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(71) Applicant *(for all designated States except US)*: **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FI-02150 Espoo (FI).

(71) Applicant *(for LC only)*: **NOKIA INC.** [US/US]; 6000 Connection Drive, Irving, TX 75039 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ROUVINEN, Jarkko** [FI/FI]; Ohrakaskensyrjä 10 E 10, FI-02340 Espoo (FI). **KAUHANEN, Petteri** [FI/FI]; Lahnatie 14 D 7, FI-02170 Espoo (FI).

(74) Agents: **MAGUIRE, Francis, J.** et al.; Ware, Fressola, Van Der Sluys & Adolphson LLP, 755 Main Street, P.o. Box 224, Monroe, CT 06468 (US).

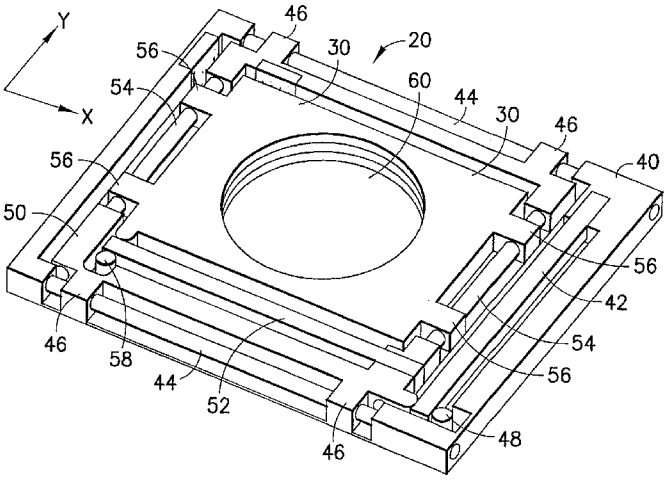
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(54) Title: METHOD AND SYSTEM FOR IMAGE STABILIZATION



(57) Abstract: An optical image stabilizer for use in a camera to compensate for an unwanted movement of camera, wherein two bending actuators are used to shift a lens element or the image sensor in different directions in a plane so as to shift a projected image on the image sensor in response to the unwanted camera movement. The plane is substantially perpendicular to the optical axis of camera, and longitudinal axis of each bending actuator is substantially parallel to the optical axis. The actuator can be fixedly mounted on one end so that the other end is allowed to bend. The actuator can be fixedly mounted on both ends so that the middle section is allowed to bend. Alternatively, the middle section is fixedly mounted and both ends can be used for shifting an imaging component.

WO 2007/063359 A1

METHOD AND SYSTEM FOR IMAGE STABILIZATION

Field of the Invention

The present invention relates generally to a camera and, more particularly, to the stabilization of an image during the exposure time of the camera.

Background of the Invention

The problem of image stabilization dates back to the beginning of photography, and the problem is related to the fact that an image sensor needs a sufficient exposure time to form a reasonably good image. Any motion of the camera during the exposure time causes a shift of the image projected on the image sensor, resulting in a degradation of the formed image. The motion related degradation is called motion blur. Using one or both hands to hold a camera while taking picture, it is almost impossible to avoid an unwanted camera motion during a reasonably long exposure time. Motion blur is particularly easy to occur when the camera is set at a high zoom ratio when even a small motion could significantly degrades the quality of the acquired image.

Optical image stabilization generally involves laterally shifting the image projected on the image sensor in compensation for the camera motion. Shifting of the image can be achieved by one of the following four general techniques:

Lens shift – this optical image stabilization method involves moving one or more lens elements of the optical system in a direction substantially perpendicular to the optical axis of the system;

Image sensor shift – this optical image stabilization method involves moving the image sensor in a direction substantially perpendicular to the optical axis of the optical system;

Liquid prism – this method involves changing a layer of liquid sealed between two parallel plates into a wedge in order to change the optical axis of the system by refraction; and

Camera module tilt – this method keeps all the components in the optical system unchanged while tilting the entire module so as to shift the optical axis in relation to a scene.

In any one of the above-mentioned image stabilization techniques, an actuator mechanism is required to effect the change in the optical axis or the shift of the image

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sensor. Actuator mechanisms are generally complex, which means that they are expensive and large in size.

The present invention provides a new method and device for shifting one or more lens elements or the image sensor in an XY-plane, wherein the actuators are arranged differently from the above-described method.

Summary of the Invention

The present invention uses an optical image stabilizer to compensate for an unwanted movement of an imaging system, such as a camera. Two separate bending actuators are used to shift a lens element or the image sensor in different directions in a plane so as to shift a projected image on the image sensor based on the movement of the imaging system. The plane is substantially perpendicular to the optical axis of the imaging system, and longitudinal axis of each bending actuator is substantially parallel to the plane. In one embodiment of the present invention, one end of each bending actuator is fixedly disposed on the image system and the other end is used to shift the lens element or the image sensor. In another embodiment of the present invention, both ends of each bending actuator are fixed, while the middle section is allowed to move for shifting the lens element or the image sensor.

Thus, the present invention provides a method and system for optical image stabilization for use in an imaging system having a plurality of imaging components arranged in relationship to an optical axis, the imaging components comprising an image sensor and at least a lens element for projecting an image on the image sensor, wherein the projected image can be shifted relative to the image sensor in a direction substantially perpendicular to the optical axis. The imaging system comprises:

a first bending actuator operatively connected to at least one of the imaging components for moving the imaging component in a first direction, the first bending actuator having a length defining a first actuator axis;

a second bending actuator operatively connecting said at least one imaging component for moving the imaging component in a second direction, the second bending actuator having a length defining a second actuator axis, wherein the image plane and each of the first and second actuator axes form an angle smaller than 45 degrees.

a driving system, in response to the movement of the imaging system, for causing at least part of the first actuator to move in a direction different from the first actuator axis so as to shift said at least one imaging component in a plane substantially perpendicular to

the optical axis, and for causing at least part of the second actuator to move in a direction different from the second actuator axis so as to shift said at least one imaging component in a plane substantially perpendicular to the optical axis. The imaging component can be a lens component or the image sensor.

Each of the bending actuator can be mounted on the imaging system in a number of ways. The actuator can be fixedly mounted on one of its ends so as to allow the other end to bend. The actuator can be fixedly mounted on both ends so as to allow the middle section to move. Alternatively, the actuator can be fixedly mounted on a middle section so that one or both ends can be used to move an imaging component.

The present invention will become apparent upon reading the description taken in conjunction with Figures 3 to 16.

Brief Description of the Drawings

Figure 1 shows the relationship between the XY-plane and the optical axis of an imaging system.

Figure 2 shows an on-axis actuator disposed parallel to the Y-axis.

Figure 3 shows a bending or off-axis actuator.

Figure 4a shows a bending actuator for shifting a carrier along the X-axis, according to the present invention.

Figure 4b shows a bending actuator for shifting a carrier along the Y-axis, according to the present invention.

Figure 5 is a schematic representation of an imaging system, according to one embodiment of the present invention.

Figure 6 shows a carrier having two bending actuators for shifting the lens element in an image system.

Figures 7a to 7c show the carrier being shifted to the upper left, center and lower right position.

Figure 8 shows a schematic representation of an imaging system, according to another embodiment of the present invention.

Figure 9 shows another carrier for mounting the image sensor, according to the present invention.

Figures 10a and 10b show a carrier with a different amount arrangement.

Figure 11 shows a different bending actuator.

Figure 12 shows a lens carrier having two bending actuators, according to a different embodiment of the present invention.

Figure 13 shows a different lens carrier design, according to the present invention.

Figure 14 shows a typical driving system for driving a bending actuator.

Figure 15 shows a variation in the placement of a bending actuator in reference to the optical axis of imaging system.

Figure 16 shows a typical image stabilizer system.

Detailed Description of the Invention

In an imaging system having an image sensor and a lens to project an image on the image sensor, the present invention uses one or more bending actuators to shift the image projected on the image sensor for image stabilization purposes. The actuators can be used to shift the lens or the image sensor or both in one or more directions substantially parallel to the image plane. The actuators are mechanically engaged with a carrier carrying the imaging component to be shifted.

When an on-axis actuator is activated, it contracts or expands in a direction that shortens or lengthens the thickness or the length of the actuator. For example, if the actuator is a long piece of piezoelectric material having a longitudinal axis along its length, then the displacement of the actuator when activated is also along the longitudinal axis, as shown in Figure 2. In a bending actuator, as shown in Figure 3, the displacement of the actuator is not along its length or longitudinal axis. Instead, the displacement is off-axis and approximately equal to the length times the bending angle.

When it is used to move a lens element or the image sensor in a camera, a bending actuator can be disposed such that the longitudinal axis of the actuator is perpendicular to the shifting direction of an imaging component of the imaging system but substantially parallel to the plane in which the imaging component is shifted. Figures 4a and 4b show the principle of using a bending actuator to move a carrier in the X-direction and in the Y-direction, with the optical axis being parallel to the Z-axis.

According to one of the embodiments of the present invention, the lens is fixedly mounted on the carrier to be moved by a pair of bending actuators, as shown in Figures 5 and 6. As shown, the imaging system **1**, according to the present invention, comprises a device body **10** for mounting an image sensor **80** and a lens **60** for projecting an image on the image sensor along the optical axis of the imaging system. The lens **60** is fixedly mounted on a carrier **30**. The carrier can be moved in the X-direction by a first bending

actuator **42** and in the Y-direction by a second bending actuator **52**. The first bending actuator **42** is mounted on an outer support frame **40** of a lens plate **20**, and the second bending actuator **52** is mounted on an inner support frame **50**. As shown in Figure 6, the inner support frame **50** has two pairs of brackets **46** and each pair is mounted on a guide pin **44** so as to allow the inner support frame to move along the X-direction by a sliding motion. Likewise, the carrier **30** has two pairs of brackets **56** and each pair is mounted on a guide pin **54** so as to allow the carrier **30** to move along the Y-direction by a sliding motion. As shown, one end of the first bending actuator **42** is fixedly mounted on the outer support frame **40**, and the other end is allowed to move sidewise when activated. The movable end of the first bending actuator **42** is urged by a spring **48** to move inward. When the first bending actuator **42** moves sidewise, it pushes the inner support frame **50** in the X-direction. Likewise, one end of the second bending actuator **52** is fixedly mounted on the inner support frame **50**, and the other end is allowed to move sidewise when activated. The movable end of the second bending actuator **52** is urged by a spring **58** to move inward. When the second bending actuator **52** moves sidewise, it pushes the carrier **30** in the Y-direction.

The shifting of the lens **60** in the various directions is depicted in Figures 7a to 7c. Figure 7a shows the lens **60** being shifted to the upper left corner of the lens plate **20**. Figure 7b shows the lens **60** being positioned in the center, and Figure 7c shows the lens **60** being shifted to the lower right corner of the lens plate **20**.

The actuator arrangement as shown in Figure 6 can also be used to shift the image sensor **80**. As shown in Figures 8 and 9, the imaging system **1**, according to another embodiment of the present invention, comprises a sensor plate **22** for mounting the image sensor **80**. The image sensor **80** and its circuit board **82** are fixedly mounted on a carrier **32**. The carrier **32** can be moved in the X direction by a first bending actuator **42** and in the Y direction by a second bending actuator **52**. The mechanical structure of the sensor plate **22** is basically the same as that of the lens plate **20**. Thus, when the first bending actuator **42** moves sidewise, it pushes the inner support frame **50** along with the image sensor **80** in the X-direction. When the second bending actuator **52** moves sidewise, it pushes the carrier **32** along with the image sensor **80** in the Y-direction.

The lens plate and the carrier plate can be constructed differently. As shown in Figures 10a and 10b, the lens plate **28** is constructed as having two layers stacked within an outer frame **72**, for example. Figure 10a shows one side of the frame **72**. As shown, the first bending actuator **42** and the spring **48** are mounted on the outer frame **72**, and the

second bending actuator **52** and the spring **58** are mounted on an inner frame **74**. The lens **60** is fixedly mounted on the lens carrier **30**. Figure 10b shows the other side of the outer frame **72**. As shown, the outer frame **72** has a first guiding pin **44** and a second guiding pin **45** for movably mounting the inner frame **74** via a pair of brackets **46** and a single bracket **47**. Likewise, the inner frame **74** has a first guiding pin **54** and a second guiding pin **55** for moving mounting the lens carrier **30**. Such construction can reduce the footprint of the imaging system.

Furthermore, the bending actuators can be used in a different setting. As shown in Figure 11, both ends of the actuator are fixedly mounted to the stationary part of the imaging system. When the activator is activated, the middle section of the actuator undergoes a bending motion to move a carrier. For example, both ends of an actuator **33** are fixedly mounted to the outer frame **40**, and both ends of another actuator **36** are fixedly mounted to the inner frame **50**, as shown in Figure 12. When the actuator **33** is activated, it is able to move to inner frame **50** along with the lens **60** in the X-direction. Likewise, when the actuator **36** is activated, it is able to move the lens carrier **30** along with the lens **60** in the Y-direction for image stabilization purposes. On the lens plate **20** as shown in Figure 12, a spring **34** is used to urge the actuator **33** to move inward along the X-direction, and a spring **37** is used to urge the actuator **36** to move inward along the Y-direction. In a different embodiment, one or more sections between the ends are fixedly mounted so as to allow both ends to bend and to use one or both of the ends for moving the lens plate or the carrier.

Moreover, the lens carrier can be designed differently as shown in Figure 13. As shown in Figure 13, the lens carrier **150** comprises a correction framework **158** for mounting an actuator **152** for the X-direction movement via a bracket **153**, and for mounting another actuator **155** for the Y-direction movement via a bracket **156**. A U-shaped hook **157** is fixedly attached to the bracket **156** and another U-shaped hook **154** is fixedly attached to the bracket **153** to move the lens element **51**. The position of the lens element **51** is determined substantially by the parallel sections of each of the hooks **154**, **157**. For example, when the actuator **155** moves in the Y-direction in response to activation, the lens element is guided by the U-shaped hook **157** to move along the Y-direction.

It should be noted that the bending actuator, according to the present invention, can be a piezoelectric monomorph actuator, a piezoelectric bimorph actuator, a piezoelectric multi-layer actuator, an ion conductive polymer actuator or the like. Furthermore, it is

known in the art that an actuator needs a driving system for activating the actuator. Figure 14 is a typical driving system. As shown, one end of the actuator is operatively connected to a driving electronic module, which is connected to a camera movement sensor / signal processor so that the actuator moves the imaging component in response to the camera movement. Preferably, when only one end of the bending actuator is fixedly mounted on a carrier or on a frame, as shown in Figures 6, 10a and 10b, the fixed end is operatively connected to the driving electronic module. But when both ends of the bending actuator are fixedly mounted to a carrier or a frame, as shown in Figure 12, either end of the bending actuator can be connected to the driving electronic module.

Furthermore, when one or more of the imaging components are shifted for image stabilization purposes, other components are also needed. For example, the image stabilizer for the imaging system also has a movement detector to determine the movement to be compensated for, at least one position sensors to determine the current position of the imaging components, a signal processor to compute the shifting amount in different directions for compensating for the camera movement based on the positions of the components and the camera movement, and an actuator control to activate the actuators in order to shift the image components by a desired amount. A block diagram illustrating such an image stabilizer is shown in Figure 16. The movement detector may include a gyroscope, accelerometer or other known movement detector, for example.

The lens of the imaging system may comprise two or more lens elements and the actuators may be used to move one or more lens elements.

It should be noted that, in Figures 6, 9, and 10b, the bending actuator is depicted as being placed in a carrier that is substantially parallel to the XY plane. However, it is also possible to place the bending actuator differently. As shown in Figure 15, the bending actuator **42** is placed off the XY-plane with the fixed end spaced from the carrier. The off-plane angle between the actuator **42** and the XY-plane is, in practice, should not be greater than 45 degrees.

It should be understood for a person skilled in the art that the lens plate **20** as depicted in Figure 6, the carrier plate **22** as depicted in Figure 9, and the lens plate **28** as depicted in Figure 10a are for illustration purposes only. The present invention in which two bending actuators are used to shift an imaging component, such as a lens element and an image sensor, can also be achieved with a different plate design or arrangement. Furthermore, any of the lens plates **20**, **28** and the carrier plate **22** can be used to shift other imaging components for optical image stabilization purposes. For example, one of

the plates can be used to shift two optical wedges or thin prisms separately in the X-direction and the Y-direction.

Thus, although the invention has been described with respect to one or more embodiments thereof, it will be understood by those skilled in the art that the foregoing and various other changes, omissions and deviations in the form and detail thereof may be made without departing from the scope of this invention.

What is claimed is:

1. An imaging system comprising imaging components arranged in relationship to an optical axis, the imaging components comprising an image sensor disposed in an image plane and at least a lens element for projecting an image on the image sensor, wherein the projected image is shiftable relative to the image plane in a direction substantially perpendicular to the optical axis in response to a movement of the imaging system, said imaging system characterized by:

a bending actuator operatively connected to at least one of the imaging components, the bending actuator having a length defining an actuator axis; and by

a driving system, in response to the movement of the imaging system, for causing at least part of the actuator to move in a direction different from the actuator axis so as to shift said at least one imaging component in a plane substantially perpendicular to the optical axis.

2. The imaging system of claim 1, characterized in that the shift of said at least one imaging component is in a first direction in the plane, said imaging system further characterized by:

a further bending actuator operatively connecting said at least one imaging component, the further bending actuator having a length defining a further actuator axis, wherein the further bending actuator is operatively connected to the driving system so that the further actuator can be caused to move in a further direction different from the further actuator axis so as to shift said at least one imaging component in the plane in a second direction different from the first direction.

3. The imaging system of claim 1, characterized in that said one imaging component comprises the lens.

4. The imaging system of claim 1, characterized in that said one imaging component comprises the image sensor.

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5. The imaging system of claim 1 characterized in that said actuator has a first end and an opposing second end defining the length and that the first end is fixedly mounted on the imaging system relative to the optical axis and the second end is operatively

connected to said at least one imaging component so that the second end of the actuator is moveable in the direction different from the actuator axis.

6. The imaging system of claim 5, characterized in that the second end of the actuator is spaced from the plane.

7. The imaging system of claim 1, characterized in that the actuator axis is substantially perpendicular to the optical axis.

8. The imaging system of claim 2, characterized in that the further actuator axis is substantially perpendicular to the optical axis.

9. The imaging system of claim 1, characterized in that said actuator has a first end, an opposing second end and a middle section between the first and second ends, and that both the first and second end are fixedly mounted on the imaging system relative to the optical axis and the middle section is operatively connected to said at least one imaging component so that the middle section of the actuator is moveable in the direction different from the actuator axis.

10. The imaging system of claim 9, characterized in that said at least one imaging component comprises the lens.

11. The imaging system of claim 1, characterized in that said actuator has a first end, an opposing second end and a middle section between the first and second ends, and that the middle section is fixedly mounted on the imaging system relative to the optical axis and both the first and second end are operatively connected to said at least one imaging component so that both the first and second end of the actuator are moveable in the direction different from the actuator axis.

12. The imaging system of claim 2, further characterized by:

~~a movement sensing module for detecting the movement of the imaging system.~~

13. The imaging system of claim 12, characterized in that the movement sensing module comprises one or more gyroscope sensors.

14. The imaging system of claim 12, characterized in that the movement sensing module comprises one or more accelerometers.

15. The imaging system of claim 12, further characterized by:

at least one position sensing module for determining the current position of the imaging component to be shifted by the bending actuator.

16. The imaging system of claim 15, further characterized by:

a processor, operatively connected to the movement sensing module and the position sensing module, for determining a shifting amount of the projected image in order to compensate for the movement of the imaging system, said processor further connected to the driving system to cause the actuator and the further actuator to move.

17. The imaging system of claim 1, characterized in that the actuator axis and the image plane form an angle smaller than 45 degrees.

18. A shifting method for use in an imaging system having imaging components arranged in relationship to an optical axis, the imaging components comprising at least an image sensor and a lens element for projecting an image on the image sensor, wherein the projected image is shiftable in an image plane in a direction substantially perpendicular to the optical axis, said method characterized by:

operatively connecting at least one of the imaging components to a bending actuator having a length defining an actuator axis, and

causing at least part of the actuator to move in a direction different from the actuator axis so as to shift said at least one imaging component in a plane substantially perpendicular to the optical axis.

19. The method of claim 18, characterized in that the shift of said at least one imaging component is in a first direction in the plane, said method further characterized by:

operatively connecting said at least one imaging component to a further bending actuator having a length defining a further actuator axis; and

causing at least part of the further actuator to move in a further direction different from the further actuator axis so as to shift said at least one imaging component in the plane in a second direction different from the first direction.

20. The method of claim 18, characterized in that said one imaging component comprises the lens.

21. The method of claim 18, characterized in that said one imaging component comprises the image sensor.

22. The method of claim 18, characterized in that said actuator having a first end and an opposing second end defining the length, said method further characterized by:

fixedly mounting the first end on the imaging system relative to the optical axis and operatively connecting the second end to said at least one imaging component so that the second end of the actuator is moveable in the direction different from the actuator axis.

23. The method of claim 18, characterized in that said actuator has a first end, an opposing second end and a middle section between the first and second ends, said method further characterized by:

fixedly mounting both the first and second end on the imaging system relative to the optical axis and operatively connecting the middle section to said at least one imaging component so that the middle section of the actuator is moveable in the direction different from the actuator axis.

24. The method of claim 18, characterized in that said actuator has a first end, an opposing second end and a middle section between the first and second ends, said method further characterized by:

fixedly mounting the middle section on the imaging system relative to the optical axis and operatively connecting the first and second ends to said at least one imaging component so that both the first and the second ends of the actuator are moveable in the direction different from the actuator axis.

25. An image stabilizer module for an imaging system, the imaging system comprising a plurality of imaging components arranged in relationship to an optical axis, the imaging components comprising an image sensor and at least a lens element for projecting an image on the image sensor, wherein the projected image is shiftable relative to the image

sensor in a direction substantially perpendicular to the optical axis in response to a movement of the imaging system, said image stabilizer module characterized by:

a first bending actuator operatively connected to at least one of the imaging components, the first bending actuator having a length defining a first actuator axis, wherein at least part of the first actuator is dimensioned to move in a direction different from the first actuator axis so as to shift said at least one imaging component in a first direction in the plane based on the movement of the imaging system, and

a second bending actuator operatively connected to said at least one imaging component, the second bending actuator having a length defining a second actuator axis, wherein at least part of the second actuator is dimensioned to move in a direction different from the second actuator axis so as to shift said at least one imaging component in a second direction in the plane also based on the movement of the imaging system.

26. The image stabilizer module of claim 25, characterized in that said one imaging component comprises the lens.

27. The image stabilizer module of claim 25, characterized in that said one imaging component comprises the image sensor.

28. The image stabilizer module of claim 25, characterized in that

said first actuator has a first end and an opposing second end defining the length of said first actuator, wherein the first end is fixedly mounted on the imaging system relative to the optical axis and the second end is operatively connected to said at least one imaging component so that the second end of the first actuator is moveable in the direction different from the first actuator axis, and that

said second actuator has a first end and an opposing second end defining the length of said second actuator, wherein the first end is fixedly mounted on the imaging system relative to the optical axis and the second end is operatively connected to said at least one imaging component so that the second end of the second actuator is moveable in the direction different from the second actuator axis

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29. The image stabilizer module of claim 25, characterized in that the first actuator axis is substantially perpendicular to the optical axis and the second actuator axis is substantially perpendicular to the optical axis.

30. The image stabilizer module of claim 25, characterized in that

said first actuator has a first end, an opposing second end and a middle section between the first and second ends, wherein both the first and second end are fixedly mounted on the imaging system relative to the optical axis and the middle section is operatively connected to said at least one imaging component so that the middle section of the first actuator is moveable in the direction different from the first actuator axis, and that

said second actuator has a first end, an opposing second end and a middle section between the first and second ends, wherein both the first and second end are fixedly mounted on the imaging system relative to the optical axis and the middle section is operatively connected to said at least one imaging component so that the middle section of the second actuator is moveable in the direction different from the second actuator axis

31. The image stabilizer module of claim 25, characterized in that

said first actuator has a first end, an opposing second end and a middle section between the first and second ends, wherein the middle section is fixedly mounted on the imaging system relative to the optical axis and both the first and second end are operatively connected to said at least one imaging component so that both the first and second end of the first actuator are moveable in the direction different from the first actuator axis, and that

said second actuator has a first end, an opposing second end and a middle section between the first and second ends, wherein the middle section is fixedly mounted on the imaging system relative to the optical axis and both the first and second end are operatively connected to said at least one imaging component so that both the first and second end of the second actuator are moveable in the direction different from the second actuator axis.

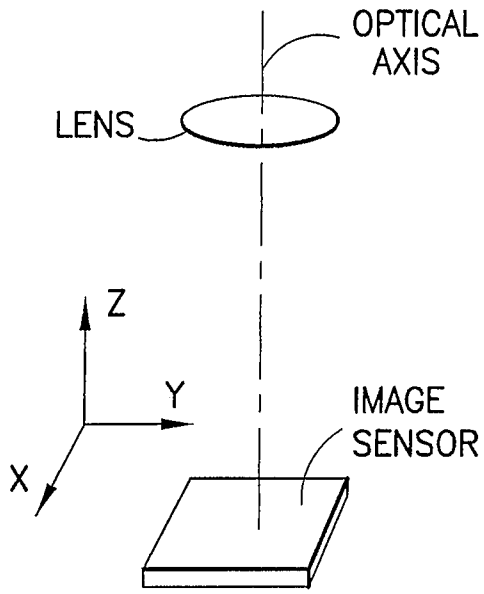


FIG.1

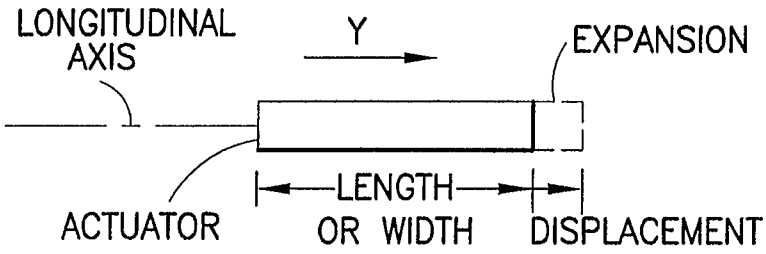


FIG.2

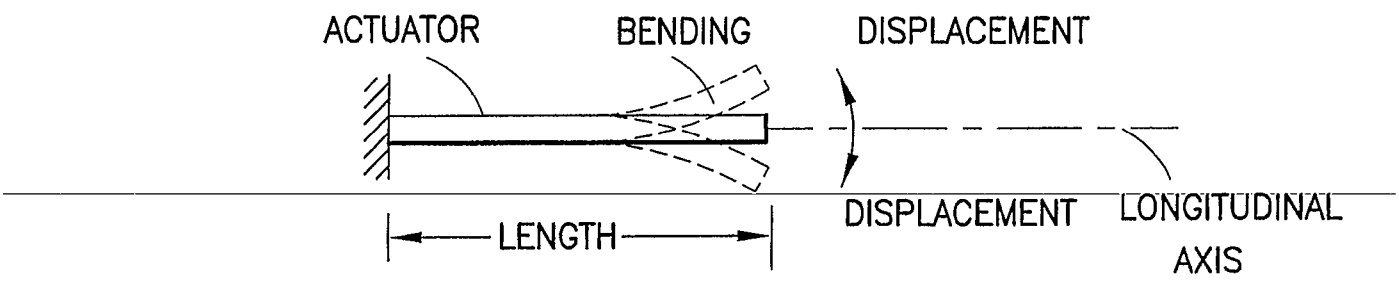


FIG.3

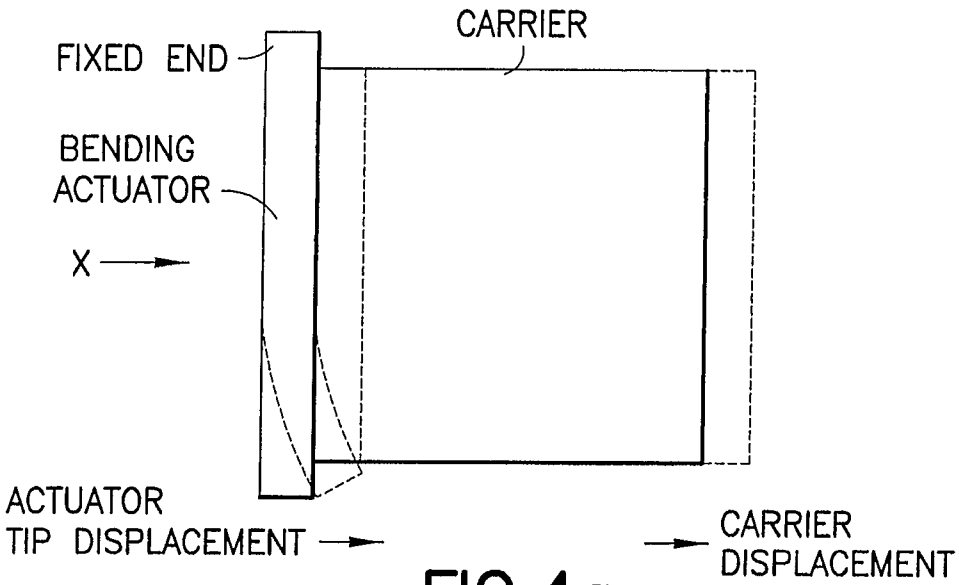

CARRIER
FIXED END
BENDING ACTUATOR
X
ACTUATOR TIP DISPLACEMENT
CARRIER DISPLACEMENT

FIG.4a

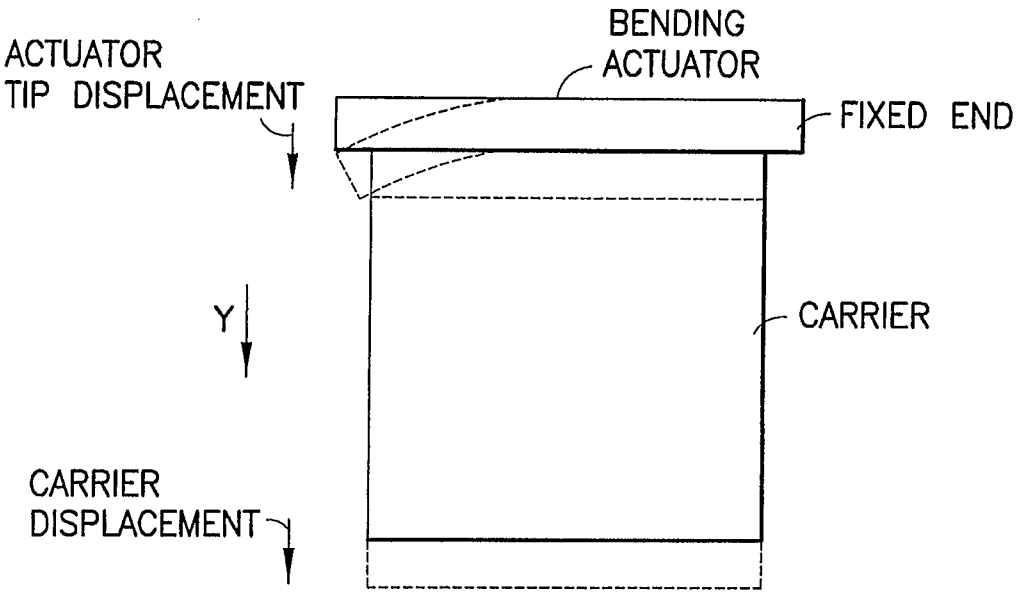

BENDING ACTUATOR
ACTUATOR TIP DISPLACEMENT
FIXED END
Y
CARRIER
CARRIER DISPLACEMENT

FIG.4b

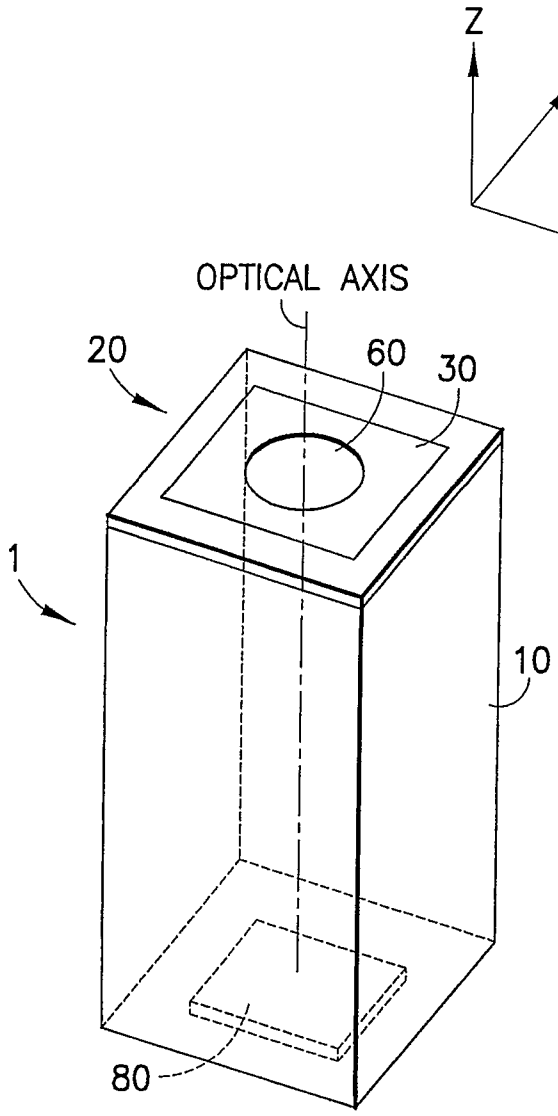

Z
Y
X
OPTICAL AXIS
20
60
30
1
10
80

FIG.5

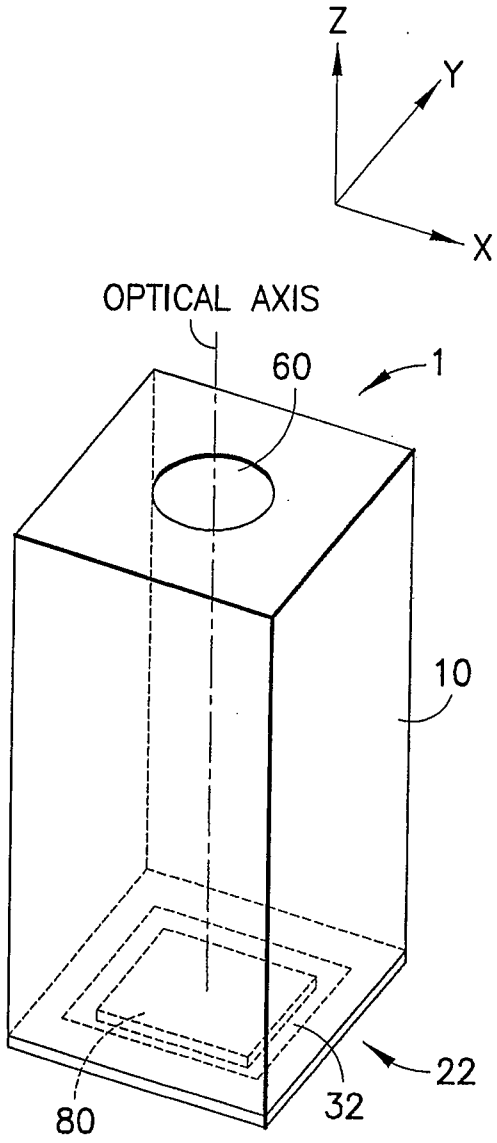

Z
Y
X
OPTICAL AXIS
60
1
10
22
80
32

FIG.8

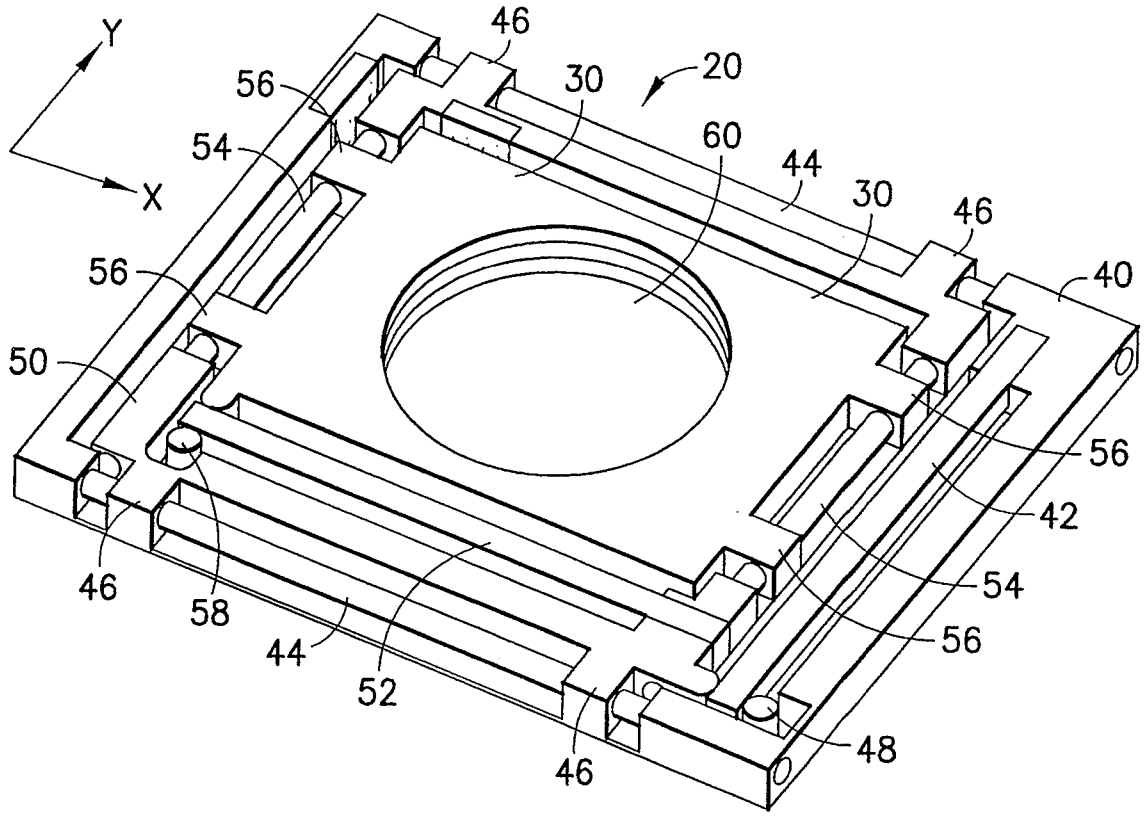


FIG.6

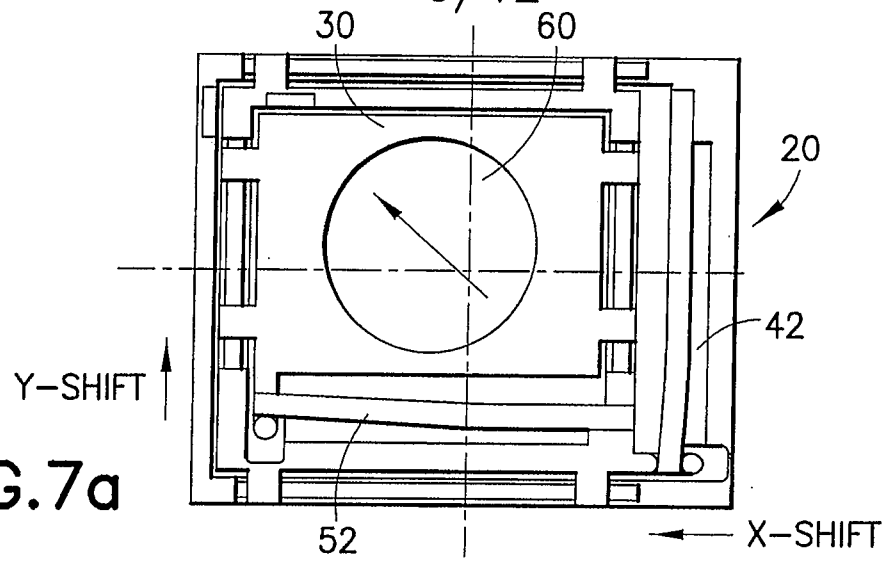


FIG.7a

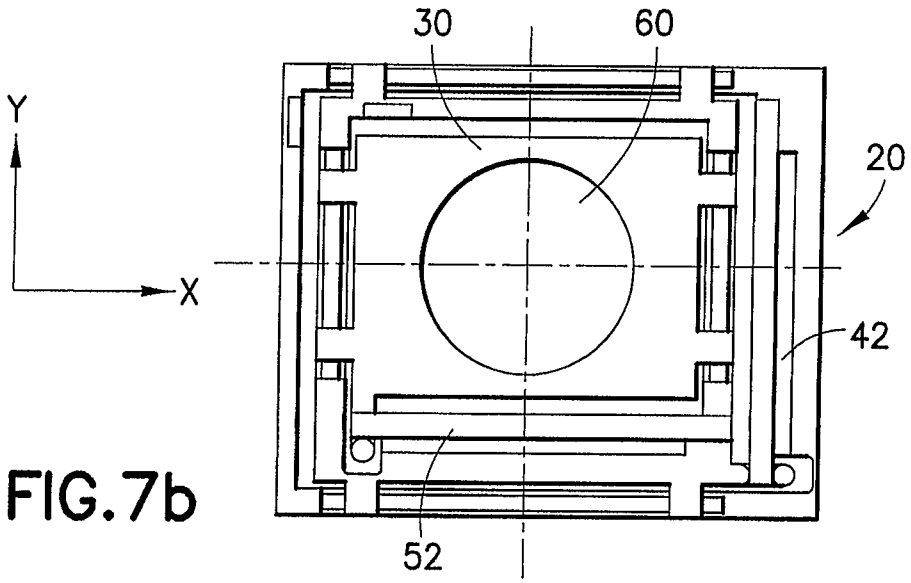


FIG.7b

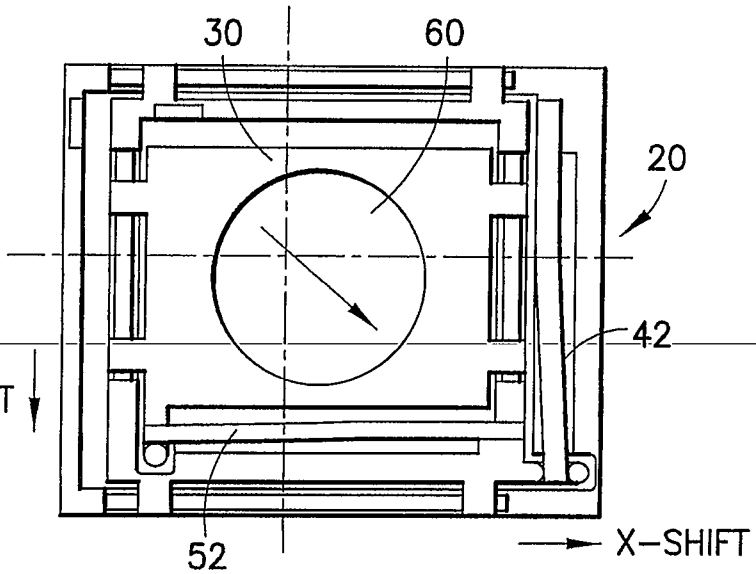


FIG.7c

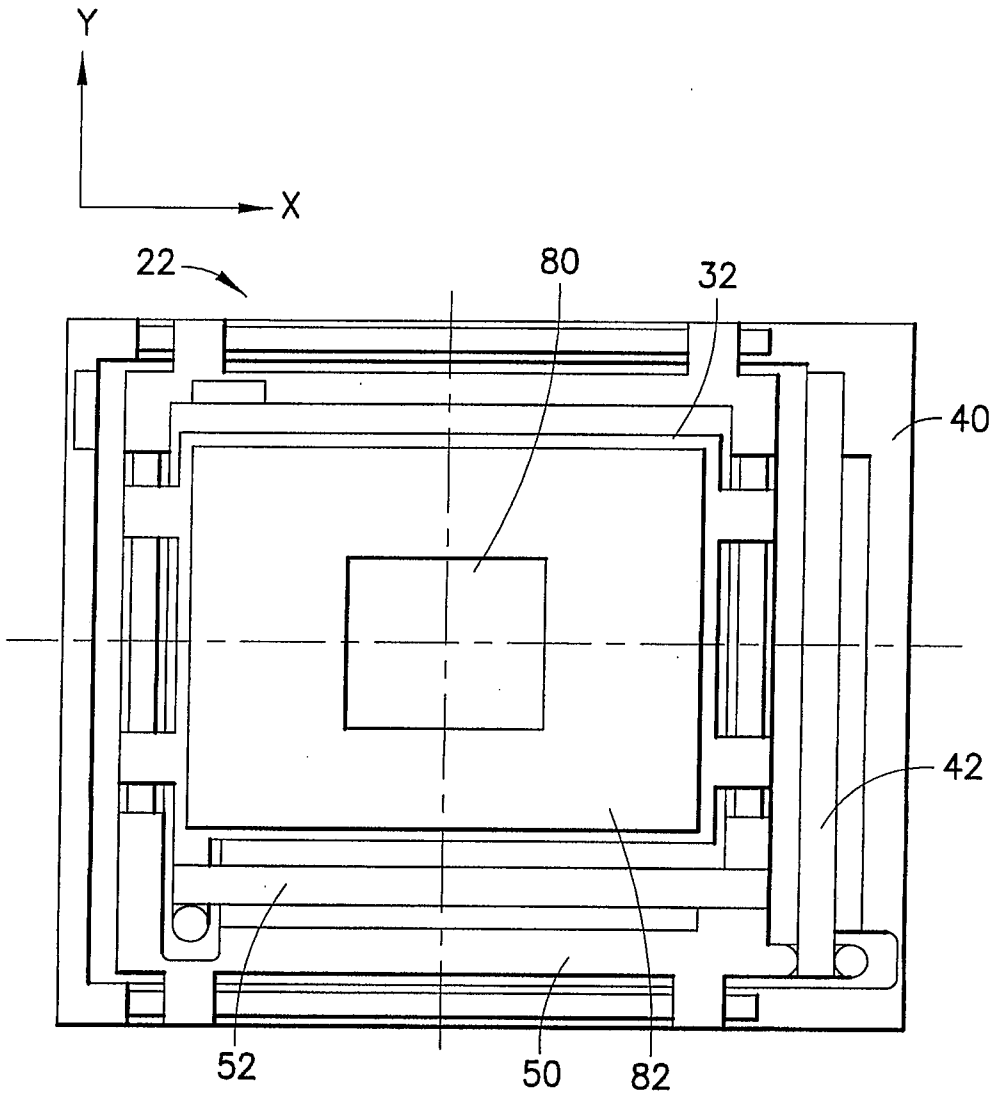


FIG.9

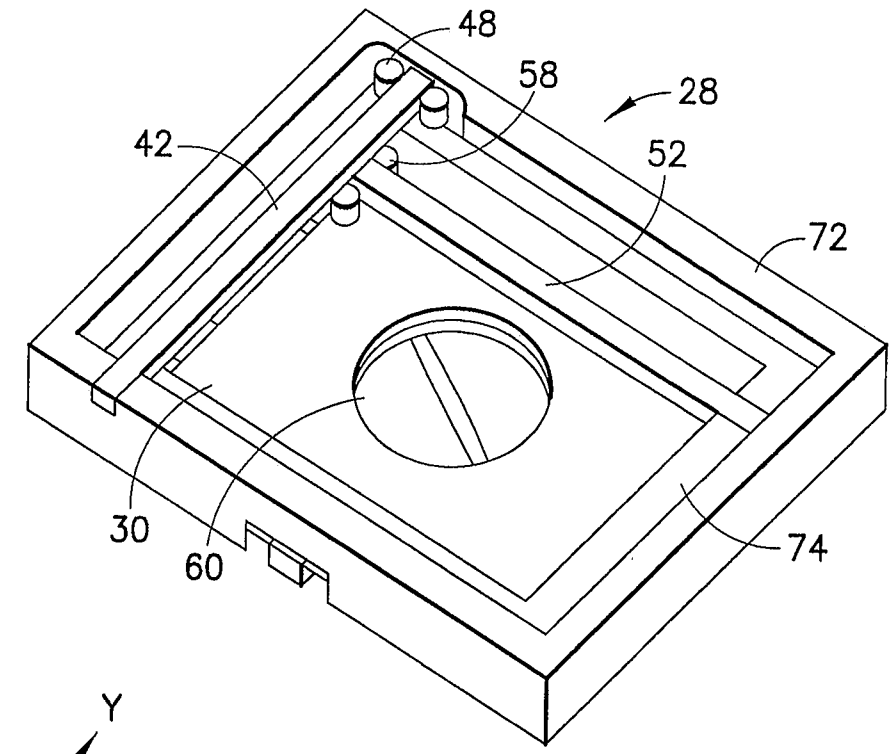


FIG.10a

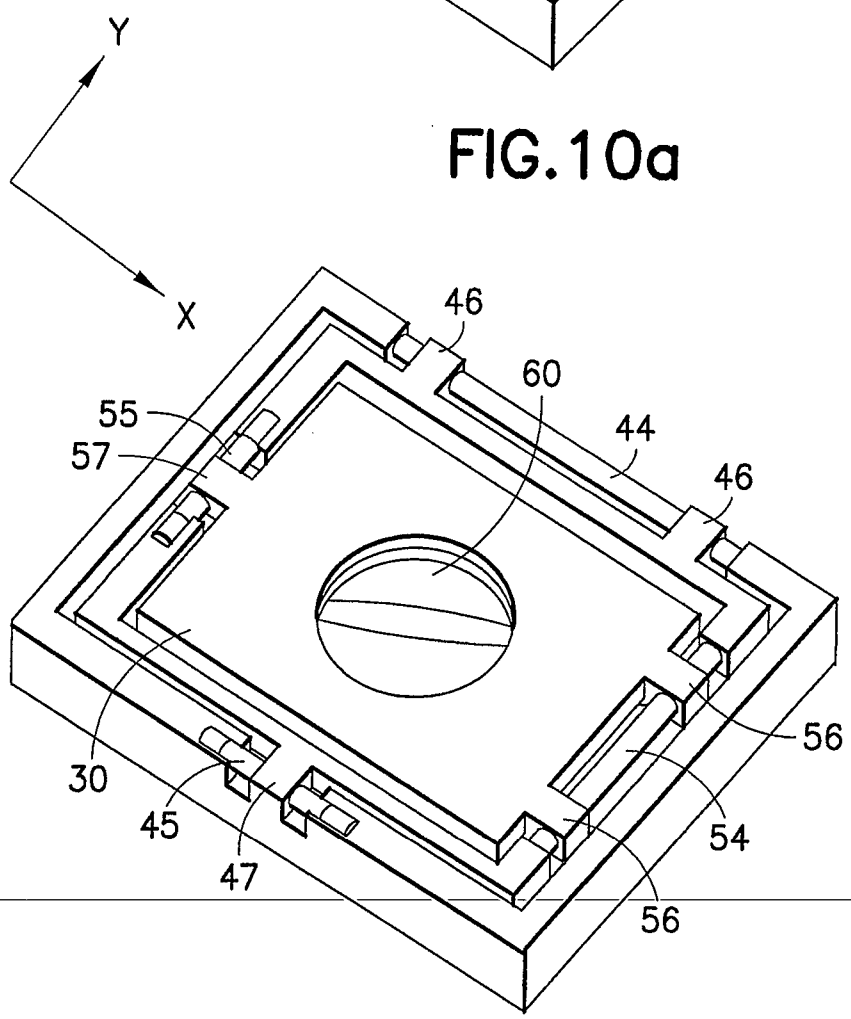


FIG.10b

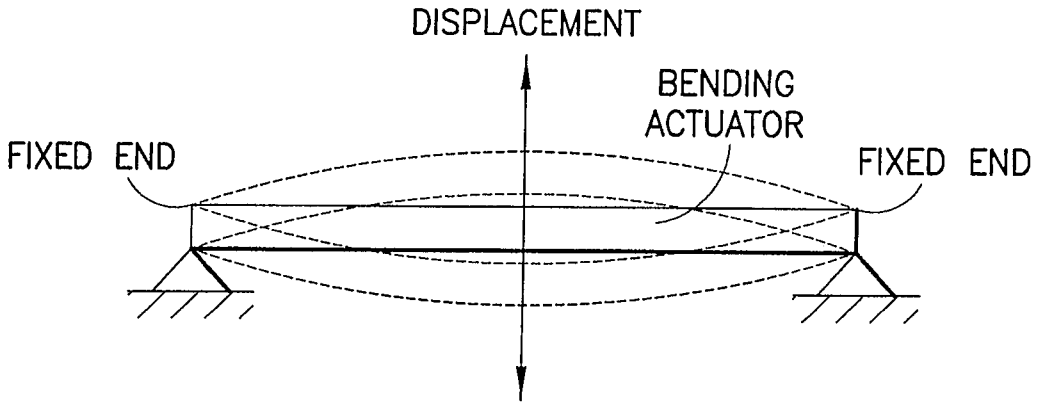

DISPLACEMENT
BENDING ACTUATOR
FIXED END
FIXED END

FIG.11

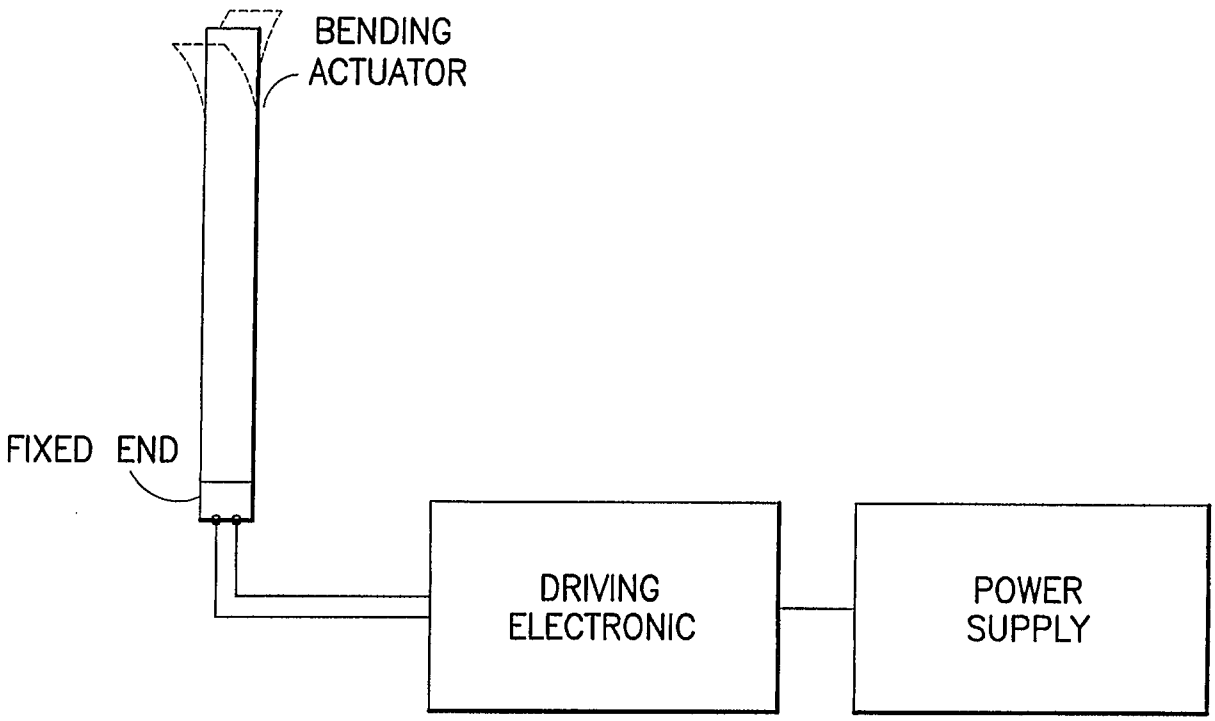

BENDING ACTUATOR
FIXED END
DRIVING ELECTRONIC
POWER SUPPLY

FIG.14

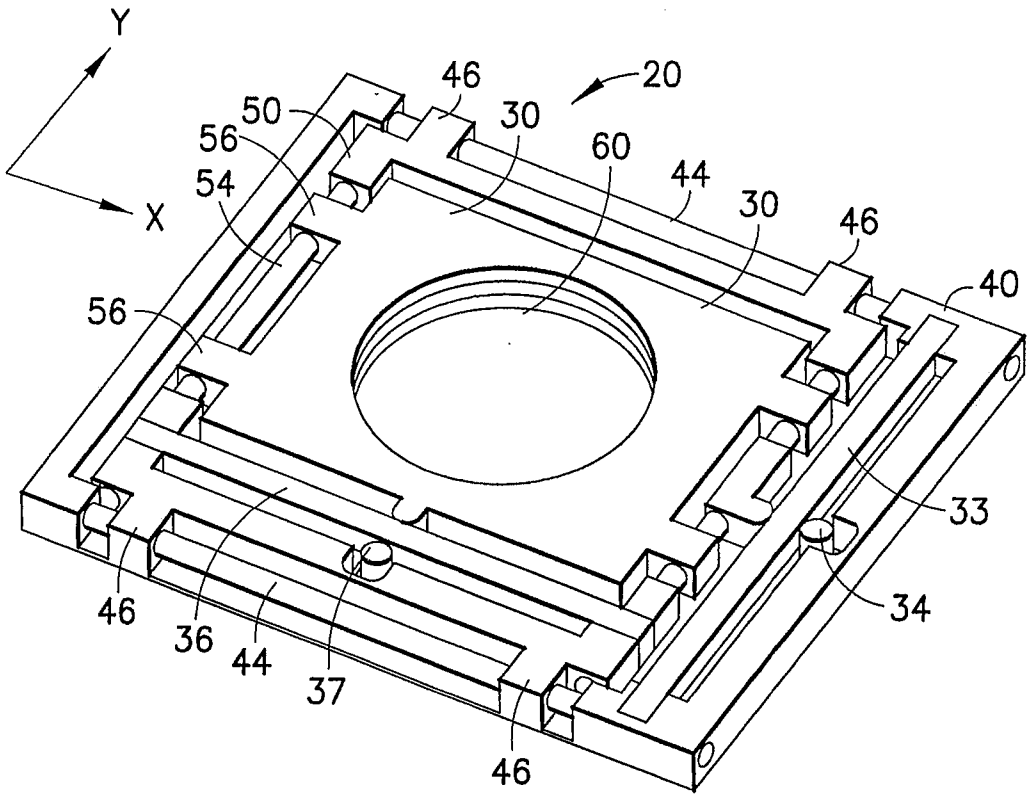


FIG.12

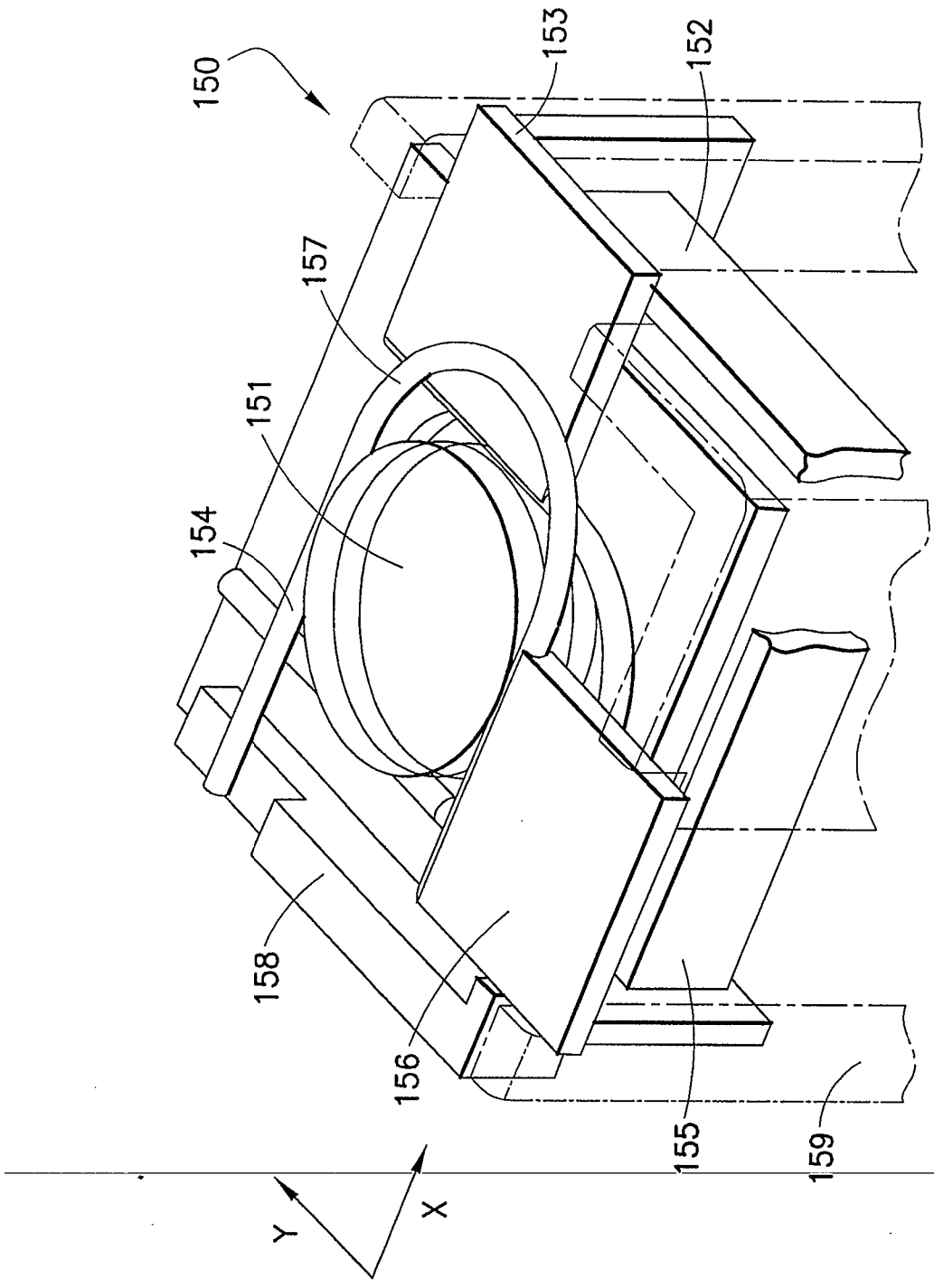


FIG.13

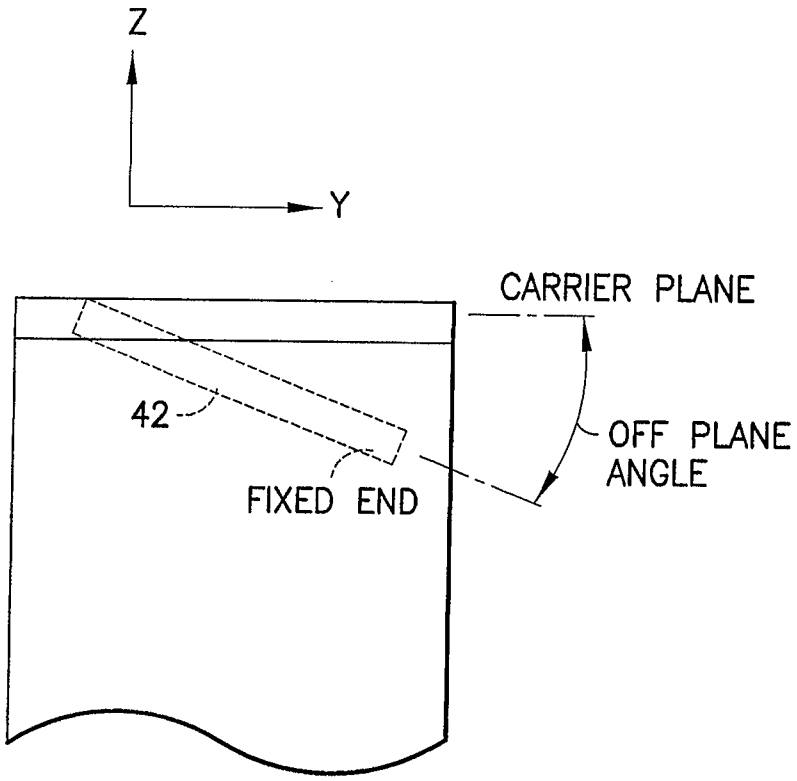


FIG.15

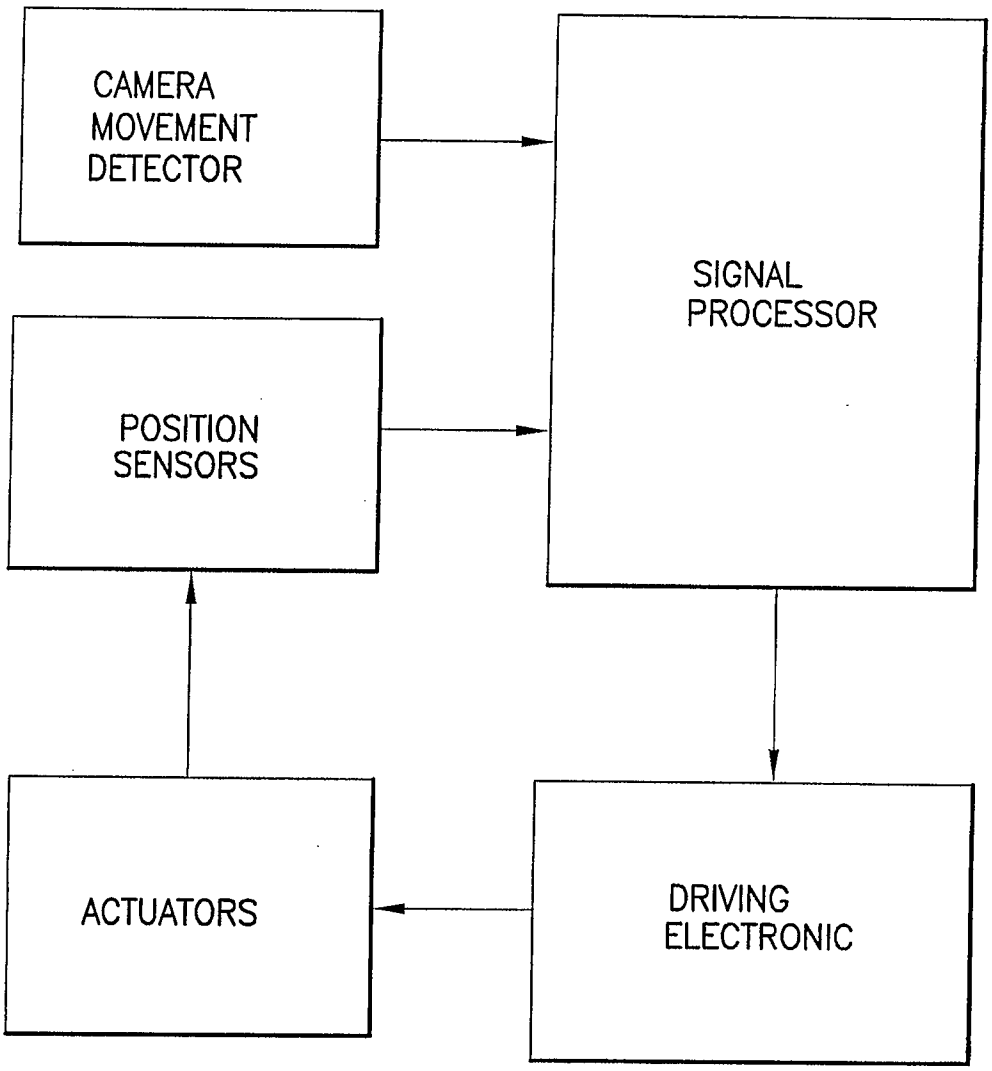

CAMERA MOVEMENT DETECTOR
POSITION SENSORS
SIGNAL PROCESSOR
ACTUATORS
DRIVING ELECTRONIC

FIG.16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2006/000153

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20050110873 A1 (ENOMOTO, S), 26 May 2005 (26.05.2005), figures 1,4, abstract	1-2,12-13, 18-19,25
X	--	3-4,14-16, 20-21,26-27
A	PATENT ABSTRACTS OF JAPAN vol. 200, no. 014 5 March 2001 (2001-03-05) & JP 2000307937 A (RICOH CO LTD) 2 November 2000 (2000-11-02) abstract	1-4,12-16, 18-21,25-27
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 October 2006	31-10-2006
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Sture Elnäs /MN Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2006/000153

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 200, no. 305 12 May 2003 (2003-05-12) & JP 2003032537 A (MIWA ENGINEERING: KK) 31 January 2003 (2003-01-31) abstract --	1-4,12-16, 18-21,25-27
E	WO 2006043549 A1 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 27 April 2006 (27.04.2006), figure 10, abstract -- --------	1-4,12-16, 18-21,25-27

International patent classification (IPC)

G02B 27/64 (2006.01)

Download your patent documents at www.prv.se
The cited patent documents can be downloaded at www.prv.se by following the links:

- In English/Searches and advisory services/Cited documents (service in English) or
- e-tjänster/anförda dokument (service in Swedish).

Use the application number as username.
The password is **ZSAYOLNMYP**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2006/000153

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Claims Nos: 1-2,12-13,18-19,25 and 3-4,14-16,20-21,26-27

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Box III

The following separate inventions were identified:

1: Claims 1-2, 12-13, 18-19 and 25 directed to system, method and module for image stabilization with the special technical feature of having a first and a further bending actuator.

2: Claims 3, 20 and 26 with special technical feature of a lens.

3: Claims 4, 21 and 27 with special technical feature of an image sensor.

4: Claims 5-6, 22, and 28 with special technical feature of fixation of components to the actuator ends.

5: Claims 7-8 and 29, with special technical feature of the direction of the actuator.

6: Claims 9-10, 23 and 30 with the special technical feature of a movable middle section.

7: Claims 11, 24 and 31 with the special technical feature of a fixedly mounted middle section.

8: Claims 17 with the special technical feature of the angular relation between the actuator axis and the image plane.

9: Claims 14-16 with special technical feature of the components for control.

The search has been carried out for invention 1, but also for inventions 2, 3 and 9 mentioned above.
The applicant was invited to pay five additional fees for the inventions 4-8 as listed above.

The present application has been considered to contain 9 inventions which are not linked such that they form a single general inventive concept, as required by Rule 13 PCT for the following reasons:

The closest prior art has been identified as D1:
US2005/0110873 A1.

Document D1 discloses an image pickup apparatus having first and second bending actuators. The apparatus comprises a lens system and an imaging device. Furthermore, the document describes a gyro for the control.

.../...

Box III

Accordingly, inventions 1, 2 and 3 are known from D1 and lack consequently novelty.

The technical features of invention 9 are disclosed in the cited document or are considered common general knowledge. Accordingly, invention 9 lacks inventive step.

The above analysis shows that the special technical features of invention 4, 5, 6, 7 and 8 are not the same.

In conclusion, therefore, the 9 groups of claims are not linked by same or corresponding special technical features and define different inventions not linked by a single general inventive concept.

The application, hence does not meet the requirements of unity of invention as defined in Rule 13.1 and 13.2 PCT.

Inventions 2, 3 and 9 could be searched without justifying additional fees.

US	20050110873	A1	26/05/2005	JP	2005176293	A	30/06/2005
WO	2006043549	A1	27/04/2006	JP	2006121769	A	11/05/2006