematic bottom view showing an example of the configuration of the front frame and the shutter unit in a case where an aspect in which the shutter unit is pressed by a plurality of compression coil springs from the outer periphery of the shutter unit toward an intersection on an imaginary line passing through a centroid in a Z direction in a state where the shutter unit is mounted on the front frame is viewed from the bottom side of the digital camera;
(9) FIG. **8** is a conceptual diagram showing an example of an aspect in which the compression coil spring is elastically deformed in a second direction as the shutter unit is shaken in the second direction;
(10) FIG. **9** is a schematic back view showing an example of the configuration of the front frame and the shutter unit in a case where an aspect in which the shutter unit is pressed by four compression coil springs from the outer periphery of the shutter unit toward an intersection on an imaginary line passing through a centroid in a Z direction in a state where the shutter unit is mounted on the front frame is viewed from the back side of the digital camera;
(11) FIG. **10** is a schematic bottom view showing an example of the configuration of the front frame and the shutter unit in a case where an aspect in which the shutter unit is pressed by the plurality of compression coil springs from the outer periphery of the shutter unit toward a centroid in a state where the shutter unit is mounted on the front frame is viewed from the bottom side of the digital camera; and
(12) FIG. **11** is a schematic back view showing an example of the configuration of the front frame and the shutter unit in a case where an aspect in which the shutter unit is pressed by three compression coil springs from the outer periphery of the shutter unit toward a predetermined range, which includes a centroid, in a state where the shutter unit is mounted on the front frame is viewed from the back side of the digital camera.

DETAILED DESCRIPTION

(13) Examples of an imaging device and a shake suppression method according to a technique of the present disclosure will be described below with reference to the accompanying drawings.
(14) First, wording used in the following description will be described.
(15) CPU is an abbreviation for “Central Processing Unit”. RAM is an abbreviation for “Random Access Memory”. NVM is an abbreviation for “Non-Volatile Memory”. ASIC is an abbreviation for “Application Specific Integrated Circuit”. PLD is an abbreviation for “Programmable Logic Device”. FPGA is an abbreviation for “Field-Programmable Gate Array”. CMOS is an abbreviation for “Complementary Metal Oxide Semiconductor”. CCD is an abbreviation for “Charge Coupled Device”. OIS is an abbreviation for “Optical Image Stabilization”. BIS is an abbreviation for “Body Image Stabilization”. QCD is an abbreviation for “Quality Cost Delivery”.
(16) In the description of this specification, “vertical” refers to “vertical” in the sense of including an error that is generally allowed in the technical field to which the technique of the present disclosure belongs and that is not contrary to the gist of the technology of the present disclosure, in addition to perfect vertical. Further, in the description of this specification, “orthogonal” refers to “orthogonal” in the sense of including an error that is generally allowed in the technical field to which the technique of the present disclosure belongs and that is not contrary to the gist of the

technology of the present disclosure, in addition to perfect orthogonality. Furthermore, in the description of this specification, “parallel” refers to “parallel” in the sense of including an error that is generally allowed in the technical field to which the technique of the present disclosure belongs and that is not contrary to the gist of the technology of the present disclosure, in addition to perfect parallel. Moreover, in the description of this specification, “same” refers to “same” in the sense of including an error that is generally allowed in the technical field to which the technique of the present disclosure belongs and that is not contrary to the gist of the technology of the present disclosure, in addition to perfect same.
(17) For example, as shown in FIG. **1**, a digital camera **10** is an example of an “imaging device” according to the technique of the present disclosure. The digital camera **10** may be a consumer digital camera, may be an industrial digital camera, or may be a military digital camera. Specific examples of the digital camera **10** include a digital single-lens reflex camera, a digital compact camera, a digital camera mounted on a smart device (for example, a smartphone), a monitoring camera, and the like.
(18) The digital camera **10** comprises a camera body **12**. A lens mount **14** is provided on the front surface of the camera body **12**. The lens mount **14** includes an aperture **16**. The aperture **16** has a circular shape in a case where the digital camera **10** is viewed from the front side. An interchangeable imaging lens **18** (see FIG. **2**) is attachably and detachably mounted on the lens mount **14**.
(19) An image sensor **20** is mounted on the camera body **12**. The image sensor **20** is a CMOS image sensor. The image sensor **20** includes an imaging surface **20**A. The imaging surface **20**A is disposed at a spot facing the aperture **16**, and is exposed to the outside through the aperture **16**. Subject light indicating a subject is incident on the inside of the camera body **12** through the aperture **16**, and is received by the imaging surface **20**A. A plurality of photosensitive pixels are two-dimensionally arranged on the imaging surface **20**A. In an example shown in FIG. **1**, the imaging surface **20**A is formed in a rectangular shape as viewed from the front side of the digital camera **10**. The subject light forms an image on the imaging surface **20**A via the imaging lens **18**, so that an optical image **22** is formed.
(20) The CMOS image sensor **20** photoelectrically converts the subject light received by the imaging surface **20**A, and outputs electrical signals, which are obtained from photoelectric conversion, as image signals. An output destination of the image signals is, for example, a storage device, a display, and the like (not shown). The storage device holds the image signals, and the display displays an image (an image showing the subject) based on the image signals.
(21) In the example shown in FIG. **1**, the rectangular shape of the imaging surface **20**A viewed from the front side of the digital camera **10** is formed by two sides **20**A**1** that are opposite sides and two sides **20**A**2** that are opposite sides. The sides **20**Al are sides of the imaging surface **20**A in a longitudinal direction, and the sides **20**A**2** are sides of the imaging surface **20**A in a lateral direction. In the example shown in FIG. **1**, the image sensor **20** is provided in the camera body **12** such that the sides **20**Al are parallel to a horizontal plane and the sides **20**A**2** are parallel to a vertical plane. The posture of the digital camera **10** in a case where the sides **20**A**1** are parallel to the horizontal plane and the sides **20**A**2** are parallel to the vertical plane as described above will be also referred to as “standard posture” in the following description.
(22) Here, the definition of the standard posture is merely an example. For example, the posture of the digital camera **10** in a case where the sides **20**A**2** are parallel to the horizontal plane and the sides **20**A**1** are parallel to the vertical plane can also be defined as “standard posture”, and which posture of the digital camera **10** is to be a standard posture may be appropriately defined.
(23) Further, in the following description, for convenience of description, a direction parallel to the sides **20**Al will be referred to as an X direction, a direction parallel to the sides **20**A**2** will be referred to as a Y direction, and a depth direction of the camera body **12** viewed from the front, that is, a direction perpendicular to both the X direction and the Y direction will be referred to as an Z

direction.
(24) A shutter unit **24** is mounted on the camera body **12**. The shutter unit **24** is disposed between the lens mount **14** and the image sensor **20** in the Z direction. The shutter unit **24** includes an aperture **24**A. The aperture **24**A is formed at a spot facing the imaging surface **20**A as viewed in the Z direction. The aperture **24**A is formed to have a size fit for the imaging surface **20**A as viewed in the Z direction. An aperture formed in a rectangular shape larger than the outer contour of the imaging surface **20**A as viewed from in the Z direction is shown in the example shown in FIG. **1** as one example of the aperture **24**A.
(25) For example, as shown in FIG. **2**, the camera body **12** comprises an exterior frame **26**. A holding frame **28** is housed in the exterior frame **26**. The holding frame **28** is an example of a "frame" according to the technique of the present disclosure. The holding frame **28** is a frame holding various devices, and is fixed to the inner wall of the exterior frame **26**.
(26) The holding frame **28** includes the lens mount **14**. In an example shown in FIG. **2**, the imaging lens **18** is mounted on the lens mount **14**. The imaging lens **18** includes an imaging optical system **30**. The imaging optical system **30** includes a plurality of optical elements. Examples of the plurality of optical elements include a plurality of lenses and stops (not shown). In the example shown in FIG. **2**, an objective lens **30**A and a vibration-proof lens **30**B are shown as an example of the plurality of lenses. The objective lens **30**A and the vibration-proof lens **30**B are arranged from the subject toward the image sensor **20** along an optical axis OA in the order of the objective lens **30**A and the vibration-proof lens **30**B. Subject light is transmitted through the objective lens **30**A and the vibration-proof lens **30**B and forms an image on the imaging surface **20**A.
(27) Incidentally, in the digital camera **10**, a shake occurs due to vibration applied to the digital camera **10** (hereinafter, also simply referred to as vibration). In the present embodiment, "shake" refers to a phenomenon in which a subject image to be formed on the imaging surface **20**A is changed since the optical axis OA is tilted with respect to a reference axis due to vibration. For example, "reference axis" mentioned here refers to the optical axis OA in a state where vibration is not applied. Examples of the subject image include the optical image **22** (see FIG. **1**) and an electron image (not shown). The electron image is, for example, an electronic image based on image signals. The subject image is changed as a positional relationship between the optical axis OA and the imaging surface **20**A is changed.
(28) The digital camera **10** comprises an optical shake correction mechanism **32** to correct a shake. In the example shown in FIG. **2**, the optical shake correction mechanism **32** is mounted on the imaging lens **18**. The optical shake correction mechanism **32** comprises a vibration-proof lens **30**B, an actuator **34**, and the like, and moves the vibration-proof lens **30**B to optically correct a shake. In the present embodiment, "correcting a shake" includes not only the meaning of removing a shake but also the meaning of reducing a shake.
(29) In the present embodiment, OIS is employed as one of methods of correcting a shake using the optical shake correction mechanism **32**. OIS refers to a method of correcting a shake by moving the vibration-proof lens **30**B on the basis of vibration data obtained in a case where vibration is detected by a vibration sensor **38** (described later). Specifically, the vibration-proof lens **30**B is moved by the amount of shake to be canceled in a direction in which a shake is canceled in a plane perpendicular to the optical axis OA, that is, a plane defined by the X direction and the Y direction (hereinafter, also referred to as "XY plane"), so that the shake is corrected.
(30) The actuator **34** is mounted on the vibration-proof lens **30**B. The actuator **34** is a shift mechanism on which a coil motor is mounted, and moves the vibration-proof lens **30**B in a direction perpendicular to the optical axis of the vibration-proof lens **30**B in a case where the coil motor is driven. Here, the shift mechanism on which the coil motor is mounted is exemplified as the actuator **34**. However, the technique of the present disclosure is not limited thereto and another drive source, such as a stepping motor or a piezoelectric element, may be applied instead of the coil motor.

(31) The holding frame **28** houses the image sensor **20**, the shutter unit **24**, a control device **36**, a vibration sensor **38**, and a camera body-side shake correction mechanism **40**. Further, the image sensor **20**, the shutter unit **24**, the control device **36**, the vibration sensor **38**, and the camera body-side shake correction mechanism **40** are fixed to the holding frame **28**. Here, the camera body-side shake correction mechanism **40** is an example of a “shake correction mechanism” according to the technique of the present disclosure.
(32) The control device **36** controls the entire digital camera **10**. The control device **36** is implemented by a computer-based device that includes a CPU, a RAM, and a NVM. An aspect in which the control device **36** is implemented by a computer-based device is described here. However, the control device **36** is not limited to the technique of the present disclosure, and may be a device including ASIC, FPGA, and/or PLD or may be implemented by a combination of hardware configuration and software configuration.
(33) The control device **36** is connected to the image sensor **20**, and controls the operation of the image sensor **20** or acquires image signals from the image sensor **20**.
(34) The vibration sensor **38** is a device including a gyro sensor, and detects vibration applied to the digital camera **10**. Examples of the vibration applied to the digital camera **10** include vibration that is applied to the digital camera **10** by a user who is gripping the digital camera **10**, vibration that is applied to the digital camera **10** installed on a support table, such as a tripod, by wind, vibration that is applied from a vehicle, and the like. The control device **36** is connected to the vibration sensor **38** and acquires a detection result of the vibration sensor **38**.
(35) The shutter unit **24** adjusts the amount of subject light, which is incident through the imaging optical system **30**, by a focal plane shutter system. The shutter unit **24** comprises a shutter frame **42**, a front curtain **44**, a rear curtain **46**, and a drive unit **48**. The aperture **24**A is formed in the shutter frame **42**. The shutter frame **42** houses and holds the front curtain **44** and the rear curtain **46** that are an example of a “focal plane shutter” according to the technique of the present disclosure. Each of the front curtain **44** and the rear curtain **46** comprises a plurality of blades, and adjusts the amount of subject light incident through the imaging optical system **30** in a case where the plurality of blades are operated. The front curtain **44** is disposed closer to the subject than the rear curtain **46** in the shutter frame **42**.
(36) A state where the front curtain **44** and the rear curtain **46** are fully opened is shown in the example shown in FIG. **2**. In a fully open state, the plurality of blades of the front curtain **44** are housed in the shutter frame **42** to overlap with a lower edge portion of the shutter frame **42** and the plurality of blades of the rear curtain **46** are housed in the shutter frame **42** to overlap with an upper edge portion of the shutter frame **42**.
(37) The drive unit **48** comprises a drive source **82** (see FIGS. **3** to **5**) and a power transmission mechanism **84** (see FIGS. **3** to **5**). Examples of the drive source **82** include a solenoid. The drive source **82** is not limited to a solenoid, and may be a combination of a solenoid and a motor or another type of drive source, such as a motor. Further, examples of the power transmission mechanism **84** include a mechanism that includes a plurality of gears, a link mechanism, and the like. The power transmission mechanism **84** is a mechanism that transmits power generated by the drive source **82** to the front curtain **44** and the rear curtain **46**. The drive unit **48** is connected to the control device **36**. Specifically, the drive source **82** of the drive unit **48** is connected to the control device **36**, and the drive source **82** generates power under the control of the control device **36**.
(38) The front curtain **44** and the rear curtain **46** are mechanically connected to the drive unit **48**. The drive unit **48** generates power for a front curtain under the control of the control device **36**, and applies the generated power for a front curtain to the front curtain **44** to selectively pull up and down the front curtain **44**. Further, the drive unit **48** generates power for a rear curtain under the control of the control device **36**, and applies the generated power for a rear curtain to the rear curtain **46** to selectively pull up and down the rear curtain **46**.
(39) The camera body-side shake correction mechanism **40** is a mechanism that corrects a shake by

a BIS system. BIS refers to a method of correcting a shake by moving the vibration-proof lens **30**B on the basis of vibration data obtained in a case where vibration is detected by the vibration sensor **38**.

(40) The camera body-side shake correction mechanism **40** comprises an actuator **50** to realize the correction of a shake in the BIS system. The actuator **50** is provided in the image sensor **20** and is fixed to the holding frame **28**. The actuator **50** is connected to the control device **36**, and is operated under the control of the control device **36**. The actuator **50** is a shift mechanism on which a coil motor is mounted, and moves the image sensor **20** in a case where the coil motor is driven in accordance with an instruction given from the control device **36**. Specifically, the control device **36** acquires a detection result of the vibration sensor **38**, and controls the actuator **50** on the basis of the acquired result to move the image sensor **20** by the amount of shake to be canceled in a direction in which a shake is canceled in the XY plane.

(41) The control device **36** is also connected to the actuator **34** of the optical shake correction mechanism **32**. The actuator **34** is operated under the control of the control device **36**. That is, the actuator **34** moves the vibration-proof lens **30**B in a case where the coil motor is driven in accordance with an instruction given from the control device **36**. Specifically, the control device **36** acquires a detection result of the vibration sensor **38**, and controls the actuator **34** on the basis of the acquired result to move the vibration-proof lens **30**B by the amount of shake to be canceled in a direction in which a shake is canceled in the XY plane.

(42) The holding frame **28** is a frame that is formed of a combination of a plurality of frames. Examples of the plurality of frames include a front frame **52** (see FIG. **3**) and a back frame (not shown). The back frame is assembled to the front frame **52**, so that the holding frame **28** is formed.

(43) For example, as shown in FIG. **3**, the front frame **52** includes the lens mount **14** and the aperture **16** is formed in the lens mount **14**. A flat surface **54** parallel to the XY plane is formed on a back surface **53** of the front frame **52**. A side wall **56** is formed at an outer peripheral edge of the flat surface **54**. The side wall **56** extends to the back side of the digital camera **10** in the Z direction, and is formed integrally with the flat surface **54**. The side wall **56** is roughly classified into a lower wall **56**A and a left wall **56**B. The lower wall **56**A extends to the back side of the digital camera **10** in the Z direction from a lower edge portion of the outer peripheral edge of the flat surface **54** as viewed from the back side of the digital camera **10**. The left wall **56**B extends to the back side of the digital camera **10** in the Z direction from a left edge portion of the outer peripheral edge of the flat surface **54** as viewed from the back side of the digital camera **10**.

(44) Brackets **58**, **60**, and **62** are erected on the back surface **53**. The bracket **58** is formed in the shape of a thin plate, and is disposed at an upper left portion in a case where the flat surface **54** is viewed from the back side of the digital camera **10**. The bracket **58** stands perpendicular to the flat surface **54**. In other words, the bracket **58** extends from the flat surface **54** to the back side of the digital camera **10** in the Z direction. A wide surface **58**A among surfaces of the bracket **58** is a flat surface parallel to a plane defined by the Y direction and the Z direction (hereinafter, also referred to as “YZ plane”). The bracket **58** includes a notch **58**B. The notch **58**B is formed from the back side of the digital camera **10** to the middle portion of the bracket **58** to have a wide shape with steps.

(45) The bracket **60** is formed in the shape of a thin plate, and is disposed at a lower right portion in a case where the flat surface **54** is viewed from the back side of the digital camera **10**. The bracket **60** stands perpendicular to the flat surface **54**. In other words, the bracket **60** extends from the flat surface **54** to the back side of the digital camera **10** in the Z direction. A wide surface **60**A among surfaces of the bracket **60** is a flat surface parallel to a plane defined by the X direction and the Z direction (hereinafter, also referred to as “XZ plane”). The bracket **60** includes a notch **60**B. The notch **60**B is formed from the back side of the digital camera **10** to the middle portion of the bracket **60** to have a wide shape with steps.

(46) The bracket **62** is formed in the shape of a thin plate, and is disposed at an upper right portion

in a case where the back surface **53** of the front frame **52** is viewed from the back side of the digital camera **10**. The bracket **62** stands perpendicular to the flat surface **54**. In other words, the bracket **62** extends from the back surface **53** to the back side of the digital camera **10** in the Z direction. A wide surface **62**A among surfaces of the bracket **62** is a flat surface inclined downward from an upper right portion, which is determined in a case where the back surface **53** of the front frame **52** is viewed from the back side of the digital camera **10**, to the right side in a back view of the digital camera **10**. The bracket **62** includes a notch **62**B. The notch **62**B is formed from the back side of the digital camera **10** to the middle portion of the bracket **62** to have a wide shape with steps.

(47) Friction materials **64**, **66**, **68**, and **70** are erected on the flat surface **54**. The friction materials **64**, **66**, **68**, and **70** are interposed between the front frame **52** and the shutter unit **24**, and regulate misregistration between the front frame **52** and the shutter unit **24** with a friction force. Here, a columnar sponge is used as an example of each of the friction materials **64**, **66**, **68**, and **70**.

(48) The friction material **64** is disposed at an upper left portion in a case where the flat surface **54** is viewed from the back side of the digital camera **10**, and one end of the friction material **64** is fixed to the flat surface **54**. The friction material **66** is disposed at a lower left portion in a case where the flat surface **54** is viewed from the back side of the digital camera **10**, and one end of the friction material **66** is fixed to the flat surface **54**. The friction material **68** is disposed at a lower right portion in a case where the flat surface **54** is viewed from the back side of the digital camera **10**, and one end of the friction material **68** is fixed to the flat surface **54**. The friction material **70** is disposed at an upper right portion in a case where the flat surface **54** is viewed from the back side of the digital camera **10**, and one end of the friction material **70** is fixed to the flat surface **54**. The friction materials **64**, **66**, **68**, and **70** protrude from the flat surface **54** to the back side of the digital camera **10** in the Z direction. The height of each of the friction materials **64**, **66**, **68**, and **70** in the Z direction is a height that allow each of the friction materials **64**, **66**, **68**, and **70** to be in pressure contact with a front surface **41** of the shutter unit **24** (see FIG. **5**) in a case where the shutter unit **24** is fitted to the front frame **52**.

(49) A columnar sponge is exemplified as an example of each of the friction materials **64**, **66**, **68**, and **70**, but the technique of the present disclosure is not limited thereto. For example, the shape of at least one of the friction material **64**, **66**, **68**, or **70** may be another shape, such as a prismatic shape. Further, at least one of the friction material **64**, **66**, **68**, or **70** may be rubber or may be another material, and may be any material as long as the misregistration between the front frame **52** and the shutter unit **24** can be regulated with a friction force.

(50) Female screws **72**, **74**, **76**, and **78** are formed on the back surface **53** of the front frame **52**. The female screw **72** is disposed at an upper left portion of the back surface **53** in the back view of the digital camera **10**. The female screw **74** is disposed at a lower left portion of the back surface **53** in the back view of the digital camera **10**. The female screw **76** is disposed at a lower right portion of the back surface **53** in the back view of the digital camera **10**. The female screw **78** is disposed at an upper right portion of the back surface **53** in the back view of the digital camera **10**.

(51) A flat surface **80** parallel to the XY plane is formed on a back surface **79** of the shutter frame **42** of the shutter unit **24**. The drive unit **48** is mounted on the flat surface **80**. The drive unit **48** is disposed on the right side of the aperture **24**A in the back view of the digital camera **10**. The drive unit **48** includes a drive source **82** and a power transmission mechanism **84**. The power transmission mechanism **84** is disposed at a spot adjacent to the aperture **24**A on the right side of the aperture **24**A in the back view of the digital camera **10**. The drive source **82** is mechanically connected to the power transmission mechanism **84**, and power generated by the drive source **82** is transmitted to the power transmission mechanism **84**.

(52) Brackets **86**, **88**, and **90** are erected on the back surface **79**. The bracket **86** is formed in the shape of a thin plate, and is disposed at an upper left portion in a case where the back surface **79** is viewed from the back side of the digital camera **10**. The shape and size of the bracket **86** are the same as the shape and size of the bracket **58**. A wide surface **86**A among surfaces of the bracket **86**

is a flat surface parallel to the YZ plane. The bracket **86** includes a notch **86**B. The notch **86**B is formed from the back side of the digital camera **10** to the middle portion of the bracket **86** to have a wide shape with steps. The shape and size of the notch **86**B are the same as the shape and size of the notch **58**B of the bracket **58**.
(53) In a case where the shutter unit **24** is fitted to the front frame **52**, the bracket **58** is positioned outside the shutter unit **24**, the surface **58**A of the bracket **58** and the surface **86**A of the bracket **86** face each other in parallel to each other, and the orientation and position of the notch **86**B of the bracket **58** coincide with the orientation and position of the notch **86**B of the bracket **86**.
(54) The bracket **88** is formed in the shape of a thin plate, and is disposed at a lower right portion in a case where the back surface **79** is viewed from the back side of the digital camera **10**. The shape and size of the bracket **88** are the same as the shape and size of the bracket **60**. A wide surface **88**A among surfaces of the bracket **88** is a flat surface parallel to the XZ plane. The bracket **88** includes a notch **88**B. The notch **88**B is formed from the back side of the digital camera **10** to the middle portion of the bracket **88** to have a wide shape with steps. The shape and size of the notch **88**B are the same as the shape and size of the notch **60**B of the bracket **60**.
(55) In a case where the shutter unit **24** is fitted to the front frame **52**, the bracket **60** is positioned outside the shutter unit **24**, the surface **60**A of the bracket **60** and the surface **88**A of the bracket **88** face each other in parallel to each other, and the orientation and position of the notch **60**B of the bracket **60** coincide with the orientation and position of the notch **88**B of the bracket **88**.
(56) The bracket **90** is formed in the shape of a thin plate, and is disposed at an upper right portion in a case where the back surface **79** is viewed from the back side of the digital camera **10**. The shape and size of the bracket **90** are the same as the shape and size of the bracket **62**. A wide surface **90**A among surfaces of the bracket **90** is a flat surface inclined downward from an upper right portion, which is determined in a case where the back surface **79** is viewed from the back side of the digital camera **10**, to the right side in the back view of the digital camera **10**. The bracket **90** includes a notch **90**B. The notch **90**B is formed from the back side of the digital camera **10** to the middle portion of the bracket **90** to have a wide shape with steps. The shape and size of the notch **90**B are the same as the shape and size of the notch **62**B of the bracket **62**.
(57) In a case where the shutter unit **24** is fitted to the front frame **52**, the bracket **62** is positioned outside the shutter unit **24**, the surface **62**A of the bracket **62** and the surface **90**A of the bracket **90** face each other in parallel to each other, and the orientation and position of the notch **62**B of the bracket **62** coincide with the orientation and position of the notch **90**B of the bracket **90**.
(58) The shutter unit **24** includes through-holes **92**, **94**, **96**, and **98**. Each of the through-holes **92**, **94**, **96**, and **98** is formed in a rectangular shape with opposite sides parallel to the X direction and opposite sides parallel to the Y direction. The through-hole **92** is disposed at an upper left portion of the shutter unit **24** in a case where the shutter unit **24** is viewed from the back side of the digital camera **10**. Since the diameter of the through-hole **92** is larger than the diameter of the female screw **72**, the female screw **72** is exposed from the through-hole **92** in a case where the shutter unit **24** is fitted to the front frame **52**.
(59) The through-hole **94** is disposed at a lower left portion of the shutter unit **24** in a case where the shutter unit **24** is viewed from the back side of the digital camera **10**. Since the diameter of the through-hole **94** is larger than the diameter of the female screw **74**, the female screw **74** is exposed from the through-hole **94** in a case where the shutter unit **24** is fitted to the front frame **52**.
(60) The through-hole **96** is disposed at a lower right portion of the shutter unit **24** in a case where the shutter unit **24** is viewed from the back side of the digital camera **10**. Since the diameter of the through-hole **96** is larger than the diameter of the female screw **76**, the female screw **76** is exposed from the through-hole **96** in a case where the shutter unit **24** is fitted to the front frame **52**.
(61) The through-hole **98** is disposed at an upper right portion of the shutter unit **24** in a case where the shutter unit **24** is viewed from the back side of the digital camera **10**. Since the diameter of the through-hole **98** is larger than the diameter of the female screw **78**, the female screw **78** is exposed

from the through-hole **98** in a case where the shutter unit **24** is fitted to the front frame **52**.
(62) The shutter unit **24** is mounted on the front frame **52** using male screws **100**, **102**, **104**, and **106** to be capable of oscillating along the XY plane.
(63) The male screw **100** includes a head portion **100**A and a shaft portion **100**B. The head portion **100**A is formed in the shape of a disk and is larger than the through-hole **92**. That is, the size of the head portion **100**A is set to a size that allows the head portion **100**A to be in contact with a peripheral edge portion of the through-hole **92** in the Z direction. The shaft portion **100**B is formed in the shape of a column extending from the center of the head portion **100**A in one direction. The thickness of the shaft portion **100**B is set to a thickness that allows the shaft portion **100**B to oscillate in the through-hole **92** in a case where the shaft portion **100**B is inserted into the through-hole **92**, that is, a thickness that allows gaps to be formed between the shaft portion **100**B and a peripheral surface of the through-hole **92** in the X direction and the Y direction. A screw thread corresponding to the screw thread of the female screw **72** is formed at a distal end portion of the shaft portion **100**B.
(64) The male screw **102** includes a head portion **102**A and a shaft portion **102**B. The head portion **102**A is formed in the shape of a disk and is larger than the through-hole **94**. That is, the size of the head portion **102**A is set to a size that allows the head portion **102**A to be in contact with a peripheral edge portion of the through-hole **94** in the Z direction. The shaft portion **102**B is formed in the shape of a column extending from the center of the head portion **102**A in one direction. The thickness of the shaft portion **102**B is set to a thickness that allows the shaft portion **102**B to oscillate in the through-hole **94** in a case where the shaft portion **102**B is inserted into the through-hole **94**, that is, a thickness that allows gaps to be formed between the shaft portion **102**B and a peripheral surface of the through-hole **94** in the X direction and the Y direction. A screw thread corresponding to the screw thread of the female screw **74** is formed at a distal end portion of the shaft portion **102**B.
(65) The male screw **104** includes a head portion **104**A and a shaft portion **104**B. The head portion **104**A is formed in the shape of a disk and is larger than the through-hole **96**. That is, the size of the head portion **104**A is set to a size that allows the head portion **104**A to be in contact with a peripheral edge portion of the through-hole **96** in the Z direction. The shaft portion **104**B is formed in the shape of a column extending from the center of the head portion **104**A in one direction. The thickness of the shaft portion **104**B is set to a thickness that allows the shaft portion **104**B to oscillate in the through-hole **96** in a case where the shaft portion **104**B is inserted into the through-hole **96**, that is, a thickness that allows gaps to be formed between the shaft portion **104**B and a peripheral surface of the through-hole **96** in the X direction and the Y direction. A screw thread corresponding to the screw thread of the female screw **76** is formed at a distal end portion of the shaft portion **104**B.
(66) The male screw **106** includes a head portion **106**A and a shaft portion **106**B. The head portion **106**A is formed in the shape of a disk and is larger than the through-hole **98**. That is, the size of the head portion **106**A is set to a size that allows the head portion **106**A to be in contact with a peripheral edge portion of the through-hole **98** in the Z direction. The shaft portion **106**B is formed in the shape of a column extending from the center of the head portion **106**A in one direction. The thickness of the shaft portion **106**B is set to a thickness that allows the shaft portion **106**B to oscillate in the through-hole **98** in a case where the shaft portion **106**B is inserted into the through-hole **98**, that is, a thickness that allows gaps to be formed between the shaft portion **106**B and a peripheral surface of the through-hole **98** in the X direction and the Y direction. A screw thread corresponding to the screw thread of the female screw **78** is formed at a distal end portion of the shaft portion **106**B.
(67) In a state where the positions of the female screws **72**, **74**, **76**, and **78** are aligned with the positions of the through-holes **92**, **94**, **96**, and **98**, the shaft portion **100**B of the male screw **100** is inserted into the through-hole **92** of the shutter unit **24** fitted to the front frame **52**, the shaft portion

102B of the male screw **102** is inserted into the through-hole **94**, the shaft portion **104**B of the male screw **104** is inserted into the through-hole **96**, and the shaft portion **106**B of the male screw **106** is inserted into the through-hole **98**. Then, the distal end portion of the shaft portion **100**B of the male screw **100** is screwed into the female screw **72**. Further, the distal end portion of the shaft portion **102**B of the male screw **102** is screwed into the female screw **74**. Furthermore, the distal end portion of the shaft portion **104**B of the male screw **104** is screwed into the female screw **76**. Moreover, the distal end portion of the shaft portion **106**B of the male screw **106** is screwed into the female screw **78**.

(68) The digital camera **10** comprises spring units **108**A, **108**B, and **108**C. The spring units **108**A, **108**B, and **108**C have the same configuration. In a case where the spring units **108**A, **108**B, and **108**C do not need to be described while being distinguished from each other in the following description, the spring units **108**A, **108**B, and **108**C are referred to as "spring units **108**".

(69) The spring unit **108** includes a compression coil spring **110**, a first engaging member **112**, and a second engaging member **114**. The compression coil spring **110** is an example of an "elastic member" and "compression coil spring" according to the technique of the present disclosure. The first engaging member **112** is fixed to one end of the compression coil spring **110**, and the second engaging member **114** is fixed to the other end of the compression coil spring **110**. Here, one end of the compression coil spring **110** is an example of a "first end portion" according to the technique of the present disclosure, and the other end of the compression coil spring **110** is an example of a "second end portion" according to the technique of the present disclosure.

(70) The first engaging member **112** and the second engaging member **114** have the same shape and size. A curved dent **114**A is formed on a side peripheral surface of the second engaging member **114**. A dent (not shown) having the same shape and size as the dent **114**A is also formed on a side peripheral surface of the first engaging member **112**.

(71) The spring unit **108**A is used for the bracket **58** of the front frame **52** and the bracket **86** of the shutter unit **24**. That is, the dent of the first engaging member **112** is inserted into the notch **58**B of the bracket **58**, so that the first engaging member **112** of the spring unit **108**A is engaged with the bracket **58**. Further, the dent **114**A of the second engaging member **114** is inserted into the notch **86**B of the bracket **86**, so that the second engaging member **114** of the spring unit **108**A is engaged with the bracket **86**. Since the spring unit **108**A is used for the bracket **58** of the front frame **52** and the bracket **86** of the shutter unit **24** as described above, the positions of the end portions of the compression coil spring **110**A of the spring unit **108**A are held.

(72) The spring unit **108**B is used for the bracket **60** of the front frame **52** and the bracket **88** of the shutter unit **24**. That is, the dent of the first engaging member **112** is inserted into the notch **60**B of the bracket **60**, so that the first engaging member **112** of the spring unit **108**B is engaged with the bracket **60**. Further, the dent **114**A of the second engaging member **114** is inserted into the notch **88**B of the bracket **88**, so that the second engaging member **114** of the spring unit **108**B is engaged with the bracket **88**. Since the spring unit **108**B is used for the bracket **60** of the front frame **52** and the bracket **88** of the shutter unit **24** as described above, the positions of the end portions of the compression coil spring **110**B of the spring unit **108**B are held.

(73) The spring unit **108**C is used for the bracket **62** of the front frame **52** and the bracket **90** of the shutter unit **24**. That is, the dent of the first engaging member **112** is inserted into the notch **62**B of the bracket **62**, so that the first engaging member **112** of the spring unit **108**C is engaged with the bracket **62**. Further, the dent **114**A of the second engaging member **114** is inserted into the notch **90**B of the bracket **90**, so that the second engaging member **114** of the spring unit **108**C is engaged with the bracket **90**. Since the spring unit **108**C is used for the bracket **62** of the front frame **52** and the bracket **90** of the shutter unit **24** as described above, the positions of the end portions of the compression coil spring **110**C of the spring unit **108**C are held.

(74) The first engaging members **112**, the second engaging members **114**, the bracket **58**, the bracket **60**, the bracket **62**, the bracket **86**, the bracket **88**, and the bracket **90** are an example of a

"holding mechanism" according to the technique of the present disclosure. The first engaging member **112** is an example of a "first engaging member" according to the technique of the present disclosure. Each of the brackets **58**, **60**, and **62** is an example of a "first fastener" according to the technique of the present disclosure. The second engaging member **114** is an example of a "second engaging member" according to the technique of the present disclosure. Each of the brackets **86**, **88**, and **90** is an example of a "second fastener" according to the technique of the present disclosure.

(75) Further, an aspect in which the first engaging members **112** are applied to the spring units **108**A, **108**B, and **108**C and the brackets **58**, **60**, and **62** are applied to the front frame **52** has been described in the present embodiment, but the technique of the present disclosure is not limited thereto. For example, members corresponding to the first engaging members **112** may be applied to the front frame **52** instead of the brackets **58**, **60**, and **62**, and members corresponding to the brackets **58**, **60**, and **62** may be applied to the spring units **108**A, **108**B, and **108**C instead of the first engaging members **112**.

(76) Furthermore, an aspect in which the second engaging members **114** are applied to the spring units **108**A, **108**B, and **108**C and the brackets **86**, **88**, and **90** are applied to the shutter unit **24** has been described in the present embodiment, but the technique of the present disclosure is not limited thereto. For example, members corresponding to the second engaging members **114** may be applied to the shutter unit **24** instead of the brackets **86**, **88**, and **90**, and members corresponding to the brackets **86**, **88**, and **90** may be applied to the spring units **108**A, **108**B, and **108**C instead of the second engaging members **114**.

(77) For example, as shown in FIG. **4**, the power transmission mechanism **84** comprises a link member **116**, a connecting pin **118**, and a connecting pin **120**. Further, the power transmission mechanism **84** comprises a link member **122**, a connecting pin **124**, and a connecting pin **126**. The link members **116** and **122** are an example of a "rotating member" according to the technique of the present disclosure.

(78) One end portion of the link member **116** in a longitudinal direction is connected to one end portion of the front curtain **44** in the X direction by the connecting pin **118** of which an axial direction is parallel to the Z direction. The other end portion of the link member **116** in the longitudinal direction is connected to a mounting part **128** by the connecting pin **120** of which an axial direction is parallel to the Z direction.

(79) One end portion of the link member **122** in a longitudinal direction is connected to one end portion of the rear curtain **46** in the X direction by the connecting pin **124** of which an axial direction is parallel to the Z direction. The other end portion of the link member **122** in the longitudinal direction is connected to the mounting part **128** by the connecting pin **126** of which an axial direction is parallel to the Z direction.

(80) The rear curtain **46** is disposed above the front curtain **44** in the Y direction. The drive source **82** generates power under the control of the control device **36** (see FIG. **2**), and applies the generated power to the link members **116** and **122**. The link members **116** and **122** are rotated by the power applied from the drive source **82** to open and close the front curtain **44** and the rear curtain **46**.

(81) For example, as shown in FIG. **5**, the shaft portion **102**B of the male screw **102** is inserted into the through-hole **94** in the Z direction and the distal end portion of the shaft portion **102**B is screwed into the female screw **74** of the front frame **52**. The male screw **102** regulates the excessive misregistration of the shutter unit **24** from the front frame **52** in the Z direction. On the other hand, the male screw **102** gives a degree of freedom that allows the shutter unit **24** to be movable with respect to the front frame **52** in the X direction and the Y direction at a portion where the through-hole **94** is formed. In addition, the male screw **102** regulates the excessive movement of the shutter unit **24** by coming into contact with the peripheral edge portion of the through-hole **94** in a case where the shutter unit **24** is moved more than necessary in the X direction and the Y direction.

(82) The shaft portion **104**B of the male screw **104** is inserted into the through-hole **96** in the Z direction and the distal end portion of the shaft portion **104**B is screwed into the female screw **76** of the front frame **52**. The male screw **104** regulates the excessive misregistration of the shutter unit **24** from the front frame **52** in the Z direction. On the other hand, the male screw **104** gives a degree of freedom that allows the shutter unit **24** to be movable with respect to the front frame **52** in the X direction and the Y direction at a portion where the through-hole **96** is formed. In addition, the male screw **104** regulates the excessive movement of the shutter unit **24** by coming into contact with the peripheral edge portion of the through-hole **96** in a case where the shutter unit **24** is moved more than necessary in the X direction and the Y direction.
(83) The shaft portion **100**B of the male screw **100** is inserted into the through-hole **92** in the Z direction and the distal end portion of the shaft portion **100**B is screwed into the female screw **72** of the front frame **52**. The male screw **100** regulates the excessive misregistration of the shutter unit **24** from the front frame **52** in the Z direction. On the other hand, the male screw **100** gives a degree of freedom that allows the shutter unit **24** to be movable with respect to the front frame **52** in the X direction and the Y direction at a portion where the through-hole **92** is formed. In addition, the male screw **100** regulates the excessive movement of the shutter unit **24** by coming into contact with the peripheral edge portion of the through-hole **92** in a case where the shutter unit **24** is moved more than necessary in the X direction and the Y direction.
(84) The shaft portion **106**B of the male screw **106** is inserted into the through-hole **98** in the Z direction and the distal end portion of the shaft portion **106**B is screwed into the female screw **78** of the front frame **52**. The male screw **106** regulates the excessive misregistration of the shutter unit **24** from the front frame **52** in the Z direction. On the other hand, the male screw **106** gives a degree of freedom that allows the shutter unit **24** to be movable with respect to the front frame **52** in the X direction and the Y direction at a portion where the through-hole **98** is formed. In addition, the male screw **106** regulates the excessive movement of the shutter unit **24** by coming into contact with the peripheral edge portion of the through-hole **98** in a case where the shutter unit **24** is moved more than necessary in the X direction and the Y direction.
(85) In a case where the shutter unit **24** is mounted on the front frame **52** as described above using the male screws **100**, **102**, **104**, and **106** and the female screws **72**, **74**, **76**, and **78**, the friction materials **64**, **66**, **68**, and **70** interposed between the flat surface **54** and the front surface **41** are pressed against the flat surface **54** by the front surface **41**. In a case where the shutter unit **24** is moved in the XY plane in a state where the friction materials **64**, **66**, **68**, and **70** are in pressure contact with the front surface **41**, misregistration between the front frame **52** and the shutter unit **24** is suppressed by a friction force generated between the front surface **41** and the friction materials **64**, **66**, **68**, and **70**.
(86) For example, as shown in FIG. **6**, the shutter unit **24** has a centroid G (see also FIG. **7**). The centroid G is a point of application of a resultant force of gravitational forces that act on the respective portions of the shutter unit **24**. The centroid G is obtained as, for example, an intersection between the line of action of the tension of a thread in a case where one point of the shutter unit **24** is suspended with the thread and is stopped and the line of action of the tension of a thread in a case where another point of the shutter unit **24** is suspended with the thread and is stopped.
(87) The spring units **108**A, **108**B, and **108**C are inserted between the shutter unit **24** and the front frame **52** on the side surfaces of the shutter unit **24**. Accordingly, the elastic force of each of the compression coil spring **110** (hereinafter, also referred to as “compression coil spring **110**A”) of the spring unit **108**A, the compression coil spring **110** (hereinafter, also referred to as “compression coil spring **110**B”) of the spring unit **108**B, and the compression coil spring **110** (hereinafter, also referred to as “compression coil spring **110**C”) of the spring unit **108**B acts on the side surface of the shutter unit **24** from the front frame **52**.
(88) The compression coil springs **110**A, **110**B, and **110**C are disposed at spots that form a triangle

130 of which vertices correspond to the respective positions of the compression coil springs **110**A, **110**B, and **110**C. An interval between adjacent vertices of the triangle **130** is an interval less than 180° in a circumferential direction around a specific spot (an intersection P (described later) in an example shown in FIG. **6**) to be described later in a case where the shutter unit **24** is viewed in the Z direction. In the example shown in FIG. **6**, in the triangle **130**, an interval between the vertex corresponding to the position of the compression coil spring **110**A and the vertex corresponding to the position of the compression coil spring **110**B is 90°, an interval between the vertex corresponding to the position of the compression coil spring **110**B and the vertex corresponding to the position of the compression coil spring **110**C is 110°, and an interval between the vertex corresponding to the position of the compression coil spring **110**C and the vertex corresponding to the position of the compression coil spring **110**A is 160°.
(89) The compression coil springs **110**A, **110**B, and **110**C are disposed on the outer periphery of a contour **132** of the shutter unit **24** in a case where the shutter unit **24** is viewed in the Z direction, and press the shutter unit **24** from the front frame **52** to support the shutter unit **24**. That is, the shutter unit **24** is supported from the outer peripheral side of the shutter unit **24** by the compression coil springs **110**A, **110**B, and **110**C in a state where the shutter unit **24** can oscillate against the elastic forces of the compression coil springs **110**A, **110**B, and **110**C.
(90) Each of the compression coil springs **110**A, **110**B, and **110**C is elastically deformed in a first direction that is a direction in which each of the compression coil springs **110**A, **110**B, and **110**C presses the shutter unit **24** from the front frame **52** and a second direction that is a direction perpendicular to the first direction. For each of the compression coil springs **110**A, **110**B, and **110**C, the elastic force in the first direction is larger than the elastic force in the second direction. Further, the first direction of the compression coil spring **110**B coincides with a vertical direction, that is, the Y direction in a case where the digital camera **10** picks up an image in the standard posture. Furthermore, the first directions of the respective compression coil springs **110**A, **110**B, and **110**C intersect with each other at the specific spot inside the contour **132**. The specific spot is positioned inside the triangle **130**.
(91) Here, the specific spot refers to, for example, one spot inside the contour **132**. One spot inside the contour **132** refers to a spot that coincides with the centroid G in a case where the shutter unit **24** is viewed in the Z direction. In the example shown in FIGS. **6** and **7**, an intersection P between the XY plane in the shutter frame **42** in a case where the shutter unit **24** is viewed in the Z direction and an imaginary line **134**, which passes through the centroid G in the Z direction, is shown as an example of one spot inside the contour **132**.
(92) In the example shown in FIG. **6**, the shutter unit **24** is in a reference position. The reference position refers to the position of the shutter unit **24** in a state where the digital camera **10** is in the standard posture and vibration is not applied to the digital camera **10**. The compression coil springs **110**A, **110**B, and **110**C are disposed on the side surface of the shutter unit **24**, that is, between the front frame **52** and the shutter unit **24** on the outer periphery of the contour **132** in a state where the compression coil springs **110**A, **110**B, and **110**C are compressed in the first direction in a case where the shutter unit **24** is in the reference position. The amount of elastic deformation of the compression coil springs **110**A, **110**B, and **110**C in a case where the position of the shutter unit **24** is the reference position is equal to or larger than the movable distance of the shutter unit **24**. Examples of the amount of elastic deformation of the compression coil springs **110**A, **110**B, and **110**C in this case is one to two times the movable distance of the shutter unit **24**.
(93) Here, the movable distance of the shutter unit **24** corresponds to, for example, the movable distances of the shaft portions **100**B, **102**B, **104**B, and the **106**B relative to the shutter unit **24** in the through-holes **92**, **94**, **96**, and **98** (see FIGS. **3** and **5**).
(94) Further, the moving distance of the shutter unit **24** in the vertical direction, that is, the Y direction in a case where the digital camera **10** picks up an image in the standard posture is set to be equal to or less than the movable distance of the shutter unit **24**. That is, the elastic force of at least

the compression coil spring **110**B among the compression coil springs **110**A, **110**B, and **110**C is set such that the moving distance of the shutter unit **24** in the Y direction is equal to or less than the movable distance of the shutter unit **24**. Examples of the moving distance of the shutter unit **24** in the Y direction, which is mentioned here, include one-third or less of the movable distance of the shutter unit **24**.

(95) Incidentally, in a case where the link members **116** and **122** (see FIG. **4**) are rotated to open or close the front curtain **44** and the rear curtain **46**, rotational forces caused by the rotation of the link members **116** and **122** are applied to the shutter unit **24**. Accordingly, for example, the shutter unit **24** oscillates in the direction of an arc arrow shown in FIGS. **6** and **8** (for example, a direction in which the shutter unit **24** is rotated in the XY plane around the intersection P). That is, the shutter unit **24** is rotated about the centroid G in the direction of the arc arrow (see FIGS. **6** and **8**) by forces of inertia that are caused by the rotation of the link members **116** and **122** and/or impact forces that are caused by the collision of the front curtain **44** and the rear curtain **46** with the shutter frame **42** in a case where the front curtain **44** and the rear curtain **46** are opened or closed by the rotation of the link members **116** and **122**. Specifically, the shutter unit **24** oscillates in a direction tangential to the direction of the arc arrow (see FIGS. **6** and **8**), that is, the second direction.

(96) In a case where the shutter unit **24** oscillates in the second direction as described above, for example, the compression coil springs **110** are elastically deformed in a direction in which shear stress is applied, that is, the second direction as shown in FIG. **8**. The elastic force of the compression coil spring **110** is set to an elastic force that allows an oscillation amplitude by which the shutter unit **24** oscillates in the second direction to be less than the maximum oscillation amplitude of the shutter unit **24** in the second direction. For example, the elastic force of the compression coil spring **110** is determined such that the oscillation amplitude of the shutter unit **24** in the second direction is about a half of the maximum oscillation amplitude of the shutter unit **24** in the second direction.

(97) Next, the action obtained from the above-mentioned configuration will be described.

(98) For example, as shown in FIG. **6**, the shutter unit **24** is pressed from the front frame **52** toward the intersection P by each of the compression coil springs **110**A, **110**B, and **110**C disposed on the outer periphery of the contour **132**. The compression coil springs **110**A, **110**B, and **110**C press the shutter unit **24** from the front frame **52** toward the intersection P to support the shutter unit **24**. Further, in a case where the digital camera **10** picks up an image in the standard posture (see FIG. **1**), for example, the first direction of the compression coil spring **110**B coincides with the vertical direction, that is, Y direction as shown in FIG. **6**. For this reason, it is possible to easily hold the shutter unit **24** at the reference position in a case where the digital camera **10** picks up an image in the standard posture, as compared to a case where the vertical direction does not coincide with the first direction of none of the compression coil springs **110**A, **110**B, and **110**C.

(99) In a case where power generated by the drive source **82** is applied to the link members **116** and **122** (see FIG. **4**) in a state where the shutter unit **24** is supported by each of the compression coil springs **110**A, **110**B, and **110**C as described above, the link members **116** and **122** are rotated. Rotational forces caused by the rotation of the link members **116** and **122** are transmitted to the front curtain **44** and the rear curtain **46**. As a result, the front curtain **44** and the rear curtain **46** are opened and closed.

(100) In this case, the shutter unit **24** oscillates in the second direction due to the forces of inertia that are caused by the rotation of the link members **116** and **122** and/or the impact forces that are caused by the collision of the front curtain **44** and the rear curtain **46** with the shutter frame **42**.

(101) In this case, the elastic forces of the respective compression coil springs **110**A, **110**B, and **110**C in the second direction act on the shutter unit **24** against the oscillation of the shutter unit **24** in the second direction. That is, the compression coil springs **110**A, **110**B, and **110**C act on the shutter unit **24** in a direction in which the shutter unit **24** returns to the reference position. Further, even in a state where the shutter unit **24** oscillates in the second direction, the compression coil

springs **110**A, **110**B, and **110**C disposed on the outer periphery of the contour **132** press the shutter unit **24** from the front frame **52** to continue to support the shutter unit **24**. Therefore, according to this configuration, it is possible to achieve both the suppression of vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** and the holding of the position of the shutter unit **24** with high accuracy as compared to a case where the shutter unit **24** is supported from the front frame **52** by two or less elastic members.

(102) Furthermore, in the digital camera **10**, the shutter unit **24** is supported from the front frame **52** by the compression coil springs **110**A, **110**B, and **110**C in a state where the shutter unit **24** can oscillate against the elastic forces of the compression coil springs **110**A, **110**B, and **110**C. That is, in a case where the shutter unit **24** is directly supported by the front frame **52**, vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** is transmitted to the shutter unit **24**. However, since the shutter unit **24** is supported from the front frame **52** by the compression coil springs **110**A, **110**B, and **110**C, vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** is absorbed by the compression coil springs **110**A, **110**B, and **110**C. Therefore, according to this configuration, it possible to cause vibration, which is caused by the opening/closing operations of the front curtain **44** and the rear curtain **46**, to be less likely to be transmitted to the front frame **52** as compared to a case where the shutter unit **24** is directly supported by the front frame **52**.

(103) Incidentally, for example, as shown in FIG. **2**, the imaging lens **18** is mounted on the front frame **52** via the lens mount **14**. That is, the optical shake correction mechanism **32** (see FIG. **2**) is mounted on the front frame **52**. Further, the camera body-side shake correction mechanism **40** (see FIG. **2**) is held by the holding frame **28**. That is, the camera body-side shake correction mechanism **40** is mounted on the holding frame **28**.

(104) Accordingly, vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** is transmitted to the optical shake correction mechanism **32** and the camera body-side shake correction mechanism **40** via the holding frame **28**. In a case where vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** is transmitted to the optical shake correction mechanism **32** and the camera body-side shake correction mechanism **40**, the quality of a captured image, which is obtained in a case where the digital camera **10** picks up an image, is caused to deteriorate.

(105) However, the compression coil springs **110**A, **110**B, and **110**C are elastically deformed, so that vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** is absorbed. In particular, the compression coil springs **110**A, **110**B, and **110**C are elastically deformed in the second direction, so that vibration generated in the second direction due to the opening/closing operations of the front curtain **44** and the rear curtain **46** is absorbed. Therefore, according to this configuration, it is possible to suppress the deterioration of the quality of a captured image that is caused in a case where vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** is transmitted to the optical shake correction mechanism **32** and the camera body-side shake correction mechanism **40**.

(106) Further, in the digital camera **10**, the compression coil springs **110**A, **110**B, and **110**C press the shutter unit **24** from the outer peripheral side of the contour **132** toward one spot inside the contour **132** (see FIG. **6**) of the shutter unit **24**. Accordingly, pressing forces applied to the shutter unit **24** by the respective compression coil springs **110**A, **110**B, and **110**C, that is, pressing forces applied in the first direction concentrate on one spot inside the contour **132**. Therefore, according to this configuration, it is possible to easily hold the position of the shutter unit **24** at the reference position and to cause vibration, which is caused by the opening/closing operations of the front curtain **44** and the rear curtain **46**, to be easily absorbed by the compression coil springs **110**A, **110**B, and **110**C, as compared to a case where the compression coil springs **110**A, **110**B, and **110**C press the shutter unit **24** toward different spots that are present inside the contour **132** and different from each other.

(107) Here, one spot inside the contour **132** refers to the intersection P (see FIG. **6**). The intersection P is positioned on the imaginary line **134** (see FIG. **7**) that passes through the centroid G in the Z direction. Accordingly, pressing forces applied to the shutter unit **24** by the respective compression coil springs **110**A, **110**B, and **110**C, that is, pressing forces applied in the first direction concentrate on the intersection P inside the contour **132**. Therefore, according to this configuration, it is possible to easily hold the position of the shutter unit **24** at the reference position and to cause vibration, which is caused by the opening/closing operations of the front curtain **44** and the rear curtain **46**, to be easily absorbed by the compression coil springs **110**A, **110**B, and **110**C, as compared to a case where the compression coil springs **110**A, **110**B, and **110**C press the shutter unit **24** toward a point not positioned on the imaginary line **134**.
(108) Further, the compression coil springs **110**A, **110**B, and **110**C press the shutter unit **24** from the front frame **52** toward the intersection P in a state where the intersection P is positioned inside the triangle **130**. Therefore, according to this configuration, it is possible to easily hold the shutter unit **24** at the reference position and to easily absorb vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46**, as compared to a case where pressing forces are applied toward a spot outside the triangle **130** by the respective compression coil springs **110**A, **110**B, and **110**C to support the shutter unit **24**.
(109) Furthermore, in the triangle **130**, all of an interval between the vertex corresponding to the position of the compression coil spring **110**A and the vertex corresponding to the position of the compression coil spring **110**B, an interval between the vertex corresponding to the position of the compression coil spring **110**B and the vertex corresponding to the position of the compression coil spring **110**C, and an interval between the vertex corresponding to the position of the compression coil spring **110**C and the vertex corresponding to the position of the compression coil spring **110**A are set to be less than 180°. Therefore, according to this configuration, it is possible to easily hold the shutter unit **24** at the reference position and to easily absorb vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46**, as compared to a case where any of an interval between the vertex corresponding to the position of the compression coil spring **110**A and the vertex corresponding to the position of the compression coil spring **110**B, an interval between the vertex corresponding to the position of the compression coil spring **110**B and the vertex corresponding to the position of the compression coil spring **110**C, and an interval between the vertex corresponding to the position of the compression coil spring **110**C and the vertex corresponding to the position of the compression coil spring **110**A is set to an interval of 180° or more in the circumferential direction around the intersection P.
(110) Moreover, the elastic force of each of the compression coil springs **110**A, **110**B, and **110**C in the first direction is larger than the elastic force thereof in the second direction. In this case, the pressing forces that are applied by the compression coil springs **110**A, **110**B, and **110**C to support the shutter unit **24** from the front frame **52**, that is, the pressing forces in the first direction are large and the compression coil springs **110**A, **110**B, and **110**C are likely to be elastically deformed in the second direction, as compared to a case where the elastic force in the first direction is equal to or smaller than the elastic force in the second direction. Therefore, according to this configuration, it is possible to suppress the misregistration of the shutter unit **24** from the reference position that is caused by the weight of the shutter unit **24** and to increase ability to absorb the oscillation of the shutter unit **24** in the second direction, as compared to a case where the elastic force of the compression coil spring **110** in the first direction is smaller than the elastic force thereof in the second direction in a situation where the first direction of the compression coil spring **110** coincides with the vertical direction, that is, the Y direction.
(111) It is conceivable that a state where the shutter unit **24** is positioned at an end of a movable range (for example, a state where the shaft portion **100**B is in contact with the outer peripheral edge of the through-hole **92**) is made depending on the magnitude (amplitude) of vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** in a case where the front

curtain **44** and the rear curtain **46** are opened and closed. However, the compression coil springs **110**A, **110**B, and **110**C are disposed between the front frame **52** and the shutter unit **24** on the outer periphery of the contour **132** in a state where the compression coil springs **110**A, **110**B, and **110**C are compressed in the first direction in a case where the position of the shutter unit **24** is the reference position, and the amount of elastic deformation of the compression coil springs **110**A, **110**B, and **110**C in a case where the position of the shutter unit **24** is the reference position is set to be equal to or larger than the movable distance of the shutter unit **24**. Accordingly, even in a case where the shutter unit **24** is positioned at an end of the movable range, the elastic forces of the compression coil springs **110**A, **110**B, and **110**C can continue to act on the shutter unit **24**.
(112) It is conceivable that the shutter unit **24** reaches an end of the movable range since the shutter unit **24** is moved in the vertical direction, that is, the Y direction in a case where the digital camera **10** picks up an image in the standard posture. The fact that the shutter unit **24** reaches an end of the movable range means that, for example, the shaft portion **100**B is in contact with the outer peripheral edge of the through-hole **92**. In a case where the shaft portion **100**B powerfully collides with the outer peripheral edge of the through-hole **92**, vibration is generated. For this reason, the moving distance of the shutter unit **24** in the vertical direction, that is, the Y direction in a case where the digital camera **10** picks up an image in the standard posture is set to be equal to or less than the movable distance of the shutter unit **24**. Therefore, according to this configuration, it is possible to suppress since the shutter unit **24** is moved beyond the movable range (for example, the generation of vibration caused by the powerful collision of the shaft portion **100**B with the outer peripheral edge of the through-hole **92**), as compared to a case where the moving distance of the shutter unit **24** in the vertical direction in a case where the digital camera **10** picks up an image in the standard posture exceeds the movable distance of the shutter unit **24**.
(113) Further, rotational forces caused by the rotation of the link members **116** and **122** are applied to the shutter unit **24**, so that the shutter unit **24** oscillates in the second direction in the digital camera **10**. Accordingly, the elastic forces of the compression coil springs **110**A, **110**B, and **110**C are set to elastic forces that allow the oscillation amplitude of the shutter unit **24** in the second direction to be less than the maximum oscillation amplitude of the shutter unit **24** in the second direction. The oscillation amplitude of the shutter unit **24** in the second direction is suppressed to be less than the maximum oscillation amplitude by the elastic forces of the compression coil springs **110**A, **110**B, and **110**C. Therefore, according to this configuration, it is possible to suppress the oscillation of the shutter unit **24** in the second direction as compared to a case where the oscillation amplitude of the shutter unit **24** in the second direction is not limited.
(114) Furthermore, in the digital camera **10**, the compression coil springs **110**A, **110**B, and **110**C are disposed between the front frame **52** and the shutter unit **24** on the outer periphery of the shutter unit **24** in a case where the position of the shutter unit **24** is the reference position. Therefore, according to this configuration, it is possible to contribute to the improvement of QCD as compared to a case where an elastic member having a structure more complicated than that of the compression coil spring **110** or an elastic member having an elastic force smaller than that of the compression coil spring **110** is used.
(115) Moreover, in the digital camera **10**, the positions of the end portions of the compression coil springs **110**A, **110**B, and **110**C are held by the first engaging members **112**, the second engaging members **114**, the bracket **58**, the bracket **60**, the bracket **62**, the bracket **86**, the bracket **88**, and the bracket **90**. Therefore, according to this configuration, it is possible to suppress the misregistration of the compression coil springs **110**A, **110**B, and **110**C as compared to a case where the positions of the end portions of the compression coil springs **110**A, **110**B, and **110**C are not held.
(116) Further, the first engaging member **112** fixed to one end of the compression coil spring **110**A is engaged with the bracket **58** in the digital camera **10**. Furthermore, the first engaging member **112** fixed to one end of the compression coil spring **110**B is engaged with the bracket **60**. Moreover, the first engaging member **112** fixed to one end of the compression coil spring **110**C is

engaged with the bracket **62**. Therefore, according to this configuration, it is possible to easily perform work for holding one end of each of the compression coil springs **110**A, **110**B, and **110**C at an appropriate position on the front frame **52** as compared to a case where work for directly fixing one end of each of the compression coil springs **110**A, **110**B, and **110**C to an appropriate position on the front frame **52** is performed. Here, the appropriate position on the front frame **52** refers to, for example, a position corresponding to the position of each of the brackets **58**, **60**, and **62**.
(117) Further, in the digital camera **10**, the second engaging member **114** fixed to the other end of the compression coil spring **110**A is engaged with the bracket **86**. Furthermore, the second engaging member **114** fixed to the other end of the compression coil spring **110**B is engaged with the bracket **88**. Moreover, the second engaging member **114** fixed to the other end of the compression coil spring **110**C is engaged with the bracket **90**. Therefore, according to this configuration, it is possible to easily perform work for holding the other end of each of the compression coil springs **110**A, **110**B, and **110**C at an appropriate position on the shutter unit **24** as compared to a case where work for directly fixing the other end of each of the compression coil springs **110**A, **110**B, and **110**C to an appropriate position on the shutter unit **24** is performed. Here, the appropriate position on the shutter unit **24** refers to, for example, a position corresponding to the position of each of the brackets **86**, **88**, and **90**.
(118) Further, in the digital camera **10**, the friction materials **64**, **66**, **68**, and **70** are interposed between the front surface **41** of the shutter unit **24** and the flat surface **54** of the front frame **52**, and the friction materials **64**, **66**, **68**, and **70** erected on the front frame **52** are in pressure contact with the front surface **41** (see FIG. **5**). Accordingly, in a case where the shutter unit **24** is moved in the X direction and the Y direction, a friction force is generated between the front surface **41** and the friction materials **64**, **66**, **68**, and **70**. The movement of the shutter unit **24** in the X direction and the Y direction is regulated by the friction force that is generated between the front surface **41** and the friction materials **64**, **66**, **68**, and **70** in a case where the shutter unit **24** is moved in the X direction and the Y direction. Therefore, according to this configuration, it is possible to cause the oscillation of the shutter unit **24** in the second direction to be rapidly converge as compared to a case where a mere space is formed between the front surface **41** of the shutter unit **24** and the flat surface **54** of the front frame **52**. Further, it is possible to suppress the tilt of the shutter unit **24** toward the front frame **52** as compared to a case where a mere space is formed between the front surface **41** of the shutter unit **24** and the flat surface **54** of the front frame **52**.
(119) An aspect in which the friction materials **64**, **66**, **68**, and **70** are interposed between the front surface **41** of the shutter unit **24** and the flat surface **54** of the front frame **52** has been described here, but is merely an example. At least one friction material having the same function as the friction materials **64**, **66**, **68**, and **70** may be interposed between an inner wall of the front frame **52** and an outer wall of the shutter unit **24**.
(120) Further, a shake suppression method applied to the digital camera **10** includes: disposing the compression coil springs **110**A, **110**B, and **110**C on the outer periphery of the contour **132** of the shutter unit **24**; causing the compression coil springs **110**A, **110**B, and **110**C to press the shutter unit **24** from the front frame **52** to support the shutter unit **24**; causing each of the compression coil springs **110**A, **110**B, and **110**C to be elastically deformed in the first direction that is a direction in which each of the compression coil springs **110**A, **110**B, and **110**C presses the shutter unit **24** from the front frame **52** and the second direction that is a direction perpendicular to the first direction; and causing the first directions of the respective compression coil springs **110**A, **110**B, and **110**C to intersect with each other at a specific spot (for example, the intersection P) inside the contour **132** of the shutter unit **24**. Therefore, according to this configuration, it is possible to achieve both the suppression of vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** and the holding of the position of the shutter unit **24** with high accuracy as compared to a case where the shutter unit **24** is supported from the front frame **52** by two or less elastic members.

(121) An aspect in which the compression coil spring **110** is disposed at each of the vertices of the triangle **130** has been described in the above-mentioned embodiment, but the technique of the present disclosure is not limited thereto. The compression coil springs may be disposed at vertices of a polygon (for example, a quadrangle, a pentagon, a hexagon, or the like) other than the triangle **130**. In an example shown in FIG. **9**, the compression coil spring **110** is disposed at each of the vertices of a quadrangle **136**. The example shown in FIG. **9** is different from the example shown in FIG. **6** in that spring units **108**D and **108**E are applied instead of the spring unit **108**C. The spring units **108**D and **108**E have the same configuration as the spring unit **108** described in the above-mentioned embodiment.
(122) The spring unit **108**D is disposed at a spot facing the spring unit **108**A with the shutter unit **24** interposed therebetween on the outer periphery of the contour **132** of the shutter unit **24** in a case where the shutter unit **24** is viewed in the Z direction. The spring unit **108**E is disposed at a spot facing the spring unit **108**B with the shutter unit **24** interposed therebetween on the outer periphery of the contour **132** of the shutter unit **24** in a case where the shutter unit **24** is viewed in the Z direction.
(123) The spring unit **108**D includes a compression coil spring **110**D and the spring unit **108**E includes a compression coil spring **110**E. The respective positions of the compression coil springs **110**A, **110**B, **110**D, and **110**E correspond to the positions of the respective vertices of the quadrangle **136**. The intersection P is positioned inside the quadrangle **136**. An interval between the adjacent vertices of the quadrangle **136** is an interval of 90° in a circumferential direction around the intersection P in a case where the shutter unit **24** is viewed in the Z direction. The compression coil springs **110**D and **110**E press the shutter unit **24** from the front frame **52** toward the intersection P to support the shutter unit **24**. For example, even in a case where the compression coil springs **110**A, **110**B, **110**D, and **110**E are disposed as shown in FIG. **9**, the same effect as the above-mentioned embodiment can be obtained.
(124) An aspect in which the elastic forces of the compression coil springs **110**A, **110**B, and **110**C are applied toward the intersection P has been described in the above-mentioned embodiment, but the technique of the present disclosure is not limited thereto. For example, the elastic forces of the compression coil springs **110**A, **110**B, and **110**C may be applied toward the centroid G. In this case, for example, as shown in FIG. **10**, the positions of the compression coil springs **110**A, **110**B (not shown in an example shown in FIG. **10**), and **110**C in the Z direction coincide with each other and the compression coil springs **110**A, **110**B, and **110**C are disposed at spots where one end portion of each of the compression coil springs **110**A, **110**B, and **110**C faces the centroid G. That is, the compression coil springs **110**A, **110**B, and **110**C are disposed such that the respective first directions of the compression coil springs **110**A, **110**B, and **110**C intersect with each other at the centroid G.
(125) In the example shown in FIG. **10**, the front frame **52** includes extension frames **138** and **140**. Further, the shutter unit **24** includes flat plate-like standing plate portions **142** and **144**. The extension frame **138** is a frame that extends in the Z direction from a portion of the front frame **52** with which the spring unit **108**C is in contact. The standing plate portion **142** is a flat plate-like portion that extends in the Z direction from a portion of the shutter unit **24** with which the spring unit **108**C is in contact. The compression coil spring **110**C is disposed to be compressed between the extension frame **138** and the standing plate portion **142** such that an elastic force is applied toward the centroid G.
(126) The extension frame **140** is a frame that extends in the Z direction from a portion of the front frame **52** with which the spring unit **108**A is in contact. The standing plate portion **144** is a flat plate-like portion that extends in the Z direction from a portion of the shutter unit **24** with which the spring unit **108**A is in contact. The compression coil spring **110**A is disposed to be compressed between the extension frame **140** and the standing plate portion **144** such that an elastic force is applied toward the centroid G. Although not shown, an extension frame and a standing plate

portion having the same configuration as the extension frame **138** (**140**) and the standing plate portion **142** (**144**) are also used for the spring unit **108**B for the same purpose.
(127) Therefore, according to this configuration, it is possible to easily hold the position of the shutter unit **24** at the reference position and to easily absorb vibration caused by the opening/closing operations of the front curtain **44** and the rear curtain **46** (particularly, the oscillation of the shutter unit **24** in the second direction), as compared to a case where the respective first directions of the compression coil springs **110**A, **110**B, and **110**C do not intersect with each other at the centroid G.
(128) Further, one point called the intersection P has been exemplified in the above-mentioned embodiment, but the technique of the present disclosure is not limited thereto. For example, one point may be a specific spot that is not a point and has an area (hereinafter, also simply referred to as “a specific spot having an area”). As long as the specific spot having an area may be, for example, one spot inside the triangle **130**, the specific spot having an area may be a three-dimensional region including the intersection P (for example, a region including the intersection P in an XYZ space) or a two-dimensional region (for example, a region including the intersection P in the XY plane) or may be, for example, a three-dimensional region including the centroid G (for example, a region including the centroid G in the XYZ space) or a two-dimensional region (for example, a region including the centroid G in the XY plane).
(129) Further, the specific spot having an area is a predetermined range **146** inside the contour **132** of the shutter unit **24**. The range **146** is one spot positioned inside the triangle **130**.
(130) Incidentally, there is a possibility that it is necessary to shift the positions of the spring units **108**A, **108**B, and **108**C for a reason such as a change in the specifications of the digital camera **10**. In such a case, the modulus of elasticity of at least one of the compression coil spring **110**A, **110**B, or **110**C is adjusted. Further, the range **146** may be set to a range in which damping performance equivalent to the damping performance of the compression coil springs **110**A, **110**B, and **110**C against the shutter unit **24**, in a case where the compression coil springs **110**A, **110**B, and **110**C are disposed such that the respective first directions intersect with each other at the intersection P or the centroid G (see FIGS. **6**, **7**, and **10**), is exhibited.
(131) Therefore, according to this configuration (an example shown in FIG. **11**), as compared to a case where the arrangement of the compression coil springs **110**A, **110**B, and **110**C is changed without the adjustment of a modulus of elasticity, it is possible to realize damping performance equivalent to the damping performance of the compression coil springs **110**A, **110**B, and **110**C against the shutter unit **24** in a case where the compression coil springs **110**A, **110**B, and **110**C are disposed such that the respective first directions intersect with each other at the intersection P or the centroid G and to improve the degree of freedom in the layout of components in the digital camera **10**, even though the arrangement of at least one of the compression coil spring **110**A, **110**B, or **110**C is changed.
(132) Further, sponge has been exemplified as the friction materials **64**, **66**, **68**, and **70** in the above-mentioned embodiment, but the technique of the present disclosure is not limited thereto. For example, a member made of a resin having elasticity and viscosity may be used together with a member made of sponge or instead of a member made of sponge. Examples of the member made of a resin include a member made of silicone rubber, a urethane rubber member, and the like. Furthermore, the number of friction materials is not limited. Moreover, the surface, which is in contact with the front surface **41** of the shutter unit **24**, of at least one of the friction material **64**, **66**, **68**, or **70** may be made of a material having a friction coefficient higher than the friction coefficient of sponge.
(133) Moreover, the compression coil spring **110** has been exemplified in the above-mentioned embodiment, but the technique of the present disclosure is not limited thereto. A spring other than the compression coil spring **110** may be applied together with the compression coil spring **110** or instead of the compression coil spring, a member made of rubber may be applied, or an elastic

member having at least elasticity of elasticity and viscosity may be applied.
(134) The description contents and shown contents having been described above are the detailed description of portions according to the technique of the present disclosure, and are merely an example of the technique of the present disclosure. For example, the description of the configuration, functions, actions, and effects having been described above is the description of examples of the configuration, functions, actions, and effects of the portions according to the technique of the present disclosure. Accordingly, it goes without saying that unnecessary portions may be deleted or new elements may be added or replaced in the description contents and shown contents described above without departing from the scope of the technique of the present disclosure. Further, the description of common technical knowledge and the like, which allow the technique of the present disclosure to be embodied and do not need to be particularly described, is omitted in the description contents and shown contents, which have been described above, to avoid complication and to facilitate the understanding of portions according to the technique of the present disclosure.
(135) In this specification, “A and/or B” is synonymous with “at least one of A or B”. That is, “A and/or B” may mean only A, may mean only B, or may mean a combination of A and B. Further, in this specification, the same meaning as “A and/or B” is applied even in a case where three or more items are expressed to be connected using “and/or”.
(136) All documents, patent applications, and technical standards disclosed in this specification are incorporated in this specification by reference such that the incorporation of each of the documents, the patent applications, and the technical standards by reference is specific and is as detailed as that in a case where the documents, the patent applications, and the technical standards are described individually.

Claims

1. An imaging device that includes a shutter unit including a shutter adjusting an amount of subject light incident on an image sensor through an imaging optical system, the shutter unit being mounted on a frame, the imaging device comprising: at least three or more elastic members, wherein the at least three or more elastic members are disposed on an outer periphery of a contour of the shutter unit in a front view and press the shutter unit from the frame to support the shutter unit, each of the at least three or more elastic members is elastically deformed in a first direction that is a direction in which each of the at least three or more elastic members presses the shutter unit from the frame and a second direction that is a direction perpendicular to the first direction, the first directions of the at least three or more elastic members intersect with each other at a specific spot inside the contour, the specific spot is one spot inside the contour, and the one spot is a spot that coincides with a centroid of the shutter unit in the front view, or is a centroid of the shutter unit.
2. The imaging device according to claim 1, wherein the at least three or more elastic members are disposed at spots that form a polygon of which vertices correspond to respective positions of the at least three or more elastic members, and the specific spot is positioned inside the polygon.
3. The imaging device according to claim 2, wherein an interval between adjacent vertices of the polygon is an interval less than 180° in a circumferential direction around the specific spot in the front view.
4. The imaging device according to claim 1, further comprising: a shake correction mechanism that moves the image sensor in a plane perpendicular to an optical axis of the imaging optical system to correct a shake, wherein the shake correction mechanism is mounted on the frame.
5. The imaging device according to claim 1, wherein the imaging optical system is capable of being mounted on the frame, and the imaging optical system includes a vibration-proof lens that is moved in a plane perpendicular to an optical axis of the imaging optical system to correct a shake.

6. The imaging device according to claim 1, wherein elastic forces of the at least three or more elastic members in the first direction are larger than elastic forces of the at least three or more elastic members in the second direction.
7. The imaging device according to claim 1, wherein the shutter unit is supported from a side of the outer periphery by the at least three or more elastic members in a state where the shutter unit is oscillatable against elastic forces of the at least three or more elastic members.
8. The imaging device according to claim 1, wherein the first direction of at least one elastic member of the at least three or more elastic members coincides with a vertical direction in a case where the imaging device picks up an image in a standard posture.
9. An imaging device that includes a shutter unit including a shutter adjusting an amount of subject light incident on an image sensor through an imaging optical system, the shutter unit being mounted on a frame, the imaging device comprising: at least three or more elastic members, wherein the at least three or more elastic members are disposed on an outer periphery of a contour of the shutter unit in a front view and press the shutter unit from the frame to support the shutter unit, each of the at least three or more elastic members is elastically deformed in a first direction that is a direction in which each of the at least three or more elastic members presses the shutter unit from the frame and a second direction that is a direction perpendicular to the first direction, the first directions of the at least three or more elastic members intersect with each other at a specific spot inside the contour, the at least three or more elastic members are disposed between the frame and the shutter unit on the outer periphery in a state where the at least three or more elastic members are compressed in the first direction in a case where a position of the shutter unit is a reference position, and an amount of elastic deformation of the at least three or more elastic members in a case where the position of the shutter unit is the reference position is equal to or larger than a movable distance of the shutter unit.
10. The imaging device according to claim 9, wherein a moving distance of the shutter unit in a vertical direction in a case where the imaging device picks up an image in a standard posture is equal to or less than the movable distance of the shutter unit.
11. The imaging device according to claim 1, wherein the shutter unit includes a rotating member, the rotating member is connected to the shutter and is rotated to open and close the shutter, a rotational force caused by rotation of the rotating member is applied to the shutter unit, so that the shutter unit oscillates in the second direction, and elastic forces of the at least three or more elastic members are set to elastic forces that allow an oscillation amplitude of the shutter unit in the second direction to be less than a maximum oscillation amplitude of the shutter unit in the second direction.
12. The imaging device according to claim 1, wherein the shutter is a focal plane shutter.
13. The imaging device according to claim 1, wherein at least one of the at least three or more elastic members is a compression coil spring.
14. The imaging device according to claim 1, further comprising: a holding mechanism that holds positions of end portions of the elastic members.
15. The imaging device according to claim 14, wherein the holding mechanism includes a first fastener and a first engaging member to be engaged with the first fastener, one of the first fastener and the first engaging member is provided on one of the frame and a first end portion of the elastic member, and the other of the first fastener and the first engaging member is provided on the other of the frame and the first end portion.
16. The imaging device according to claim 14, wherein the holding mechanism includes a second fastener and a second engaging member to be engaged with the second fastener, one of the second fastener and the second engaging member is provided on one of the shutter unit and a second end portion of the elastic member, and the other of the second fastener and the second engaging member is provided on the other of the shutter unit and the second end portion.
17. The imaging device according to claim 1, further comprising: a friction material that is

interposed between the frame and the shutter unit and regulates misregistration between the frame and the shutter unit with a friction force.

18. An imaging device that includes a shutter unit including a shutter adjusting an amount of subject light incident on an image sensor through an imaging optical system, the shutter unit being mounted on a frame, the imaging device comprising: at least three or more elastic members, wherein the at least three or more elastic members are disposed on an outer periphery of a contour of the shutter unit in a front view and press the shutter unit from the frame to support the shutter unit, each of the at least three or more elastic members is elastically deformed in a first direction that is a direction in which each of the at least three or more elastic members presses the shutter unit from the frame and a second direction that is a direction perpendicular to the first direction, the first directions of the at least three or more elastic members intersect with each other at a specific spot inside the contour, the specific spot is a predetermined range inside the contour, and the predetermined range is a range in which damping performance equivalent to damping performance of the at least three or more elastic members against the shutter unit, in a case where the specific spot is a centroid, is exhibited by adjustment of a modulus of elasticity of at least one elastic member of the at least three or more elastic members.

19. A shake suppression method applied to an imaging device that includes a shutter unit including a shutter adjusting an amount of subject light incident on an image sensor through an imaging optical system, and at least three or more elastic members, the shutter unit being mounted on a frame, the shake suppression method comprising: disposing the at least three or more elastic members on an outer periphery of a contour of the shutter unit in a front view; causing the at least three or more elastic members to press the shutter unit from the frame to support the shutter unit; causing each of the at least three or more elastic members to be elastically deformed in a first direction that is a direction in which each of the at least three or more elastic members presses the shutter unit from the frame and a second direction that is a direction perpendicular to the first direction; causing the first directions of the at least three or more elastic members to intersect with each other at a specific spot inside the contour, wherein the specific spot is one spot inside the contour, and the one spot is a spot that coincides with a centroid of the shutter unit in the front view, or is a centroid of the shutter unit.