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(54) Liquid ejecting apparatus and liquid ejecting system

(57) A liquid ejecting apparatus (100) includes a mounting portion (300) configured to move and a liquid cartridge (10) including a liquid chamber (11) and a movable member (90), an optical detector fixed to the mounting portion (300) and having a light emitter (342B) and a light receiver (342C), and a state determiner (400) configured to determine a change in a state of the light receiver (342C). The movable member (90) is configured to move according to a position of a surface of liquid stored in the liquid chamber (11). The light receiver (342C) is configured to assume two predetermined states according to a position of a portion of the movable member (90) in the liquid chamber (11). The state determiner (400) determines that the liquid cartridge (10) is normal or abnormal according to the change in the state of the light receiver (342C).

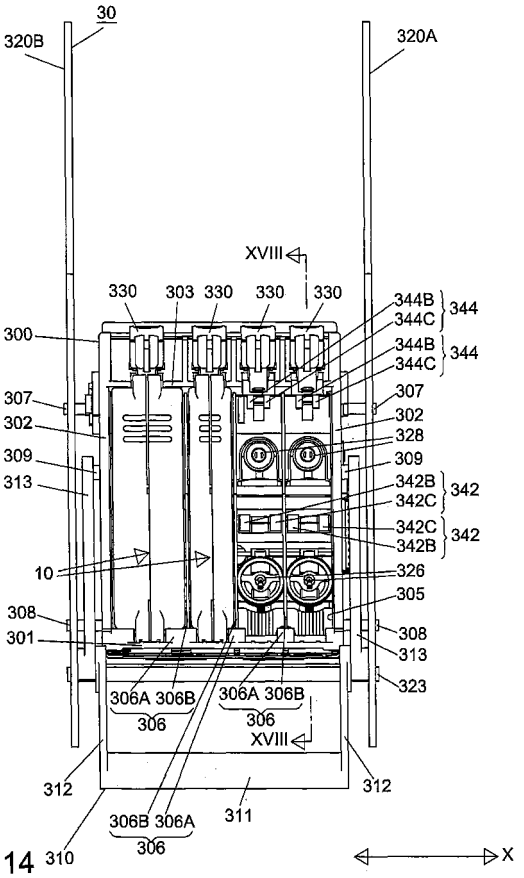

Fig. 14

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates generally to a liquid ejecting apparatus and a liquid ejecting system comprising a mounting portion to which a liquid cartridge, which comprises a movable member configured to move according to a position of a surface of liquid in a liquid chamber, is removably mounted. In particular, the present invention relates to a liquid ejecting apparatus and a liquid ejecting system comprising a determiner configured to determine whether or not the liquid cartridge is normal when the liquid cartridge is mounted to the mounting portion.

2. Description of Related Art

[0002] A known inkjet printer as an example of a liquid ejecting apparatus is used with an ink cartridge. The inkjet printer includes a cartridge mounting portion to which the ink cartridge is removably mounted. The inkjet printer includes a recording head. When the ink cartridge is mounted to the mounting portion, the ink cartridge is connected to the recording head such that ink stored in the ink cartridge is supplied to the recording head. When ink is ejected from the recording head, ink is accordingly supplied from the ink cartridge to the recording head.

[0003] When there is no ink in the ink cartridge, ink can not be ejected from the recording head in the inkjet printer. Once the recording head becomes unable to eject ink with the empty ink cartridge, in order to eject ink from the recording head, a new ink cartridge is mounted to the cartridge mounting portion, and then an operation to suck out large quantity of ink from nozzles of the recording head, that is, a purge operation, is required. The purge operation requires time and wastes a large quantity of ink. Thus, the inkjet printer needs to be configured to recognize the amount of ink in the cartridge mounted to the cartridge mounting portion. To recognize the amount of ink in the cartridge mounted to the cartridge mounting portion, the inkjet printer includes a movable member configured to move in response to a change in the amount of ink in the ink cartridge, and a detector configured to detect whether the movable member is in a specified position. The inkjet printer determines whether ink is sufficient in the ink cartridge based on whether the detector detects the movable member. When the inkjet printer determines that ink in the ink cartridge is not sufficient, it stops image-recording onto a recording medium, e.g. a recording sheet, or notifies the user to replace the ink cartridge with a new one.

[0004] Japanese Laid-Open Patent Publication No. 2005-125738 describes an example of the above ink cartridge and inkjet printer. The ink cartridge includes a case and an ink chamber formed inside the case. A pivotable member in the ink chamber. The pivotable member includes a light blocking member at one end, and a float at the other end. The float has a specific gravity which is less than that of ink. A support base is positioned at the bottom of the ink chamber. The support base supports the pivotable member at a position between the light blocking member and the float. The pivotable member is pivotalbe about a portion supported by the support base. A restricting member is positioned in the ink chamber. The restricting member restricts the pivotal movement of the pivotable member. That is, when the pivotable member rotates in a direction and contacts the restricting member, it cannot further rotate in the direction. Because the specific gravity of the float is less than that of ink, the float attempts to float on the ink surface. However, the movement of the float to the ink surface is restricted with the pivotal movement of the pivotable member restricted by the restricting member. Thus, when the amount of ink stored in the ink chamber is greater than a predetermined amount, the pivotable member is positioned in a predetermined position in contact with the restricting member. At this time, the float is submerged in ink. When ink in the ink chamber is consumed, the ink surface is lowered. When the amount of ink reaches the predetermined amount, a portion of the float is exposed from the ink surface. When ink is further consumed and the ink surface is further lowered, the float moves downward according to the lowering ink surface. The pivotable member rotates in response to the downward movement of the float, and the light blocking member moves upward. The case of the ink cartridge is formed with a protruding portion on a side. The case is made of a material through which light can pass. The protruding portion of the case has an inner space. The inner space of the protruding portion is a portion of the ink chamber. The light blocking member is positioned in the inner space of the protruding portion. The inkjet printer used with this ink cartridge includes an optical detector having a light emitter and a light receiver. When the ink cartridge is mounted to the inkjet printer, the protruding portion of the ink cartridge is positioned between the light emitter and the light receiver. When the amount of ink in the ink chamber is greater than a predetermined amount and the pivotable member is positioned in the predetermined position, light emitted from the light emitter is blocked by the light blocking member and thus dos not reach the light receiver. When the amount of ink in the ink chamber is less than the predetermined amount and the pivotable member is positioned in a position other than the predetermined position, the light blocking member is positioned above the light emitter and the light receiver. Thus, when the amount of ink in the ink chamber is less than the predetermine amount, light emitted from the light emitter passes through the protruding portion of the case and reaches the light receiver. The inkjet printer determines whether the amount of ink in the ink chamber is sufficient based on whether the light receiver receives light.

[0005] Nevertheless, even the inkjet printer having the

above configuration may incorrectly determine that the amount of ink in the ink cartridge is greater than the predetermined amount in some cases in spite of the fact that the amount of ink in the ink cartridge is less than the predetermined amount. The following may be regarded as a possible cause of the incorrect determination. When the ink cartridge is transported or a user handles the ink cartridge, the ink cartridge may be shaken, and a bubble or some bubbles may be produced in ink in the ink chamber. When bubbles contact the pivotable member and a surface of a wall defining the ink chamber, the surface tension of the bubbles may hinder the movement of the pivotable member. That is, even when the amount of ink in the ink chamber is reduced to become less than the predetermined amount, the pivotable member may be caught by the bubbles adhering to the surface of the wall, and prevented from rotating. In this case, the inkjet printer may incorrectly determine that the amount of ink in the ink chamber is greater than the predetermined amount. As an alternative possible cause of the incorrect determination, the following may be regarded. At ink cartridge manufacturing, ink may be first de-aerated to prevent the chemical property of ink from changing, and then stored in the ink chamber. To maintain de-aeration of ink, the ink chamber may be depressurized. A pair of opposing walls defining the ink chamber may be made of films having flexibility. When the ink chamber is depressurized, the opposing walls having flexibility may be deformed so as to protrude toward the inside of the ink chamber and the deformed opposing walls may sandwich the pivotable member from both sides thereof. Even if the pressure in the ink chamber is returned to atmospheric pressure when the ink cartridge is used, the opposing walls may remain deformed to sandwich the pivotable member. In this case, even when the amount of ink in the ink chamber becomes less than the predetermined amount, the pivotable member sandwiched between the opposing walls of the ink chamber cannot move. As a further possible cause of the incorrect determination, an ink cartridge of one type that is not intended to use with an ink jet printer of another type may be wrongly mounted to the inkjet printer. If the ink cartridge of one type does not have the pivotable member and the ink jet printer of another type has the detector to detect the pivotable member, the inkjet printer can not determine the amount of ink remaining in the ink chamber of the ink cartridge of because of the type difference.

SUMMARY OF THE INVENTION

[0006] Therefore, a need has arisen for a liquid ejecting apparatus and a liquid ejecting system which overcome these and other shortcomings of the related art. A technical advantage of the present invention is whether or not a liquid cartridge mounted to a mounting portion is normal can be determined.

[0007] According to an aspect of the present invention, a liquid ejecting apparatus according to claim 1 is provided.

[0008] Because the surface of the liquid stored in the liquid chamber is always parallel with the horizontal plane, when inclinations of the liquid chamber and the optical detector with respect to the horizontal plane change with the movement of the mounting portion, the position of the liquid surface with respect to the liquid chamber and the optical detector changes. Because the movable member moves in the liquid chamber according to the position of the liquid surface, when the mounting portion moves, the portion of the movable member moves along the path relative to the liquid chamber. Because the state of the light receiver changes according to the position of the portion of the movable member in the path, when the mounting portion moves, the state of the light receiver changes accordingly. When the state of the light receiver changes, the state determiner determines that the liquid cartridge is normal, i.e., the movable member functions normally. If the movement of the movable member is hampered or the liquid cartridge does not comprise the movable member, the state of the light receiver remains unchanged even when the mounting portion moves. Thus, the state determiner determines that the liquid cartridge is abnormal. As a result, the liquid ejecting apparatus can determine whether the liquid cartridge is normal or abnormal at an early stage of mounting the liquid cartridge to the mounting portion. Thus, a user can effectively deal with a problem at the early stage if an abnormal ink cartridge is mounted to the mounting portion.

[0009] The liquid ejecting apparatus may be an inkjet printer for forming images on recording media by ejecting ink and a device for adhering liquid to an object by ejecting liquid, for example, a device for forming wiring patterns on boards for printed wiring boards or manufacturing liquid crystal color filters.

[0010] The mounting portion may be moved manually or driven by a drive system comprised in the liquid ejecting apparatus. For example, the mounting portion may be moved by a motor.

[0011] The predetermined two states of the light receiver are, for example, a state in which the light receiver receives the light emitted from the light emitter at an intensity greater than or equal to a specified intensity, and a state in which the light receiver receives the light emitted from the light emitter at an intensity less than the specified intensity. The state in which the light receiver receives the light emitted from the light emitter at an intensity less than the specified intensity comprises a state where the light receiver does not receive the light emitted from the light emitter at all, that is, the intensity of light received by the light receiver is zero.

[0012] The portion of the movable member may be configured to prevent the light emitted from the light emitter from passing therethrough. Alternatively, the portion of the movable member may be configured to alter a path of the light emitted from the light emitter.

[0013] Timing at which the state determiner deter-

mines the change of the state of the light receiver is not limited. The state determiner may be configured to start to determine the change of the state of the light receiver when power is supplied to the liquid ejecting apparatus. Alternatively, the state determiner may be configured to start to determine the change of the state of the light receiver when the liquid cartridge is mounted to the mounting portion.

[0014] According to an aspect of the invention, a liquid ejecting apparatus according to claim 2 is provided.

[0015] As a result, the state determiner can reliably determine the change of the state of the light receiver associated with the movement of the mounting portion. For example, when the liquid ejecting apparatus is accidentally shaken, the movable member may move and the state of the light receiver may change. In this case, however, the determiner does not determine the state of the liquid cartridge. Thus, the probability of wrong determination of the state determiner can be reduced.

[0016] According to an aspect of the invention, a liquid ejecting apparatus according to claim 3 is provided.

[0017] Because the movement detector comprises the position detector that is configured to detect that the mounting portion is in the first or second position, the movement detector can detect that the mounting portion started to move by detecting that the mounting portion was moved from the first position. In addition, the movement detector can detect that the mounting portion moved from the first position up to the second position by detecting that the mounting portion which had been positioned in the first position reached the second position. Thus, the period of time in which the movement of the mounting portion is detected corresponds to a period of time from when the mounting portion moves from the first position to when the mounting portion reaches the second position. The state determiner determines whether the state of the light receiver has changed during the period of time in which the movement of the mounting portion is detected by comparing the state of the light receiver in the first detection state and the state of the light receiver in the second detection state. As a result, the state determiner does not need to monitor the state of the light receiver during the period of time in which the movement of the mounting portion is detected. In other words, the state determiner does not need to periodically determine the state of the light receiver over and over again. The state determiner determines the state of the light receiver only when the mounting portion is in the first position and the second position. Thus, the load on the state determiner during determination process is low. The light emitter emits light at least in the first detection state and the second detection state. The light emitter does not need to continue emitting light during the period of time in which the movement of the mounting portion is detected. Thus, the rate of deterioration of the light emitter due to light emission can be slowed down and the useful life of the light emitter can be increased. In addition, the state determiner finds the state of the light receiver in the first detection state and the second detection state in which the mounting portion is standing still. Thus, the state determiner can determine whether or not the ink cartridge is normal more reliably in comparison with a case where the state determiner determines the change in the state of the light receiver by monitoring the state of the light receiver while the mounting portion moves.

[0018] The mounting portion may be moved between the first position and the second position manually or driven by a drive system comprised in the liquid ejecting apparatus. For example, the mounting portion may be moved by a motor.

[0019] The first position and the second position both may be inclined with respect to the horizontal plane. Alternatively, one of the first position and the second position may be inclined with respect to the horizontal plane, and the other may be parallel with the horizontal plane.

[0020] The mounting portion may be configured such that the liquid cartridge can be mounted to the mounting portion in either of the first position and the second position.

[0021] The position detector may comprise a detector for detecting the mounting portion positioned in the first position and a detector for detecting the mounting portion positioned in the second position separately. For example, the position detector may comprise a first limit switch that contacts the mounting portion positioned in the first position, and a second limit switch that contacts the mounting portion positioned in the second position. Alternatively, the position detector may comprise a single detector for detecting both the mounting portion positioned in the first position and the mounting portion positioned in the second position. For example, when the mounting portion is moved by a motor, the position detector may detect the position of the mounting position indirectly from a rotational angle of the motor detected by an encoder attached to the motor. Alternatively, when the mounting portion is moved by a stepping motor, the position detector may detect the position of the mounting portion indirectly from the number of pulses given to the stepping motor.

[0022] According to an aspect of the invention, a liquid ejecting apparatus according to claim 4 is provided.

[0023] As a result, the following advantages may be obtained. If the liquid ejecting apparatus does not comprise a mount detector, it is difficult to distinguish between a case where the ink cartridge is not mounted to the mounting portion and a case where the movement of the movable member is hampered or the ink cartridge does not have the movable member. Thus, the state determiner may determine that the ink cartridge is abnormal in any of the both cases. However, because the liquid ejecting apparatus comprises the mount detector, it is possible to distinguish between the case where the ink cartridge is not mounted to the mounting portion and the case where the movement of the movable member is hampered or the ink cartridge does not have the movable

member. Thus, the state determiner can determine the abnormality of the ink cartridge with precision.

[0024] According to an aspect of the invention, a liquid ejecting apparatus according to claim 5 is provided.

[0025] As a result, the liquid ejecting apparatus can determine whether the liquid cartridge is normal or abnormal at an early stage of mounting the liquid cartridge to the mounting portion. Thus, a user can effectively deal with a problem at the early stage if an abnormal ink cartridge is mounted to the mounting portion.

[0026] A determination as to whether the state of the light receiver has changed during the period of time in which the movement of the mounting portion is detected may be made before or after it is detected that the mounting portion reaches the second position. Similarly, a determination that the liquid cartridge is normal may be made before or after it is detected that the mounting portion reaches the second position.

[0027] According to an aspect of the invention, a liquid ejecting apparatus according to claim 6 is provided.

[0028] As a result, the state determiner can determine that the ink cartridge is normal at an early stage without having to wait until the mounting portion reaches the second position.

[0029] According to an aspect of the invention, a liquid ejecting apparatus according to claim 7 is provided.

[0030] Because the movement detector comprises the position detector configured to detect that the mounting portion is in the first position, the movement detector can detect that the mounting portion started to move by detecting that the mounting portion was moved from the first position. Thus, the period of time in which the movement of the mounting portion is detected corresponds to a period of time in which the mounting portion is not in the first position. The time measure starts to measure a predetermined period of time when it is detected that the mounting portion started to move. The state determiner starts to monitor the state of the light receiver when it is detected that the mounting portion started to move, and determines whether the state of the light receiver has changed during the predetermined period of time. As a result, even if the liquid ejecting apparatus does not comprise a detector configured to detect that the mounting portion is in the second position, the state determiner can determine the state of the liquid cartridge. If the liquid ejecting apparatus comprised the detector configured to detect that the mounting portion is in the second position, the detector might be realized as a physical element, e.g. a mechanical switch configured to contacts the mounting portion to detect the position of the mounting portion, or an optical switch that emits light to the mounting portion to detect the position of the mounting portion. On the contrary, because the liquid ejecting apparatus of the invention does not need to comprise the detector configured to detect that the mounting portion is in the second position, the number of physical elements of the liquid ejecting apparatus is reduced. In addition, even when the state of the light receiver is unchanged because the mounting portion is out of order and is immovable, the state determiner determines that the ink cartridge is abnormal after the predetermined period of time elapses. Thus, a user can effectively deal with a failure in the mounting portion.

[0031] According to an aspect of the invention, a liquid ejecting apparatus according to claim 8 is provided.

[0032] The first position, in which the liquid cartridge is mountable to the mounting portion, and the second position, in which the ejection controller allows the liquid ejecting portion to eject liquid, are different. As a result, the first position can be set such that a user can easily mount the liquid cartridge to the mounting portion. In addition, the second position can be set such that the liquid ejection portion can eject liquid reliably. For example, when the liquid ejection portion comprises a plurality of nozzles and ejects the liquid from the nozzles, the second position can set such that the liquid cartridge is positioned lower than the nozzles, to apply an appropriate negative pressure to the liquid in the nozzles. With this configuration, the liquid ejection portion can reliably eject the liquid.

[0033] According to an aspect of the invention, a liquid ejecting apparatus according to claim 9 is provided.

[0034] As a result, the liquid ejecting apparatus can determine whether the liquid cartridge is normal or abnormal at an early stage of mounting the liquid cartridge to the mounting portion. Thus, a user can effectively deal with a problem at the early stage if an abnormal ink cartridge is mounted to the mounting portion.

[0035] A determination as to whether the state of the light receiver has changed during the period of time from when the mount detector detects that the liquid cartridge is mounted to the mounting portion to when the position detector detects that the mounting portion reaches the second position may be made before or after the position detector detects that the mounting portion reaches the second position. Similarly, a determination that the liquid cartridge is normal may be made before or after the position detector detects that the mounting portion reaches the second position.

[0036] According to an aspect of the invention, a liquid ejecting apparatus according to claim 10 is provided.

[0037] As a result, the state determiner can determine that the ink cartridge is normal at an early stage without having to wait until the mounting portion reaches the second position.

[0038] According to an aspect of the invention, a liquid ejecting apparatus according to claim 11 is provided.

[0039] As a result, even if the liquid ejecting apparatus does not comprise a detector configured to detect the position of the mounting portion, the state determiner can determine the state of the liquid cartridge. If the liquid ejecting apparatus comprised the detector configured to detect the position of the mounting portion, the detector may be realized as a physical element, e.g. a mechanical switch configured to contacts the mounting portion to detect the position of the mounting portion, or an optical switch that emits light to the mounting portion to detect

the position of the mounting portion. On the contrary, because the liquid ejecting apparatus of the invention does not need to comprise the detector configured to detect the position of the mounting portion, the number of physical elements of the liquid ejecting apparatus is reduced. In addition, even when the state of the light receiver is unchanged because the mounting portion is out of order and is immovable, the state determiner determines that the ink cartridge is abnormal after the predetermined period of time elapses. Thus, a user can effectively deal with a failure in the mounting portion.

[0040] According to an aspect of the invention, a liquid ejecting apparatus according to claim 12 is provided.

[0041] The first position, in which the liquid cartridge is mountable to the mounting portion, and the second position, in which the ejection controller allows the liquid ejecting portion to eject liquid, are different. As a result, the first position can be set such that a user can easily mount the liquid cartridge to the mounting portion. In addition, the second position can be set such that the liquid ejection portion can eject liquid reliably. For example, when the liquid ejection portion comprises a plurality of nozzles and ejects the liquid from the nozzles, the second position can set such that the liquid cartridge is positioned lower than the nozzles, to apply an appropriate negative pressure to the liquid in the nozzles. With this configuration, the liquid ejection portion can reliably eject the liquid.

[0042] According to an aspect of the invention, a liquid ejecting system according to claim 13 is provided.

[0043] Because the surface of the liquid stored in the liquid chamber is always parallel with the horizontal plane, when inclinations of the liquid chamber and the optical detector with respect to the horizontal plane change with the movement of the mounting portion, the position of the liquid surface with respect to the liquid chamber and the optical detector changes. Because the pivotable member moves in the liquid chamber according to the position of the liquid surface, when the mounting portion moves, the portion of the pivotable member moves along the path relative to the liquid chamber. Because the state of the light receiver changes according to the position of the portion of the pivotable member in the path, when the mounting portion moves, the state of the light receiver changes accordingly. When the state of the light receiver changes, the state determiner determines that the liquid cartridge is normal, i.e., the movable member functions normally. If the movement of the pivotable member is hampered or the liquid cartridge does not comprise the pivotable member, the state of the light receiver remains unchanged even when the mounting portion moves. Thus, the state determiner determines that the liquid cartridge is abnormal. As a result, the liquid ejecting apparatus can determine whether the liquid cartridge is normal or abnormal at an early stage of mounting the liquid cartridge to the mounting portion. Thus, a user can effectively deal with a problem at the early stage if an abnormal ink cartridge is mounted to the mounting portion.

[0044] The liquid cartridge is mounted to the mounting portion along the mounting direction extending from up to down. Because the liquid ink cartridge is pulled from up to down by the gravity, the liquid cartridge can be mounted to the mounting portion reliably.

[0045] The mounting portion can be moved in a relatively small space, and the liquid ejecting system can become smaller in size. Different from the liquid ejecting system according to claim 13, a relatively great space might be required for moving the mounting portion if the liquid ejecting system were configured as follows: when the mounting portion is in the second position and the pivotable member is submerged in liquid, the pivotable member contacts the contact portion and a distance between the center of buoyancy of the pivotable member and the surface of the liquid is greater than a distance between the center of the pivotal movement of the pivotable member and the surface of the liquid; and, while the liquid cartridge is mounted to the mounting portion positioned in the first position along the mounting direction, the center of the pivotal movement of the pivotable member is positioned below the center of buoyancy of the pivotable member with respect to the mounting direction. This is because, when the mounting portion is in the second position and the pivotable member is submerged in the liquid, a first angle, which is formed between: (a) a line segment connecting the center of the pivotal movement of the pivotable member and the center of buoyancy; and (b) a line that is parallel to the direction of gravity and passes through the center of the pivotal movement of the pivotable member, in the predetermined direction from the line segment to the line, would become obtuse. When the mounting portion moves from the first position to the second position, an angle of the mounting portion with respect to the horizontal plane changes. In order that the pivotable member moves relative to the liquid chamber in accordance with a change of the position of the surface of the liquid, if an offset between the center of buoyancy and the center of gravity of the pivotable member is relatively small, the mounting portion should move by at least about an angle equal to the first angle with respect to the horizontal plane. When the first angle is obtuse, the angle of the mounting portion moving between the first position and the second position with respect to the horizontal plane is also obtuse, and thus a space required for moving the mounting portion becomes relatively large. On the contrary, in the liquid ejecting system according to claim 13, the first angle is acute and the mounting portion can move in a relatively small space. As a result, the liquid ejecting system can become smaller in size.

[0046] The liquid ejecting system may be an inkjet system for forming images on recording media by ejecting ink and a system for adhering liquid to an object by ejecting liquid, for example, a system for forming wiring patterns on boards for printed wiring boards or manufacturing liquid crystal color filters..

[0047] The liquid cartridge may be mounted to the

mounting portion from up to down along the direction of gravity. Alternatively, the liquid cartridge may be mounted from up to down in a direction intersecting the direction of gravity.

[0048] According to an aspect of the invention, a liquid ejecting system according to claim 14 is provided.

[0049] When the center of buoyancy of the pivotable member coincides with the center of gravity of the pivotable member, by moving the mounting portion with respect to the horizontal plane by an angle greater than the first angle, the pivotable member can move relative to the liquid chamber according to a change of the position of the liquid surface. As a result, the amount of change in angle of the mounting portion with respect to the horizontal plane, which is necessary to determine the state of the liquid cartridge, can be easily found from the first angle.

[0050] Other objects, features, and advantages of embodiments of the present invention will be apparent to persons of ordinary skill in the art from the following description of preferred embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0051] For a more complete understanding of the present invention, the needs satisfied thereby, and the objects, features, and advantages thereof, reference now is made to the following description taken in connection with the accompanying drawings.

[0052] Fig. 1 is a schematic view showing an ink ejecting system according to a first embodiment of the invention.

[0053] Fig. 2A is a front perspective view of an ink cartridge, and Fig. 2B is a rear perspective view of the ink cartridge.

[0054] Fig. 3A is a front perspective view of an ink tank, and Fig. 3B is a rear perspective view of the ink tank.

[0055] Fig. 4A is a front perspective view of a frame, and Fig. 4B is a rear perspective view of the frame.

[0056] Fig. 5 is a cross sectional view of the ink cartridge taken along the line V - V of Fig. 2.

[0057] Fig. 6 is an enlarged view of a portion enclosed by a dash dot line VI of Fig. 5.

[0058] Fig. 7 is an enlarged view of a portion enclosed by a dash dot line VII of Fig. 5.

[0059] Fig. 8 is an enlarged view of a portion enclosed by a dash dot line VIII of Fig. 5.

[0060] Fig. 9A is a side view of the frame as viewed from one side of the frame along a width direction, and Fig. 9B shows walls defining an ink chamber, which are taken out from the frame of Fig. 9A.

[0061] Fig. 10A is a side view of the frame as viewed from the other side of the frame along the width direction, and Fig. 10B shows walls defining the ink chamber, which are taken out from the frame of Fig. 10A.

[0062] Figs. 11A and 11B are perspective views of a pivotable member as viewed from different angles.

[0063] Fig. 12 is a perspective view of an ink supply device when a mounting portion is positioned in a first position.

[0064] Fig. 13 is a perspective view of the ink supply device when the mounting portion is positioned in a second position.

[0065] Fig. 14 is a front view of the ink supply device as viewed from an arrowed direction XIV of Fig. 12.

[0066] Fig. 15 is a side view of the ink supply device when the mounting portion is positioned in the first position as viewed along a direction X.

[0067] Fig. 16 is a side view of the ink supply device when the mounting portion is in a position between the first position and the second position as viewed along the direction X.

[0068] Fig. 17 is a side view of the ink supply device when the mounting portion is positioned in the second position as viewed along the direction X.

[0069] Fig. 18 is a cross sectional view of the mounting portion taken along the line XVIII - XVIII of Fig. 14.

[0070] Fig. 19 is a perspective view of an optical detector.

[0071] Fig. 20 is a perspective view of another optical detector.

[0072] Fig. 21 is a cross sectional view of the ink cartridge and the mounting portion when the ink cartridge is mounted to the mounting portion of Fig. 18, that is, Fig. 21 is a cross sectional view of the mounting portion and the ink cartridge mounted thereto taken along the line XVIII - XVIII of Fig. 14.

[0073] Fig. 22 is an enlarged view of an area enclosed by a dash dot line XXII of Fig. 21.

[0074] Fig. 23 is an enlarged view of an area enclosed by a dash dot line XXIII of Fig. 21.

[0075] Fig. 24 is a block diagram showing an electrical configuration of the inkjet printer.

[0076] Fig. 25 is a cross sectional view of the ink cartridge mounted to the mounting portion positioned in the first position taken along the line V - V of Fig. 2, in which a first cover, a second cover, a portion of an ink supply portion, and a portion of an air communication portion are omitted to show the frame and a pivotable member.

[0077] Fig. 26 is a cross sectional view of the ink cartridge mounted to the mounting portion being in a position between the first position and the second position, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member similarly to Fig. 25.

[0078] Fig. 27 is a cross sectional view of the ink cartridge mounted to the mounting portion being in a position between the first position and the second position, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member similarly to Fig. 25.

[0079] Fig. 28 is a cross sectional view of the ink cartridge mounted to the mounting portion in the second

position, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member similarly to Fig. 25.

[0080] Fig. 29 is a flowchart of a determination process executed by a controller to determine whether or not the ink cartridge is normal.

[0081] Fig. 30 is a cross sectional view of the ink cartridge mounted to the mounting portion positioned in the second position taken along the line V - V of Fig. 2, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member. A first amount of ink is stored in the ink chamber.

[0082] Fig. 31 a cross sectional view of the ink cartridge mounted to the mounting portion positioned in the second position taken along the line V - V of Fig. 2, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member. A second amount of ink is stored in the ink chamber.

[0083] Fig. 32 a cross sectional view of the ink cartridge mounted to the mounting portion positioned in the second position taken along the line V - V of Fig. 2, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member. No ink is stored in an ink chamber.

[0084] Fig. 33 is a cross sectional view of an ink cartridge according to a second embodiment mounted to the mounting portion positioned in the first position taken along the line V - V of Fig. 2, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member.

[0085] Fig. 34 is a cross sectional view of the ink cartridge according to the second embodiment mounted to the mounting portion positioned in the second position taken along the line V - V of Fig. 2, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member.

[0086] Fig. 35 is a block diagram showing an electrical configuration of an inkjet printer according to a third embodiment.

[0087] Fig. 36 is a flowchart of a determination process executed by a controller of the third embodiment to determine whether or not the ink cartridge is normal.

[0088] Fig. 37 is a flowchart of a determination process executed by a controller of a fourth embodiment to determine whether or not the ink cartridge is normal.

[0089] Fig. 38 is a flowchart of a determination process executed by a controller of a fifth embodiment to determine whether or not the ink cartridge is normal.

[0090] Fig. 39 is a flowchart of a determination process executed by a controller of a sixth embodiment to determine whether or not the ink cartridge is normal.

[0091] Fig. 40 is a flowchart of a determination process executed by a controller of a seventh embodiment to determine whether or not the ink cartridge is normal.

[0092] Fig. 41 is a flowchart of a determination process executed by a controller of an eighth embodiment to determine whether or not the ink cartridge is normal.

[0093] Fig. 42 is a flowchart of a determination process executed by a controller of a ninth embodiment to determine whether or not the ink cartridge is normal.

[0094] Fig. 43 is a cross sectional view of an ink cartridge according to a tenth embodiment mounted to the mounting portion positioned in the first position taken along the line V - V of Fig. 2, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member.

[0095] Fig. 44 is a cross sectional view of the ink cartridge according to the tenth embodiment mounted to the mounting portion positioned in the second position taken along the line V - V of Fig. 2, in which the first cover, the second cover, the portion of the ink supply portion, and the portion of the air communication portion are omitted to show the frame and the pivotable member.

DETAILED DESCRIPTION OF EMBODIMENTS

[0096] Embodiments of the present invention and their features and technical advantages may be understood by referring to Figs. 1 - 44, like numerals being used for like corresponding portions in the various drawings.

[0097] <A first embodiment> A first embodiment of a liquid ejecting system, to which the present invention is applied, e.g. an ink ejecting system 1 comprising an inkjet printer 100 and an ink cartridge 10, will be described with reference to Figs. 1 - 32.

[0098] <Description of Overall configuration of ink ejecting system> An overall configuration of the ink ejecting system 1 will be described with reference to Fig. 1. The ink ejecting system 1 as an example of a liquid ejecting system comprises the inkjet printer 100 as an example of a liquid ejecting apparatus, and at least one ink cartridge 10 as an example of a liquid cartridge. The inkjet printer 100 is configured to record an image, e.g., a monochrome image or color image, on a recording medium, e.g. a sheet of paper, with at least one ink, e.g., four inks such as a black ink, a yellow ink, a cyan ink, and a magenta ink. The inkjet printer 100 comprises a feeding device 110, a transferring device 120, and a recording device 130. The inkjet printer 100 further comprises a first tray 140 and a second tray 141 and a transfer path 142 extending from the first tray 140 to the second tray 141. The feeding device 110 is configured to feed sheets of paper accommodated in the first tray 140 one by one to transfer path 142.

[0099] The transferring device 120 comprises a first pair of transfer rollers 121 and a second pair of transfer rollers 122 positioned along the transfer path 142. The first pair of transfer rollers 121 is positioned on an up-

stream side of the recording device 130, and the second pair of transfer rollers 122 is positioned on a downstream side of the recording device 130 along the transfer path 142.

[0100] The inkjet printer 100 also comprises a platen 145 positioned directly below the recording device 130. The sheet of paper fed by the feeding device 120 is transferred onto the platen 145 by the first pair of transfer rollers 121. The recording device 130 is configured to record an image on the sheet of paper being transferred over the platen 145. The sheet of paper having passed over platen 145 is transferred by the second pair of transfer rollers 122 to the second tray 141, which is positioned at the downstream end of the transfer path 142.

[0101] The recording device 130 comprises a carriage 131, and a recording head 132, as an example of a liquid ejection portion, which is mounted to the carriage 131. The recording device 130 comprises a head control circuit 133, as an example of an ejection controller, which is mounted to the carriage 131. The recording head 132 is formed with a plurality of nozzles 134. The recording head 132 comprises at least one sub-tank, e.g., four sub-tanks 135 storing four kinds of inks such as a black ink, a yellow ink, a cyan ink, and a magenta ink, respectively. The carriage 131 is supported by rails (not shown) such that the carriage 131 slides on the rails in a direction perpendicular to the paper plane of Fig. 1. Each of the sub-tanks 135 is configured to store ink of a corresponding color to be supplied to the nozzles 134. When a signal is input to the head control circuit 133, the head control circuit133 controls the recording head 132 based on the signal, to eject ink from the nozzles 134.

[0102] The recording head 132 comprises an actuator having a piezoelectric element, corresponding to each nozzle 134. When a voltage is applied to the piezoelectric element by the head control circuit 133, the piezoelectric element is deformed. The deformation of the piezoelectric element pressurizes ink in the nozzle 134, such that ink is ejected from the nozzle 134.

[0103] The inkjet printer 100 comprises an ink supply device 30. The ink supply device 30 comprises a mounting portion 300 to which at least one ink cartridge 10 is removably mounted. For example, four ink cartridges 10 storing a black ink, a yellow ink, a cyan ink, and a magenta ink, respectively, are mounted to the mounting portion 300 independently and removably. The ink supply device 30 comprises at least one connection portion, e.g., flexible tube 350. The ink supply device 30 comprises, for example, four flexible tubes 350. Each tube 350 is inserted into the mounting portion 300 at one end and fitted into a joint provided in the sub-tank 135 at the other end. The ink cartridge 10 comprises an ink chamber 11, as an example of a liquid chamber. When the ink cartridge 10 is mounted to the mounting portion 300, the ink chamber 11 and the sub-tank 135 communicate with each other via the tube 350. When ink is ejected from the recording head 132, ink is accordingly supplied from the ink chamber 11 to the sub-tank 135.

[0104] <Description of ink cartridge> The structure of the ink cartridge 10 will be described with reference to Figs. 2A - 11B.

[0105] Fig. 2A is a perspective view of the ink cartridge 10 as viewed from front, and Fig. 2B is a perspective view of the ink cartridge 10 as viewed from rear. Front and rear are referred to as those with respect to a mounting direction along which the ink cartridge 100 is mounted to the mounting portion 300. As shown in Figs. 2A and 2B, the ink cartridge 10 has a substantially rectangular parallelepiped shape. A width of the ink cartridge 10 in a width direction as indicated by an arrow 12 is relatively short, and each of a height of the ink cartridge 10 in a height direction as indicated by an arrow 14, and a depth of the ink cartridge 10 in a depth direction as indicated by an arrow 13, is greater than the width of the ink cartridge 10. The ink cartridge 10 comprises a first cover 15 and a second cover 16, which provide a most portion of an outward appearance of the ink cartridge 10.

[0106] The ink cartridge 10 comprises an ink tank 18 which is enclosed by the first cover 15 and the second cover 16. In Figs. 3A and 3B, the first cover 15 and the second cover 16 are removed from the ink cartridge 10, and the ink tank 18 is shown. The ink tank 18 comprises a frame 20 and a pair of sidewalls 21. The frame 20 has a substantially rectangular parallelepiped shape having a width in the width direction 12, a height in the height direction 14, and a depth in the depth direction 13. The outer surface of the frame 20 comprises a front surface 22, a rear surface 23 opposite to the front surface 22 in the depth direction 13, a top surface 24, and a bottom surface 25 opposite to the top surface 24 in the height direction 14. The top surface 24 is connected to the front surface 22 and the rear surface 23. Similarly, the bottom surface 25 is connected to the front surface 22 and the top surface 23.

[0107] The frame 20 is formed of a translucent resin material, e.g., a transparent material or a semi-transparent material, such that light, e.g., visible or infrared light passes therethrough. In this embodiment, the frame 20 is manufactured by injection-molding nylon, polyethylene, polypropylene or the like.

[0108] The sidewalls 21 are connected to, e.g., welded or bonded by adhesive to, both sides of the frame 20 in the width direction 12, respectively.

[0109] In Figs. 4A and 4B, the pair of sidewalls 21 is removed from the ink tank 18, and the frame 20 is shown. As shown in Figs. 4A and 4B, the ink chamber 11 is formed inside the frame 20. The ink chamber 11 is defined by the frame 20 and the pair of sidewalls 21 connected to both sides of the frame 20 in the width direction 12. More specifically, the ink chamber 11 is defined by the walls of the frame 20 shown in Figs. 9B and 10B and the pair of side walls 21 connected to the walls.

[0110] Referring again to Figs. 3(A) and 3(B), the pair of sidewalls 21 is formed of a resin material, e.g., nylon, polyethylene, polypropylene or the like. When the pair of sidewalls 21 is welded to both sides of the frame 20 in

the width direction 12, the pair of sidewalls 21 is preferably formed of the same material as the frame 20. The pair of sidewalls 21 may be a pair of flexible films. In other words, the pair of sidewalls 21 may have a thickness allowing the pair of sidewalls 21 to deform toward the ink chamber 11 when an external force is applied to the pair of sidewalls 21. For example, the pair of sidewalls 21 may have a thickness allowing the pair of sidewalls 21 to deform toward the ink chamber 11 due to a pressure differential between the pressure inside the ink chamber 11 and the atmospheric pressure outside the ink chamber 11 when the inside of the ink chamber 11 is depressurized to be less than the atmospheric pressure.

[0111] Fig. 5 is a cross sectional view of the ink cartridge 10 taken along the line V - V of Fig. 2, i.e., a cross sectional view of the ink cartridge 10 in a plane which passes through a center of the ink cartridge 10 with respect to the width direction 12 and which is parallel to the depth direction 13 and the height direction 14. As shown in Figs. 3B, 4B, and 5, the frame 20 comprises a cylindrical ink inlet portion 40. The ink inlet portion 40 extends in the depth direction 13 from the rear surface 23 toward the front surface 22. The ink inlet portion 40 communicates with the ink chamber 11. In manufacturing the ink cartridge 10, ink is introduced into the ink chamber 11 via the ink inlet portion 40. After ink is introduced into the ink chamber 11, a cylindrical rubber plug 42 is pressed into the ink inlet portion 40. The rubber plug 42 closes off communication between the ink chamber 11 and the outside of the ink tank 18 via the ink inlet portion 40.

[0112] As shown in Figs. 3A - 5, the frame 20 comprises a protrusion 24A positioned on the top surface 24. The protrusion 24A extends from the top surface 24 in the height direction 14 away from the ink chamber 11.

[0113] As shown in Figs. 3A - 5, the ink tank 18 comprises an ink supply portion 50 and an air communication portion 60 positioned at the front surface 24. The ink supply portion 50 is positioned adjacent to the bottom surface 25 of the frame 20. The air communication portion 60 is positioned adjacent to the top surface 24.

[0114] As shown in Fig. 7, the ink supply portion 50 comprises a cylindrical ink supply chamber 51, a valve body 52 made of resin, a sealing member 53 made of rubber, a coil spring 54 made of metal, a check valve 55 made of resin and rubber, and a cap 56 made of resin.

[0115] The ink supply chamber 51 extends in the depth direction 13 from the front surface 22 of the frame 20 toward the ink chamber 11. The ink supply chamber 51 comprises a first end 51A and a second end 51B opposite to the first end 51A in the depth direction 13. The first end 51A is positioned closer to the ink chamber 11 than the second end 51B is. The ink supply chamber 51 communicates with the ink chamber 11 via the first end 51A.

[0116] The check valve 55 is positioned at the first end 51A of the ink supply chamber 51. The check valve 55 is configured to allow ink to flow from the ink chamber 11 toward the ink supply chamber 51 and to prevent ink from flowing from the ink supply chamber 51 toward the ink chamber 11.

[0117] The second end 51B of the ink supply chamber 51 is open to the outside of the frame 20. The sealing member 53 is positioned at the second end 51B. The sealing member 53 has a cylindrical opening 53A formed therethrough in the depth direction 13.

[0118] The cap 56 is fitted in the frame 20. The cap 56 has an opening 56A formed therethrough in the depth direction 13. The sealing member 53 is sandwiched between a portion of the frame 20 defining the second end 51B of the ink supply chamber 51 and the cap 56 while being elastically deformed. Thus, the portion of the frame 20 defining the second end S1B and the cap 56 close communication between the ink supply chamber 51 and the outside of the ink tank 18.

[0119] The valve body 52 and the coil spring 54 are positioned in the ink supply chamber 51. A protruding member 57 is positioned at the first end 51A of the ink supply chamber 51 and comprises a cylindrical protrusion extending from the first end 51A toward the second end 51B. The protruding member 57 is fitted in the ink supply chamber 51. The protrusion of the protruding member 57 is inserted into one end of the coil spring 54, such that the coil spring 54 is attached to the protruding member 57. The valve body 52 has a cylindrical protrusion which is inserted into the other end of the coil spring 54, such that the coil spring 54 is attached to the valve body 52. The coil spring 54 is held under compression to press the valve body 52 toward the sealing member 53. The valve body 52 is positioned in contact with the sealing member 53 to cover the opening 53A. Thus, the valve body 52 closes off communication between the ink supply chamber 51 and the outside of the ink tank 18 via the opening 53A.

[0120] As shown in Figs. 5 and 8, the air communication portion 60 comprises a cylindrical air communication chamber 61, a valve body 62 made of resin, a sealing member 63 made of rubber, a coil spring 64 made of metal, and a cap 66 made of resin.

[0121] The air communication chamber 61 extends in the depth direction from the front surface 22 of the frame 20 toward the ink chamber 11. The air communication chamber 61 comprises a first end 61A and a second end 61B opposite to the first end 61A in the depth direction 13. The first end 61A is positioned closer to the ink chamber 11 than the second end 61B is.

[0122] The second end 61B of the air communication chamber 61 is open to the outside of the frame 20. The sealing member 63 is positioned at the second end 61B. The sealing member 63 has a cylindrical opening 63A formed therethrough in the depth direction 13.

[0123] The cap 66 is fitted in the frame 20. The cap 66 has an opening 66A formed therethrough in the depth direction 13. The sealing member 63 is sandwiched between a portion of the frame 20 defining the second end 61B of the air communication chamber 61 and the cap 66 while being elastically deformed. Thus, the portion of

the frame 20 defining the second end 61B and the cap 66 close communication between the air communication chamber 61 and the outside of the ink tank 18.

[0124] The sealing member 63 comprises a cylindrical leg portion 63B. The leg portion 63B passes through the opening 66a of the cap 66 and extends in the depth direction 13 away from the air communication chamber 61. The leg portion 63B has a cylindrical opening 63C formed therethrogh in the depth direction 13. The opening 63C is contiguous with the opening 63A.

[0125] The valve body 62 and the coil spring 64 are positioned in the air communication chamber 61. A protrusion 65 extends from the first end 61A toward the second end 61B. The protrusion 65 is inserted into one end of the coil spring 64, such that the coil spring 64 is attached to the protrusion 65. The valve body 62 has a cylindrical protrusion which is inserted into the other end of the coil spring 64, such that the coil spring 64 is attached to the valve body 62. The coil spring 64 is held under compression to press the valve body 62 toward the sealing member 63. The valve body 62 is positioned in contact with the sealing member 63 to cover the opening 63A. Thus, the valve body 62 closes off communication between the air communication chamber 61 and the outside of the ink tank 18 via the opening 63A and the opening 66A. The valve body 62 has a protrusion 62A. The protrusion 62A extends in the depth direction 13 through the openings 63A and 63C away from the air communication chamber 61.

[0126] As shown in Figs. 4, 8, and 10, an air communication passage 67 is formed in the frame 20. The air communication passage 67 extends in the depth direction 13 along an end of the frame 20 with respect to the width direction 12, continues to the first end 61A of the air communication chamber 61 at a position close to the front surface 22, and continues to the ink chamber 11 at a position close to the rear surface 23. Thus, the air communication chamber 61 communicates with the ink chamber 11 via the air communication passage 67. The air communication passage 67 is covered by one of the pair of sidewalls 21 connected to the frame 20.

[0127] As shown in Figs. 3A - 6, the frame 20 comprises a protrusion 70 on the front surface 22. The protrusion 70 extends from the front surface 22 in the depth direction 13 away from the rear surface 23. The protrusion 70 has a substantially rectangular parallelepiped shape having a width in the width direction, which is less than the width of the front surface 22. The protrusion 70 comprises a front wall 71, a pair of sidewalls 72 connected to the front wall 71, a top wall 73 connected to the front wall 71, the front surface 22, and the pair of sidewalls 72, and a bottom wall 74 positioned opposite to the top wall 73 in the height direction 14 and connected to the front wall 71, the front surface 22 and the pair of sidewalls 72. As shown in Figs. 5 and 6, the protrusion 70 comprises an inner space 75 defined by the front wall 71, the pair of sidewalls 72, the top wall 73, and the bottom wall 74. The inner space 75 is a portion of the ink chamber 11. Because the frame 20 allows light to pass therethrough as described above, visible or infrared light passes through the protrusion 70.

[0128] As shown in Fig. 6, the frame 20 comprises a first contact portion 74A and a second contact portion 73A in the inner space 75. The first contact portion 74A is a wall extending from a center of the bottom wall 74 with respect to the width direction 12 toward the top wall 73. The second contact portion 73A is a wall extending from a center of the top wall 73 with respect to the width direction 12 toward the bottom surface 74.

[0129] As shown in Figs. 4A - 5, the frame 20 comprises a pair of walls 80 having a substantially circular plate shape. The pair of walls 80 extends from a portion of a wall defining the ink chamber 11 into the ink chamber 11. As shown in Fig. 5, the pair of walls 80 is positioned adjacent to the first end 51a of the ink supply chamber 51. The pair of walls 80 is aligned in the width direction 12. A cylindrical shaft 82 extends in the width direction from one of the walls 80 to the other of the walls 80.

[0130] <Description of movable member (pivotable member)> As shown in Figs. 4A - 6, the ink tank 18 comprises a movable member, e.g., a pivotable member 90, positioned in the ink chamber 11. The pivotable member 90 is pivotally supported by the shaft 82 shown in Fig. 5.

[0131] The pivotable member 90 is formed of a resin material, e.g., polyethylene, polypropylene, or polyolefin, having a specific gravity which is less than that of ink stored in the ink chamber 11, and black pigment, e.g., carbon black is added to the resin material. Because the pivotable member 90 comprises black carbon, the pivotable member 90 blocks light when irradiated with light, e.g., visible or infrared light. That is, the pivotable member 90 absorbs light and thus light can not pass through the pivotable member 90.

[0132] As shown in Figs. 11A and 11B, the pivotable member 90 comprises a first portion 92, a second portion 93, and a support portion 94. The support portion 94 comprises a rotation center portion 94A having a substantially circular plate shape, and a connection portion 94B having a substantially rectangular parallelepiped shape extending from the rotation center portion 94A. The rotation center portion 94A comprises a cylindrical opening 94C formed therethrough in the width direction 12.

[0133] As shown in Fig. 5, the shaft 82 extends from one of the walls 80 through the opening 94C to the other of the walls 80 in the width direction 12. The pivotable member 90 is supported by the shaft 82, such that the pivotable member 90 pivots about the center axis of the shaft 82 extending in the width direction 12, i.e., the center axis of the shaft 82 is the center of the pivotal movement of the pivotable member 90. The pivotable member 90 is pivotable in the ink chamber 11 according to a position of the surface of ink in the ink chamber 11 in a plane substantially parallel with the depth direction 13 and the height direction 14.

[0134] As shown in Figs. 11A and 11B, the first portion 92 comprises a bulky portion 92A having a substantially

circular plate shape and a connection portion 92B having a substantially sector shape in a side view. The connection portion 92B is connected to the connection portion 94B of the support portion 94.

[0135] The second portion 93 comprises a light blocking portion 93A, a first connection portion 93B, and a second connection portion 93C. The first connection portion 93B is connected at one end to the light blocking portion 93A and at the other end to the second connection portion 93C. The second connection portion 93C is connected at one end to the first connection portion 93C and at the other end to the connection portion 94B of the support portion 94 and the connection portion 92B of the first portion 92. As shown in Fig. 5, the light blocking portion 93A is positioned in the inner space 75 of the protrusion 70.

[0136] The volume of the first portion 92 is greater than the total of the volume of the second portion 93 and the volume of the support portion 94. As shown in Fig. 5, in this embodiment, when the pivotable member 90 is submerged in ink in the ink chamber 11, the center of buoyancy 91 and the center of gravity of the pivotable member 90 are in the first portion 92. In this embodiment, the pivotable member 90 has a uniform density distribution and ink stored in the ink chamber 11 also has a uniform density distribution. Thus, the center of buoyancy 91 of the pivotable member 90 submerged in ink in the ink chamber 11 coincides with the center of gravity of the pivotable member 90. However, the center of buoyancy 91 and the center of gravity of the pivotable member 90 may not coincide with each other in another embodiment.

[0137] With reference to Figs. 2A and 2B, the first cover 15 and the second cover 16 will be described in detail. The first cover 15 and the second cover 16 cover the ink tank 18 except for a portion of the front surface 22 of the frame 20 and a portion of the top surface 24 of the frame 20. Specifically, the first cover 15 covers a portion of the front surface 22 of the frame 20, a front surface 22-side of the top surface 24 of the frame 20, a front surface 22-side of the bottom surface 25 of the frame 20, and a front surface 22-side of the pair of sidewalls 22. The second cover 16 covers the rear surface 23 of the frame 20, a portion of a rear surface 23-side of the top surface 24 of the frame 20, a rear surface 23-side of the bottom surface 25 of the frame 20, and a rear surface 23-side of the pair of sidewalls 21.

[0138] The first cover 15 comprises a front wall 150 facing the front surface 22 of the frame 20, a top wall 151 facing the front surface 22-side of the top surface 24 of the frame 20, and a pair of sidewalls 152 facing the front surface 22-side of the pair of sidewalls 21. The front wall 150 comprises a cylindrical first opening 154 and a cylindrical second opening 156 formed therethrough and extending in the depth direction 13. The ink supply portion 50 passes through the first opening 154 and extends to the outside of the first cover 15 from the inside of the first cover 15. The air communication portion 60 is positioned inside the first cover 15 and aligned with the second opening 156 in the depth direction 13. Thus, the air communication portion 60 is accessible from the outside of the first cover 15 via the second opening 156 along the depth direction 13. The sidewalls 152 comprise third openings 158, respectively, formed therethrough in the width direction 12 and having a substantially rectangular shape. The sidewalls 72 of the protrusion 70 shown in Fig. 3A are exposed to the outside of first cover 15 via the third openings 158 of the sidewalls 152.

[0139] The top wall 151 comprises a protrusion 159 at a center thereof with respect to the width direction 12. The protrusion 159 is positioned adjacent to the boundary between the front wall 150 and the top wall 151. The protrusion 159 has a substantially rectangular parallelepiped shape having a width in the width direction 12, a depth in the depth direction 13, and a height in the height direction 14. The width of the protrusion 159 is less than the height thereof, and the height is less than the depth.

[0140] The first cover 15 is formed of a resin material, e.g., nylon, polyethylene, polypropylene, polycarbonate, polyolefin, polystyrene, acrylic resin, acrylonitrile butadiene styrene (ABS), to which black pigment, e.g., carbon black is added. As the first cover 15 comprises carbon black, the first cover 15 blocks light when irradiated with light, e.g., visible or infrared light. That is, the first cover 15 absorbs light and thus light can not pass through the first cover 15.

[0141] The second cover 16 comprises a top wall 160 facing the rear surface 23-side of the top surface 24 of the frame 20. The top wall 160 comprises a fourth opening 162 formed therethrough in the height direction 14. A portion of the top surface 24 of the frame 20 and the protrusion 24A are exposed to the outside of the second cover 16 via the fourth opening 162.

[0142] The second cover 16 is formed of a resin material, e.g., nylon, polyethylene, polypropylene, polycarbonate, polyolefin, polystyrene, acrylic resin, acrylonitrile butadiene styrene (ABS), to which black pigment, e.g., carbon black is added.

[0143] <Description of ink supply device and mounting portion> With reference to Figs. 12 - 23, the ink supply device 30 comprising the mounting portion 300 will be described. In the figures, two directions parallel to the horizontal plane and perpendicular to each other are referred to as an X direction and a Y direction, and a direction perpendicular to the X direction and the Y direction and parallel to the direction of gravity is referred to as a Z direction.

[0144] In Figs. 12 -17, two ink cartridges 10 are mounted to the mounting portion 300. In Figs. 12, 13 and 15 - 17, a support wall 320A is shown as partially cut away. In Figs. 12 - 14, a first limit switch 346 and a second limit switch 348 are omitted. In Figs. 15 - 17, a support wall 320B is not shown.

[0145] As shown in Figs. 12 - 17, the ink supply device 30 comprises the mounting portion 300, a link mechanism 310, and a pair of support walls 320A, 320B.

[0146] Each of the support walls 320A, 320B have a

flat plate shape extending in the Y and Z directions. The support walls 320A, 320B are aligned with each other in the X direction. The support walls 320A, 320B are fixed to a casing (not shown) of the inkjet printer 100. Each of the support walls 320A, 320B comprises a first opening 321 and a second opening 322 formed therethrough in the X direction. The second opening 322 is positioned below the first opening 321. The first opening 321 has an elongate shape and extends in the Y direction. One end of the first opening 321 in the Y direction (a right-side end in Figs. 15 - 17) is higher than the other end of the first opening 321 in the Y direction (a left-side end in Figs. 15 - 17). The first opening 321 extends from the one end thereof to the other end thereof, such that the first opening 321 is slightly curved to be convex upward. The second opening 322 has an elongate shape and extends substantially linearly in the Y direction. A cylindrical shaft 323 extends in the X direction between the pair of support walls 320A, 320B. The shaft 323 is positioned directly below one end of the second opening 322 (a left-side end in Figs. 15 - 17).

[0147] As shown in Figs. 12, 13, and 14, the mounting portion 300 is positioned between the pair of support walls 320A, 320B. As shown in Figs. 12, 13, 14, and 18, the mounting portion 300 has a substantially rectangular parallelepiped shape. The mounting portion 300 comprises a bottom wall 301, a pair of sidewalls 302, a top wall 303, and a rear wall 304 (shown in Fig. 18 only). The sidewalls 302 extend from both ends of the bottom wall 301 with respect to the X direction, respectively, and face the support walls 320A, 320B respectively. The top wall 303 is connected to ends of the sidewalls 302 opposite to the bottom wall 301, and extends between the sidewalls 302. The rear wall 304 is connected to the bottom wall 301, the pair of sidewalls 302, and the top wall 303. Ends of the bottom wall 301, the pair of sidewalls 302, and the top wall 303 opposite to ends thereof connected to the rear wall 304 define an opening 305.

[0148] As shown in Figs. 14 and 18, the mounting portion 300 comprises three partition walls 306. Each of the three partition walls 306 has a first partition wall 306A and a second partition wall 306B. The first partition walls 306A extend from the bottom wall 301 toward the top wall 303. The first partition walls 306A are spaced apart in the X direction. The first walls 306A extend from the rear wall 304 up to the opening 305. The second partition walls 306B extend from a surface of the respective first partition walls 306A facing the top wall 303 up to the top wall 303. The second partition walls 306B reach the top wall 303. The second partition walls 306B extend from the rear wall 304 toward the opening 305. The second partition walls 306B do not reach the opening 305. The second partition walls 306B are spaced apart in the X direction. The inside of the mounting portion 300 is divided into four spaces in the X direction by the three first partition walls 306A and the second partition walls 306B, such that four ink cartridges 10 are mounted to the four spaces in the mounting portion 300, respectively.

[0149] As shown in Figs. 12 - 17, the mounting portion 300 comprises a pair of cylindrical first shafts 307, a pair of cylindrical second shafts 308, and a pair of cylindrical third shafts 309, which extend from the pair of sidewalls 302 toward the pair of support walls 320a, 320B of the ink supply device 30, respectively. The first shafts 307 are inserted into the first openings 321 formed through the support walls 320A, 320B, respectively. The second shafts 308 are inserted into the second openings 322 formed through the support walls 320A, 320B, respectively. The third shafts 309 do not reach the support walls 320A, 320B. As shown in Fig. 14, the third shafts 309 are positioned between the first shafts 307 and the second shafts 308.

[0150] As shown in Figs. 12 - 17, the link mechanism 310 is positioned between the pair of support walls 320A, 320B in the X direction. The link mechanism 310 comprises a handle 311, a pair of L-shaped portions 312, and a pair of linearly-extending links 313. The mounting portion 300 is positioned between the pair of L-shaped portions 312 and the pair of links 313 in the X direction. The handle 311 extends between the pair of L-shaped portions 312. The handle 311 has a cylindrical shape and extends in the X direction. Each of the L-shaped portions 312 comprises a bending portion in which two linear portions are connected to form a 90-degree angle. Each end of the handle 311 in the X direction is connected to one end of each of the L-shaped portions 312. The other end of each of the L-shaped portions 312 comprises a cylindrical opening 314 formed therethrough in the X direction. The shaft 323 passes through the opening 314 of each of the L-shaped portions 312 and extends between the support walls 320A, 320B. A pair of cylindrical fourth shafts 315 extends from the bending portions of the L-shaped portions 312, respectively, in the X direction away from each other. Each of the pair of links 313 comprises an opening 316 and an opening 317, formed therethrough in the X direction, at one end and the other end, respectively. Each of the third shafts 309 of the mounting portion 300 is inserted into the opening 316 of a corresponding one of the links 313. Each of the fourth shafts 315 of the L-shaped portions 312 is inserted into the opening 317 of a corresponding one of the links 313.

[0151] The link mechanism 310 causes the mounting portion 300 to be movable between a first position and a second position in a direction parallel with a plane defined by the Y direction and the Z direction. As shown in Fig. 15, when the mounting portion 300 is in the first position, the pair of first shaft 307 and the pair of second shaft 308 are positioned at the left-side ends of the first and second openings 321, 322 of the pair of support walls 320A, 320B, respectively. When in the first position, the mounting portion 300 is inclined such that a reference surface 301A of the bottom wall 301 and the horizontal plane indicated by alternate long and short lines in Fig. 15 form a 30-degree angle. When the mounting portion 300 is in the first position, the ink cartridge 10 can be mounted to the mounting portion 300.

[0152] In Fig. 15, when a user raises the handle 311 in an upper right direction, the L-shaped portions 312 rotate about the shaft 323 clockwise. Upon the clockwise rotation of the L-shaped portions 312, the fourth shafts 315 raise the left-side ends of the links 313 in the upper right direction. When the left-side ends of the links 313 are raised, the links 313 push the third shafts 309 rightward while rotating about the third shafts 309 and about fourth shafts 315. Accordingly, while the first shafts 307 and the second shafts 308 are guided in the first openings 321 and the second openings 322 respectively, the mounting portion 300 is moved rightward and reaches the second position shown in Fig. 17 via a position shown in Fig. 16. On the other hand, to move the mounting portion 300 from the second position to the first position, a user pulls the handle 311 in a lower left direction in Fig. 17.

[0153] As shown in Fig. 17, when the mounting portion 300 is in the second position, the first shafts 307 and the second shafts 308 are positioned at the right-side ends of the first openings 321 and the second openings 322, respectively. When the mounting portion 300 is in the second position, the reference surface 301 of the bottom wall 301 of the mounting portion 300 is parallel with the horizontal plane indicated by alternate long and short lines of Fig. 17. In other words, when the mounting portion 300 is moved from the first position to the second position, a change in angle of the mounting portion 300 with respect to the horizontal plane is 30 degrees. As shown in Fig. 1, when the mounting portion 300 is in the second position, the ink cartridge 10 mounted to the mounting portion 300 is positioned lower than the nozzles 134 of the recording head 132.

[0154] As shown in Figs. 14 and 18, the ink supply device 30 comprises four ink supply tubes 326. In Fig. 14, two of the four ink supply tubes 326 are shown. In Fig. 18, one of the four ink supply tubes 326 is shown. As with the tubes 350, the ink supply tubes 326 are an example of a connection portion. The four ink supply tubes 326 are positioned in the four spaces in the mounting portion 300 partitioned by the first partition walls 306A and the second partition walls 306B in the X direction. The four ink supply tubes 326 are fixed to the rear wall 304 of the mounting portion 300, and protrude from the rear wall 304 toward the opening 305. The four ink supply tubes 326 are inserted into and connected to the four tubes 350 respectively. To reliably connect the ink supply tubes 326 to the tubes 350, round clamps or bands may be tightened around the tubes 350 in which the ink supply tubes 326 are inserted.

[0155] As shown in Figs. 14 and 18, the ink supply device 30 comprises four protrusions 328. Two of the four protrusions 328 are shown in Fig. 14, and one of them is shown in Fig. 18. The four protrusions 328 are positioned in the four spaces in the mounting portion 300 partitioned in the X direction. The four protrusions 328 protrude from the rear wall 304 of the mounting portion 300 toward the opening 305. Each of the protrusions 328 comprises an inner space therein. The inner space of each protrusion 328 communicates with the outside of the protrusion 328 at an end of the protrusion 328 positioned within the mounting portion 300. Each protrusion 328 extends from the inside of the mounting portion 300 through the rear wall 304 to the outside of the mounting portion 300. The inner space of each protrusion 328 is open to the outside the mounting portion 300.

[0156] As shown in Figs. 14 and 18, the ink supply device 30 comprises four lock mechanisms 330. The four lock mechanisms 330 are provided, corresponding to the four spaces in the mounting portion 300 partitioned in the X direction, respectively. The four lock mechanisms 330 are positioned in the top wall 303 of the mounting portion 300. As shown in Fig. 18, each lock mechanism 330 comprises a lever 331 and a coil spring 332. The lever 331 comprises a contact portion 333, an operating portion 334, and a shaft 335 positioned between the contact portion 333 and the operating portion 334. The shaft 335 extends in the X direction. The lever 331 is pivotable on the shaft 335 in a direction parallel to a plane defined by the Y direction and the Z direction. The operating portion 334 extends from the shaft 335 to the outside of the mounting portion 300. The coil spring 332 is connected to the lever 331 at one end and to a portion of the top wall 303 at the other end. The coil spring 332 is held under tension. The coil spring 332 pulls the lever 331 to cause the lever 331 to rotate clockwise in Fig. 18. The clockwise rotation of the lever 331 is restricted by a stopper (not shown).

[0157] <Description of optical detector > As shown in Figs. 14 and 18, the inkjet printer 100 comprises four optical detectors 342. Two of the four optical detectors 342 are shown in Fig. 14, and one of them is shown in Fig. 18. The four optical detectors 342 are provided, corresponding to the four spaces in the mounting portion 300 partitioned in the X direction, respectively. Each of the optical detectors 342 is fixed to the rear wall 304 of the mounting portion 300. As shown in Fig. 19, each optical detector 342 comprises a base 342A, a light emitter 342B, a light receiver 342C, which are all shaped in a substantially rectangular parallelepiped. The base 342A is fixed to the rear wall 304 of the mounting portion 300. The light emitter 342B extends from one end of the base 342A with respect to the X direction toward the opening 305 of the mounting portion 300. The light receiver 342C extends from the other end of the base 342A with respect to the X direction toward the opening 305 of the mounting portion 300. The light emitter 342B and the light receiver 342C are aligned in the X direction. The light emitter 342B has a rectangular slit formed in a surface thereof facing the light receiver 342C. The light emitter 342B emits light, e.g. visible or infrared light, via the slit toward the light receiver 342C. The light receiver 342C has a rectangular slit (not shown) formed in a surface thereof facing the light emitter 342B. The light receiver 342C receives light emitted from the light emitter 342C via the slit formed in the light receiver 342C. An optical path 342D is formed between the light emitter 342B and the light receiver

342C.

[0158] When the light receiver 342C receives light emitted from the light emitter 342B at an intensity greater than or equal to a predetermined intensity, the light receiver 342C outputs a voltage higher than or equal to a predetermined voltage. When the light receiver 342C receives light emitted from the light emitter 342B at an intensity less than the predetermined value, the light receiver 342C outputs a voltage lower than the predetermined voltage. A case where the light receiver 342C receives light emitted from the light emitter 342B at an intensity less than the predetermined intensity comprises a case where the light receiver 342C does not receive light emitted from the light emitter 342B at all, that is, a case where the intensity of light received by the light receiver 342C is zero. In addition, a case where the light receiver 342C outputs a voltage lower than the predetermined voltage comprises a case where the light receiver 342C does not output any voltage at all, that is, a case where a voltage value output by the light receiver 342C is at the ground level. In this way, the light receiver 342C assumes predetermined two states. When the light receiver 342C outputs a voltage higher than or equal to the predetermined voltage, a controller 400 of the inkjet printer 100 (which will be described later) determines that the light receiver 342C is in an ON state. When the light receiver 342C outputs a voltage lower than the predetermined voltage, the controller 400 determines that the light receiver 342C is in an OFF state.

[0159] <Description of mount detector> As shown in Figs. 14 and 18, inkjet printer 100 comprises four mount detectors, e.g. optical detectors 344. Two of the four optical detectors 344 are shown in Fig. 14, and one of them is shown in Fig. 18. The four optical detectors 344 are provided, corresponding to the four spaces in the mounting portion 300 partitioned in the X direction, respectively. As shown in Fig. 20, each optical detector 344 comprises a base 344A, a light emitter 344B, a light receiver 344C, which are all shaped in a substantially rectangular parallelepiped. The base 344A is fixed to the top wall 303 of the mounting portion 300. The light emitter 344B extends from one end of the base 344A with respect to the X direction toward the bottom wall 301 of the mounting portion 300. The light receiver 344C extends from the other end of the base 344A with respect to the X direction toward the bottom wall 301 of the mounting portion 300. The light emitter 344B and the light receiver 344C are aligned in the X direction. The light emitter 344B has a rectangular slit formed in a surface thereof facing the light receiver 344C. The light emitter 344B emits light, e.g. visible or infrared light, via the slit toward the light receiver 344C. The light receiver 344C has a rectangular slit (not shown) formed in a surface thereof facing the light emitter 344B. The light receiver 344C receives light emitted from the light emitter 344C via the slit formed on the light receiver 344C. An optical path 344D is formed between the light emitter 344B and the light receiver 344C.

[0160] The light emitter 344B and the light receiver 344C operate in the same manner as the light emitter 342B and the light receiver 342C, such that the light receiver 344C assumes predetermined two states. When the light receiver 344C outputs a voltage higher than or equal to the predetermined voltage, the controller 400 of the inkjet printer 100 (which will be described later) determines that the light receiver 344C is in an ON state. When the light receiver 344C outputs a voltage lower than the predetermined voltage, the controller 400 determines that the light receiver 344C is in an OFF state.

[0161] <Description of movement detector (position detector)> The inkjet printer 100 comprises a movement detector that detects movement of the mounting portion 300. More specifically, the movement detector has a position detector that detects a position of the mounting portion 300. As shown in Figs. 15 - 17, the position detector has a first limit switch 346 and a second limit switch 348. The first limit switch 346 is configured to detect that the mounting portion 300 is in the first position. The second limit switch 348 is configured to detect that the mounting portion 300 is in the second position.

[0162] The first limit switch 346 is fixed to the support wall 320A via a fixing member (not shown). As shown in Figs. 15 - 17, the first limit switch 346 comprises a case 346A and an actuator 346B. The case 346A is fixed to the support wall 320A via a fixing member (not shown). The actuator 346B extends from the inside of the case 346A to the outside of the case 346A and is movable with respect to the case 346A. A movable contact (not shown) is connected to the actuator 346B, and the movable contact is positioned within the case 346A. The movable contact is movable together with the actuator 346B with respect to the case 346A. A fixed contact (not shown) is fixed to the case 346A within the case 346A. Due to displacement of the actuator 346B with respect to the case 346A, the movable contact assumes a contact state where the movable contact contacts the fixed contact and a separation state where the movable contact is separated away from the fixed contact. When the movable contact contacts the fixed contact, the first limit switch 346 outputs an voltage higher than or equal to a predetermined voltage. When the movable contact is separated away from the fixed contact, the first limit switch 346 outputs a voltage lower than the predetermined voltage. A case where the first limit switch 346 outputs a voltage lower than the predetermined voltage comprises a case where the first limit switch 346 does not output any voltage at all, that is, a case where a voltage value output by the first limit switch 346 is at ground level. Thus, the first limit switch 346 assumes predetermined two states. When the first limit switch 346 outputs a voltage greater than or equal to the predetermined voltage, the controller 400 of the inkjet printer 100 (which will be described later) determines that the first limit switch 346 is in an ON state. When the first limit switch 346 outputs a voltage lower than the predetermined voltage, the controller 400 determines that the first limit switch 346 is in an OFF state.

[0163] The second limit switch 348 is fixed to the sup-

port wall 320A via a fixing member (not shown). As shown in Figs. 15 - 17, the second limit switch 348 comprises a case 348A and an actuator 348B. The case 348A is fixed to the support wall 320A via a fixing member (not shown). The actuator 348B extends from the inside of the case 348A to the outside of the case 348A and is movable with respect to the case 348A. The second limit switch 348 is similar in structure and operation to the first limit switch 346, and the first limit switch 348 also assumes predetermined two states. When the second limit switch 348 outputs a voltage greater than or equal to the predetermined voltage, the controller 400 of the inkjet printer 100 (which will be described later) determines that the second limit switch 348 is in an ON state. When the second limit switch 348 outputs a voltage less than the predetermined voltage, the controller 400 determines that the second limit switch 348 is in an OFF state.

[0164] As shown in Fig. 15, when the mounting portion 300 is in the first position, a portion of the bottom wall 301 of the mounting portion 300 contacts the actuator 346B of the first limit switch 346, and presses the actuator 346B into the case 346A. When this occurs, the movable contact of the first limit switch 346 contacts the fixed contact, and thus the controller 400 determines that the first limit switch 346 is in the ON state. As shown in fig. 16, when the mounting portion 300 is moved from the first position, the bottom wall 301 of the mounting portion 300 is separated from the actuator 346B, and the actuator 346B moves toward the outside of the case 346A. When this occurs, the movable contact of the first limit switch 346 is separated away from the fixed contact, and thus the controller 400 determines that the first limit switch 346 is in the OFF state. In this way, it is detected by the first limit switch 346 whether or not the mounting portion 300 is in the first position.

[0165] As shown in Fig. 17, when the mounting portion 300 is in the second position, a portion of the bottom wall 301 of the mounting portion 300 contacts the actuator 348B of the second limit switch 348, and presses the actuator 348B into the case 348A. When this occurs, the movable contact of the second limit switch 348 contacts the fixed contact, and thus the controller 400 determines that the second limit switch 348 is in the ON state. As shown in fig. 16, when the mounting portion 300 is moved from the second position, the bottom wall 301 of the mounting portion 300 is separated from the actuator 348B, and the actuator 348B moves toward the outside of the case 348A. When this occurs, the movable contact of the second limit switch 348 is separated away from the fixed contact, and thus the controller 400 determines that the second limit switch 348 is in the OFF state. In this way, it is detected by the second limit switch 348 whether or not the mounting portion 300 is in the second position.

[0166] The movement detector, which comprises the position detector having the first limit switch 346 and the second limit switch 348, detects that the mounting portion 300 started to move by detecting that the mounting portion 300 was moved from the first position and is not in the first position. In addition, the movement detector detects that the mounting portion 300 moved from the first position up to the second position by detecting that the mounting portion 300 which had been positioned in the first position reached the second position. In other words, a period of time in which the movement of the mounting portion 300 is detected corresponds to a period of time from when the mounting portion 300 moves from the first position to when the mounting portion 300 reaches the second position.

[0167] When the mounting portion 300 is in the first position as shown in Fig. 15, the ink cartridge 10 is mounted to the mounting portion 300 along a mounting direction 360 extending from up to down. The mounting direction 360 is a direction extending from the opening 305 of the mounting portion 300 toward the rear wall 304 and inclined 30 degrees with respect to the horizontal plane. Fig. 25 shows the ink cartridge 10 mounted to the mounting portion 300 positioned in the first position. In Fig. 25, the first cover 15, the second cover 16, a portion of the ink supply portion 50, and a portion of the air communication portion 60 are removed from the ink cartridge 10 for convenience of illustration. As shown in Fig. 25, while the ink cartridge 10 is mounted to the mounting portion 300, the depth direction 13 of the ink cartridge 10 becomes parallel with the mounting direction 360. The ink cartridge 10 is mounted to the mounting portion 300 from the front surface 22 side of the frame 20. While the ink cartridge 10 is mounted to the mounting portion 300, the center of the pivotal movement of the pivotable member 90 is positioned below the center of buoyancy 91 of the pivotable member 90 submerged in ink in the ink chamber 11 with respect to the mounting direction 360. Because the ink cartridge 10 is mounted from up to down along the mounting direction 360, a user can readily mount the ink cartridge 10 to the mounting portion 300 compared to a case where the ink cartridge 10 is mounted from down to up. The inkjet printer 100 may be placed on a desktop in most cases. The inkjet printer 100 placed on the desktop is positioned lower than the eyes of the user. The user may look down at the inkjet printer 100 and mount the ink cartridge 10 to the mounting portion 300. Thus, because the ink cartridge 10 is mounted to the mounting portion 300 from up to down, the user can visually see the ink cartridge 10 and the mounting portion 300, and therefore the user can readily mount the ink cartridge 10 to the mounting portion 300. In addition, because the ink cartridge 10 is pulled from up to down by the gravity, the ink cartridge 10 can be mounted to the mounting portion 300 securely.

[0168] When the ink cartridge 10 is mounted to the mounting portion 300, the protrusion 70 is positioned between the light emitter 342B and the light receiver 342C of the optical detector 342, and one of the pair of sidewalls 72 faces the light emitter 342B and the other faces the light receiver 342C. As shown in Fig. 21, the optical path 342D crosses the pair of sidewalls 72. The optical path

342D also crosses a path along which the light blocking portion 93A moves relative to the ink chamber 11 and the optical detector 342 in accordance with the movement of the pivotable member 90. When the optical path 342D crosses the light blocking portion 93A, the light blocking portion 93A blocks light emitted from the light emitter 342B. When this occurs, it is determined that the light receiver 342C is in the OFF state. When the optical path 342 does not cross the light blocking portion 93A, the light emitted from the light emitter 342B passes the pair of sidewalls 72 and reaches the light receiver 342C. When this occurs, it is determined that the light receiver 342C is in the ON state.

[0169] When the ink cartridge 10 is mounted to the mounting portion 300, the protrusion 159 of the first cover 15 of the ink cartridge 10 is positioned between the light emitter 344B and the light receiver 344C of the optical detector 344, and the optical path 344D crosses the protrusion 159 as shown in Fig. 21. When the optical path 344D crosses the protrusion 159, the protrusion 159 blocks the light emitted from the light emitter 344B. When this occurs, it is determined that the light receiver 344C is in the OFF state. When the optical path 344D does not cross the protrusion 159, the light emitted from the light emitter 344B reaches the light receiver 344C. When this occurs, it is determined that the light receiver 344C is in the ON state. In other words, when the ink cartridge 10 is mounted to the mounting portion 300, the light receiver 344C is determined to be in the OFF state, and when the ink cartridge 10 is removed from the mounting portion 300, the light receiver 344C is determined to be in the ON state. Thus, it is detected by the optical detector 344 whether or not the ink cartridge 10 is mounted to the mounting portion 300.

[0170] As shown in Fig. 21, when the ink cartridge 10 is mounted to the mounting portion 300, the contact portion 333 of the lever 331 of the lock mechanism 330 contacts the protrusion 24A of the frame 20. Even when the user attempts to move the ink cartridge 10 to the left in Fig. 21, because the contact portion 333 contacts 24A, and the ink cartridge 10 can not be moved. Thus, the ink cartridge 10 is retained in the mounting portion 300. When the user wishes to remove the ink cartridge 10 from the mounting portion 300, the user presses down the operating portion 334. When the operating portion 334 is pressed down, the lever 331 rotates counterclockwise in Fig. 21 against a force of the coil spring 332 pulling the lever 331. When the lever 331 rotates counterclockwise, the contact portion 333 separates from the protrusion 24A, and the user can pull out the ink cartridge 10 to the left in Fig. 21. In this embodiment, when the mounting portion 300 is in the first position, the ink cartridge 10 is mounted to or removed from the mounting portion 300.

[0171] As shown in Fig. 22, when the ink cartridge 10 is mounted to the mounting portion 300, the ink supply tube 326 passes through the opening 56A of the cap 56 and the opening 53A of the sealing member 53, and presses the valve body 52 toward the first end 51A of the ink supply chamber 51 against a force of the coil spring 54 pressing the valve body 52. When this occurs, the sealing member 53 elastically deforms and contacts the ink supply tube 326. When pressed toward the first end 51A of the ink supply chamber 51, the valve body 52 separates from the sealing member 53. As a result, the ink supply chamber 51 communicates with the tube 350 via the ink supply tube 326. Thus, the ink chamber 11 communicates with the sub tank 135 via the ink supply chamber 51, the ink supply tube 326, and the tube 350, such that ink can be supplied from the ink chamber 11 to the sub tank 135.

[0172] As shown in Fig. 23, when the ink cartridge 10 is mounted to the mounting portion 300, the protrusion 328 presses the protrusion 62A toward the first end 61A of the air communication chamber 61 against a force of the coil spring 64 pressing the valve body 62. When this occurs, the leg portion 63B of the sealing member 63 elastically deforms and contacts the protrusion 328. When pressed toward the first end 61A of the air communication chamber 61, the valve body 62 separates from the sealing member 63. As a result, air communication chamber 61 communicates with the space outside of the mounting portion 300 via the openings 63A and 63C of the sealing member 63 and the inner space of the protrusion 328. Thus, the ink chamber 11 communicates with the space outside of the mounting portion 300 via the openings 63A and 63C of the sealing member 63 and the inner space of the protrusion 328, and air can be introduced into the ink chamber 11 from the space outside of the mounting portion 300.

[0173] As shown in Fig. 1, when the mounting portion 300 is in the second position, the ink cartridge 10 is positioned lower than the nozzles 134 of the recording head 132. More specifically, a surface L of ink stored in the ink chamber 11 is positioned lower than the nozzles 134 of the recording head 132. As a result, an appropriate negative pressure can be applied to liquid in the nozzles 134, and ink can be reliably ejected from the nozzles 134 of the recording head 132.

[0174] <Description of electrical configuration> As shown in Fig. 24, the inkjet printer 100 comprises the controller 400. The controller 400 is configured to control operations of the inkjet printer 100 and make determination in various cases. The controller 400 is configured as a microcomputer, and mainly comprises a central processing unit (CPU) 402, read-only memory (ROM) 404, random access memory (RAM) 406, electrically erasable programmable read-only memory (EEPROM) 408, and application specific integrated circuit (ASIC) 410.

[0175] The ROM 404 stores programs for the CPU 402 to control various operations of the inkjet printer 100 and to execute various determinations, such as a program for executing steps shown in Fig. 29. The RAM 406 is used as a storage area for storing various data temporarily or a working area when the CPU 402 executes the programs. The EEPROM 408 stores information to be

maintained even after the inkjet printer 100 is turned off.

[0176] The ASIC 410 is electrically connected to the head control circuit 133, the optical detectors 342 and 344, the first limit switch 346, and the second limit switch 348. Although not shown, the ASIC 410 is electrically connected to drive circuits for driving the feeding device 110 and the transferring device 120, input/output portions for inputting and outputting signals between the inkjet printer 100 and an external personal computer, an instruction input portion to be used by a user for issuing printing instruction or the like to the ink-jet printer 100, and a display portion that displays information to the user.

[0177] When receiving a print instruction from the external personal computer (not shown) or the instruction input portion (not shown), the controller 400 sends signals to the head control circuit 133. The head control circuit 133 is configured to control ejection of ink from the recording head 132 based on the signals received from the controller 400. When the controller 400 determines that the second limit switch 348 is in the ON state, the controller 400 is configured to send signals to the head control circuit 133 to cause ink to be ejected from the recording head 132. That is, when it is detected that the mounting portion 300 is in the second position, ink is allowed to be ejected from the recording head 132. The head control circuit 133 and the controller 400 are examples of an ejection controller.

[0178] The light emitter 342B of the optical detector 342 and the light emitter 344B of the optical detector 344 are configured to emit light, e.g. visible or infrared light when receiving a signal from the controller 400.

[0179] The controller 400 is configured to determine that the light receiver 342C of the optical detector 342, the light receiver 344C of the optical detector 344, the first limit switch 346, and the second limit switch 348 are in the ON state or the OFF state, as needed. As shown in Fig. 29, the controller 400 determines the state of the light receiver 342C of the optical detector 342, the state of the light receiver 344C of the optical detector 344, the state of the first limit switch 346, and the state of the second limit switch 348 according to steps, and determines whether or not the ink cartridge 10 in the mounting portion 300 is normal.

[0180] <Description of operation and action> The operations and actions of the embodiment configured above will be described with reference drawings.

[0181] With reference to Figs. 25 - 28, the following descriptions will be made as to the positional changes of the frame 20 and the pivotable member 90 with respect to the horizontal plane when the mounting portion 300 moves from the first position to the second position.

[0182] As shown in Fig. 25, when the ink cartridge 10 is mounted to the mounting portion 300 and the mounting portion 300 is in the first position, an angle formed between the bottom surface 25 of the frame 20 and the horizontal plane indicated by alternate long and short dashed lines is 30 degrees. A brand-new ink cartridge 10 comprises, in the ink chamber 11, ink having such an amount that the pivotable member 90 can be submerged in ink when mounted to the mounting portion 300. In the embodiment, the center of buoyancy 91 of the pivotable member 90 submerged in ink coincides with the center of gravity of the pivotable member 90. Therefore, when the pivotable member 90 is submerged in ink stored in the ink chamber 11, the pivotable member 90 assumes a position in which the center of buoyancy 91 becomes closest to the ink surface L. When the center of buoyancy 91 is positioned closest to the ink surface L, the center of buoyancy 91 is positioned on a line extending from the center of the pivotal movement of the pivotable member 90 perpendicular to the ink surface L. When the mounting portion 300 is in the first position, the light blocking portion 93A of the pivotable member 90 does not cross the optical path 342D of the optical detector 342, and light emitted from the light emitter 342B reaches the light receiver 342C. That is, when the light is emitted from the light emitter 342B, the light receiver 342C is determined to be in the ON state. Incidentally, when the center of buoyancy 91 does not coincide with the center of gravity of the pivotable member 90, the pivotable member 90 stands still at a position where the moment of the buoyancy and the moment of the gravity acting on the pivotable member 90 balance out.

[0183] When the mounting portion 300 moves from the first position, the inclination of the ink chamber 11 and the inclination of the optical detector 342 with respect to the horizontal plane change. On the other hand, even when the mounting portion 300 moves, the ink surface L is always parallel with the horizontal plane. Because the center of buoyancy 91 remains on the line extending from the center of the pivotal movement of the pivotable member 90 perpendicular to the ink surface L, the position of the pivotable member 90 with respect to the horizontal plane is unchanged even when the mounting portion 300 moves. Thus, when the mounting portion 300 moves, the position of the ink surface L relative to the ink chamber 11 and the optical detector 342 changes, and the pivotable member 90 moves relative to the ink chamber 11 and the optical detector 342 according to the position of the ink surface L relative to the ink chamber 11 and the optical detector 342. In Figs. 25 - 27, the pivotable member 90 rotates clockwise relative to the ink chamber 11, and the light blocking portion 93A moves along the path relative to the ink chamber 11 and the optical detector 342.

[0184] As shown in Fig. 26, when the angle formed between the bottom surface 25 of the frame 20 and the horizontal plane indicated by alternate long and short lines is 25 degrees, the light blocking portion 93A crosses the optical path 342D, and blocks light emitted from the light receiving portion. That is, when the light is emitted from the light emitter 342B, the light receiver 342C is determined to be in the OFF state.

[0185] As shown in Fig. 27, when the mounting portion 300 further moves and the angle formed between the bottom surface 25 of the frame 20 and the horizontal

plane indicated by alternate long and short lines becomes 20 degrees, the light blocking portion 93A contacts the first contact portion 74A. The light blocking portion 93A crosses the optical path 342D.

[0186] After the angle becomes 20 degrees, even when the mounting portion 300 further moves, the movement of the pivotable member 90 is restricted because the light blocking portion 93A contacts the first contact portion 74A. The pivotable member 90 cannot move clockwise relative to the ink chamber 11.

[0187] When the mounting portion 300 is in the second position, the bottom surface 25 of the frame 20 and the horizontal plane indicated by alternate long and short lines become parallel. The light blocking portion 93A crosses the optical path 342D. If the movement of the pivotable member 90 were not restricted, the center of buoyancy 91 would be on the line extending from the center of the pivotal movement of the pivotable member 90 perpendicular to the ink surface L. However, when the mounting portion 300 is in the second position, the light blocking portion 93A contacts the first contact portion 74A and the movement of the pivotable member 90 is restricted. Therefore, an angle of 20 degrees is formed between: (a) a line segment that connects the center of the pivotal movement of the pivotable member 90 and the center of buoyancy 91; and (b) a line that is parallel to the direction of gravity and passes through the center of the pivotal movement of the pivotable member 90 in a clockwise direction from the line segment to the line in Fig. 28. In the embodiment, because the center of buoyancy 91 coincided with the center of gravity of the pivotable member 90, this angle is equal to the angle formed between the bottom surface 25 of the frame 20 and the horizontal plane as shown in Fig. 27 when the light blocking portion 93A initially contacts the first contact portion 74A after the mounting portion 300 moved from the first position. As shown in Fig. 28, when the mounting portion is in the second position, a distance between the center of buoyancy 91 and the ink surface L is less than a distance between the center of the pivotal movement of the pivotable member 90 and the ink surface L.

[0188] <Description of process for determining state of ink cartridge> A process for determining the state of the ink cartridge 10 will be described with reference to Fig. 29. The controller 400 causes the light emitter 344B of the optical detector 344 to emit light, monitors the state of the light receiver 344C of the optical detector 344, and starts the process shown in Fig. 29 when the light receiver 344C changed from the ON state to the OFF state. In other words, the process shown in Fig. 29 is started when it is detected that the ink cartridge 10 was mounted to the mounting portion 300. When the state of the light receiver 344C changed from the OFF state to the ON state in the middle of the process, the controller 400 causes the display portion (not shown) of the inkjet printer 100 to display a message and prompts a user to re-mount the ink cartridge 10 to the mounting portion 300.

[0189] In Fig. 29 and hereinafter, each step is abbreviated as "S". When the process is started, the controller 400 determines whether the first limit switch 346 is in the ON state at S1. That is, the controller 400 determines whether it is detected that mounting portion 300 is in the first position. When the controller 400 determines that the first limit switch 346 is in the ON state, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light, determines the state of the light receiver 342C, and stores the determined state in a storage area I of the RAM 406 at S2. Then, the controller 400 stops the light emission of the light emitter 342B, and determines whether the first limit switch 346 is in the OFF state at S3. That is, the controller 400 determines whether it is detected that the mounting portion 300 is not in the first position. When the controller 400 determines that the first limit switch 346 is not in the OFF state, the controller 400 repeats S3. When the controller 400 determines that the first limit switch 346 is in the OFF state, the controller 400 determines whether the second limit switch 348 is in the ON state at S4. That is, the controller 400 determines whether it is detected that the mounting portion 300 is in the second position. When the controller 400 determines that the second limit switch 348 is not in the ON state, the controller 400 repeats S4. When the controller 400 determines that the second limit switch 348 is in the ON state, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light, determines the state of the light receiver 342C, and stores the determined state in a storage area J of the RAM 406 at S5. Then, the controller 400 stops the light emission of the light emitter 342B, and compares the state of the light receiver 342C stored in the storage area I and the state of the light receiver 342C stored in the storage area J. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from that stored in the storage area J at S6, the controller 400determines that the ink cartridge 10 is normal at S7, and ends the process. Then, the controller 400 waits a print instruction from the external personal computer (not shown) or instruction input portion (not shown). When the controller 400 determines that the state of the light receiver 342C stores in the storage area I is the same as that stored in the storage area J at S6, the controller 400 determines that the ink cartridge 10 is abnormal at S8, and ends the process. In this case, the controller 400 causes the display portion (not shown) of the inkjet printer 100 to display a message, and notifies the user that the ink cartridge 10 is abnormal or needs replacement. In addition, the controller 400 does not to send signals to the head control circuit 133 even when receiving the print instruction from the external personal computer or the instruction input portion.

[0190] When the ink cartridge 10 mounted to the mounting portion 300 is brand-new and normal, that is, when the ink cartridge 10 has the pivotable member 90 and the pivotable member 90 pivots normally, the state of the light receiver 342C stored in the storage area I is the ON state and the state of the light receiver 344C

stored in the storage area J is the OFF state. Thus, the controller 400 determines in the above process that the ink cartridge 10 is normal. When the ink cartridge 10 mounted to the mounting portion 300 is abnormal, for example, when the movement of the pivotable member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90, even if the mounting portion 300 moves from the first position to the second position, the state of the light receiver 342C does not change. Namely, the state of the light receiver 342C stored in the storage area I becomes the same state as the state of the light receiver 344C stored in the storage area J, and the controller 400 determines in the above process that the ink cartridge 10 is abnormal.

[0191] When the controller 400 determines in S1 that the first limit switch 346 is not in the ON state, the controller 400 determines in S9 whether the second limit switch 348 is in the ON state. When the controller 400 determines in S9 that the second limit switch 348 is in the ON state, the mounting portion 300 moved to the second position before the controller 400 determines the state of the ink cartridge 10. Thus, the controller 400 causes the display portion (not shown) of the inkjet printer 100 to display a message to prompt a user to re-mount the ink cartridge 10 to the mounting portion 300 in S10, and ends the process. When the controller 400 determines that the second limit switch 348 is not in the ON state in S9, the flow returns to S1.

[0192] The controller 400 may cause the light emitter 342B to emit light all the time during S2, S3, S4, and S5. The controller 400 may cause the light emitter 342B to emit light at least during S2 and S5.

[0193] In the embodiment, a plurality of, e.g. four, ink cartridges 10 are supposed to be mounted to the mounting portions 300. The above process to determine whether the ink cartridge 10 is normal is performed for each ink cartridge 10.

[0194] <Description of process for determining remaining amount of ink> After the controller 400 determines that the ink cartridge 10 is normal, when the controller 400 receives a print instruction from the external personal computer (not shown) or the instruction input portion (not shown), the controller 400 sends signals to the drive circuit (not shown) for driving the feeding device 110 and the transferring device 120 to cause the feeding device 110 and the transferring device 120 to supply and feed a recording sheet, and causes the recording head 132 to eject ink onto the recording sheet. When this occurs, ink is supplied from the ink chamber 11 to the sub tank 135. The controller 400 causes the light emitter 342B of the optical detector 342 to emit light and monitors the state of the light receiver 342C. Namely, the controller 400 periodically determines the state of the light receiver 342C. Ink is allowed to be ejected from the recording head 132 when the mounting portion 300 is in the second position.

[0195] Figs. 30 - 32 show the ink cartridge 10 mounted to the mounting portion 300 positioned in the second position. In Figs. 30 - 32, the first cover 15, the second cover 16, a portion of the ink supply portion 50, and a portion of the air communication portion 60 are omitted for convenience of illustration.

[0196] When ink is supplied from the ink chamber 11 to the sub tank 135 and the amount of ink stored in the ink chamber 11 reaches a first amount, the ink surface is positioned at a position shown in Fig. 30. When this occurs, a portion of the bulky portion 92A of the pivotable member 90 is exposed to the air in the ink chamber 11 and the gravity and the buoyancy acting on the pivotable member 90 become equal.

[0197] When ink is further supplied from the ink chamber 11 to the sub tank 135, the pivotable member 90 rotates counterclockwise in Fig. 30 with the lowering of the ink surface L. When the ink amount stored in the ink chamber 11 reaches a second amount, the ink surface L is positioned at a position shown in Fig. 31. When this occurs, the light blocking portion 93A deviates from the optical path 342D of the optical detector 342, and light emitted from the light emitter 342B passes through the pair of sidewalls 72 of the protrusion 70 and reaches the light receiver 342C. That is, the light receiver 342C is changed from the OFF state to the ON state.

[0198] When determining that the light receiver 342C is changed from the OFF state to the ON state, the controller 400 determines that the ink stored in the ink chamber 11 reached the second amount, and counts the number of times that the recording head 132 ejects ink. In addition, the controller 400 causes the display portion (not shown) of the inkjet printer 100 to display a message notifying a user that remaining amount of ink stored in the ink cartridge 10 is low.

[0199] When the counted number of times that the recording head 132 ejects ink reaches a predetermined number of times, the controller 400 stops the recording head 132 from ejecting ink, causes the display portion (not shown) of the inkjet printer 100 to display a message notifying a user that, for example, the ink cartridge 10 is empty or the ink cartridge 10 should be replaced with a new one. At this time, an actual amount of ink stored in the ink chamber 11 may not be zero but preferably may be lower and close to zero. When there is no ink in the ink chamber 11, the light blocking portion 93A contacts the second contact portion 73A as shown in Fig. 32.

[0200] As a result of executing the process shown in Fig. 29, the controller 400 can determine whether the ink cartridge 10 is normal or abnormal at an early stage of mounting the ink cartridge 10 to the mounting portion 300. Thus, a user can effectively deal with a problem at the early stage if an abnormal ink cartridge 10 is mounted to the mounting portion 300.

[0201] The period of time from when the mounting portion 300 moves from the first position to when the mounting portion 300 reaches the second position is the period of time in which the movement of the mounting portion is detected by the movement detector, which comprises the position detector comprises the first limit switch 346

and the second limit switch 348. The controller 400 can determine whether the state of the light receiver 342C has changed during the period of time in which the movement of the mounting portion 300 is detected, by comparing the state of the light receiver 342C when it is detected that the mounting portion 300 is in the first position and the state of the light receiver 342C when it is detected that the mounting portion 300 is in the second position. As a result, the controller 400 does not need to monitor the state of the light receiver 342C during the period of time in which the movement of the mounting portion 300 is detected. In other words, the controller 400 does not need to periodically determine the state of the light receiver 342C over and over again. The controller 400 determines the state of the light receiver 342C only when the mounting portion 300 is in the first position and the second position. Thus, the load on the controller 400 during the process is low. The light emitter 342B emits light at least when it is detected that the mounting portion 300 is in the first position and when it is detected that the mounting portion 300 is in the second position. The light emitter 342B does not need to continue emitting light during the period of time in which the movement of the mounting portion 300 is detected. Thus, the rate of deterioration of the light emitter 342B due to light emission can be slowed down and the useful life of the light emitter 342B can be increased. In addition, the controller 400 finds the state of the light receiver 342C while the mounting portion 300 is standing still. Thus, the controller 400 can determine whether the ink cartridge 10 is normal more reliably in comparison with a case where the controller 400 determines the change in the state of the light receiver 342C by monitoring the state of the light receiver 342C while the mounting portion 300 moves.

[0202] When the mounting portion 300 is in the second position and the movement of the pivotable member 90 is restricted by the first contact portion 74A, the angle is formed between: (a) the line segment that connects the center of the pivotal movement of the pivotable member 90 and the center of buoyancy 91; and (b) the line that is parallel to the direction of gravity and passes through the center of the pivotal movement of pivotable member 90 in the clockwise direction from the line segment to the line in Fig. 28. This angle is referred to as a first angle. When the light blocking portion 93A initially contacts the first contact portion 74A after the mounting portion 300 moved from the first position, an angle is formed between the bottom surface 25 of the frame 20 and the horizontal plane. This angle is referred to as a second angle. The first angle is equal to the second angle. Thus, if an amount of change in an angle of the mounting portion 300 with respect to the horizontal plane while the mounting portion 300 moves between the first position and the second position is set to an angle greater than the first angle, the pivotable member 90 can move relative to the ink chamber 11 and the optical detector 342 while the mounting portion 300 moves between the first position and the second position. Thus, in order for the controller 400 to determine the state of the ink cartridge 10, the amount of change in angle of the mounting portion 300 with respect to the horizontal plane is set to be greater than the first angle. As a result, the amount of change in angle of the mounting portion 300 with respect to the horizontal plane, which is necessary for the controller 400 to determine the state of the ink cartridge 10, can be easily found from the first angle. In addition, if the position of the optical path 342D is set to a position where the optical path 342D crosses the light blocking portion 93A when the pivotable member 90 contacts the first contact portion 74A and the optical path 342D does not cross the light blocking portion 93A as soon as the pivotable member 90 separates from the first contact portion 74A, the amount of change in angle of the mounting portion 300 with respect to the horizontal plane may be slightly greater than the first angle.

[0203] In the embodiment, the specific gravity of the pivotable member 90 is less than the specific gravity of ink stored in the ink chamber 11. However, in another embodiment, the specific gravity of at least a portion of the pivotable member 90 may be less that the specific gravity of ink stored in the ink chamber 11. For example, the specific gravity of the first portion 92 may be less than the specific gravity of ink, and the specific gravity of the second portion 93 and the support portion 94 may be greater than the specific gravity of ink. Moreover in another embodiment, although the specific gravity of the material forming the pivotable member 90 may be greater than the specific gravity of ink, the first portion 92 may have a hollow portion formed therein, such that the specific gravity of the first portion becomes less than the specific gravity of ink. The pivotable member 90 may be formed of a resin material such as nylon, polycarbonate, and acrylic resin.

[0204] In the embodiment, the light blocking portion 93A and the protrusion 159 are configured to prevent light emitted from the light emitters 342B and 344B from passing therethrough. In another embodiment, the light blocking portion 93A and the protrusion 159 may be configured to alter paths of light emitted from the light emitters 342B and 344B. For example, aluminum foil may be adhered to the light blocking portion 93A and the protrusion 159 so as to reflect light emitted from light emitters 342B and 344B.

[0205] In the embodiment, the light receivers 342C and 344C of the optical detectors 342 and 344 are configured to receive light emitted from the light emitters 342B and 344B when the light is not blocked by the light blocking portion 93A and the protrusion 159. However, when the light blocking member portion and the protrusion are configured to reflect light emitted from the light emitters in another embodiment, the light receivers may be configured to receive light reflected by the light blocking member portion and the protrusion.

[0206] In the embodiment, when the mounting portion 300 is in the first position, the reference surface 301A of the bottom wall 301 and the horizontal plane indicated

by alternate long and short lines in Fig. 15 form a 30-degree angle. When the mounting portion 300 is in the second position, the reference surface 301A of the bottom wall 301 and the horizontal plane are parallel. However, in another embodiment, even when the mounting portion 300 is in the second position, the reference surface 301A of the bottom wall 301 may be inclined with respect to the horizontal plane.

[0207] In the embodiment, when the mounting portion 300 is in the first position, the ink cartridge 10 is mounted to the mounting portion 300. However, the position of the mounting portion 300 when the ink cartridge 10 is mounted may not limited to the first position in another embodiment.

[0208] In the embodiment, the mounting portion 300 moves between the first position and the second position. The mounting portion 300 may move beyond the first position or the second position.

[0209] In the embodiment, the mounting portion 300 has four spaces partitioned in the X direction. However, the number of spaces partitioned in the X direction in the mounting portion 300 can be changed with the number of ink cartridges 10 to be mounted to the mounting portion 300. In other words, the number of spaces in the mounting portion 300 is equal to the number of ink cartridges 10 to be mounted to the mounting portion 300.

[0210] In the embodiment, the number of ink supply tubes 326 is four. However, the number of ink supply tubes 326 can be changed with the number of ink cartridges 10 to be mounted to the mounting portion 300. In other words, the number of ink supply tubes 326 is equal to the number of ink cartridges 10 to be mounted to the mounting portion 300.

[0211] In the embodiment, the number of lock mechanisms 330 is four. However, the number of lock mechanisms 330 can be changed with the number of ink cartridges 10 to be mounted to the mounting portion 300. In other words, the number of lock mechanisms 330 is equal to the number of ink cartridges 10 to be mounted to the mounting portion 300.

[0212] In the embodiment, the number of optical detectors 342 is four. However, the number of optical detectors 342 can be changed with the number of ink cartridges 10 to be mounted to the mounting portion 300. In other words, the number of optical detectors 342 is equal to the number of ink cartridges 10 to be mounted to the mounting portion 300.

[0213] In the embodiment, the number of optical detectors 344 is four. However, the number of optical detectors 344 can be changed with the number of ink cartridges 10 to be mounted to the mounting portion 300. In other words, the number of optical detectors 344 is equal to the number of ink cartridges 10 to be mounted to the mounting portion 300.

[0214] In the embodiment, the storage areas I and J are areas in the RAM 406. However, the storage areas I and J may be areas in a register of the CPU 402.

[0215] <Second embodiment> A second embodiment of a liquid ejecting system of the invention will be described with reference to Figs. 33 and 34. In Figs. 33 and 34, the first cover 15, the second cover 16, a portion of the ink supply portion 50, and a portion of the air communication portion 60 are omitted for convenience of illustration. It is noted that elements similar to or identical with those described in the first embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the first embodiment.

[0216] The second embodiment is different from the first embodiment in pivotable member, internal shape of a frame, and an amount of change in angle of a mounting portion with respect to a horizontal plane when the mounting portion moves from the first position and the second position.

[0217] The ink cartridge 10 of the second embodiment comprises a pivotable member 2090. The pivotable member 2090 is positioned in the ink chamber 11.

[0218] The pivotable member 2090 is formed of a resin material having a specific gravity which is less than the specific gravity of ink stored in the ink chamber 11. The pivotable member 2090 is formed of a resin material similar to that used for the pivotable member 90 of the first embodiment. The pivotable member 2090 is configured to block light.

[0219] The pivotable member 2090 comprises a first portion 2092 and a second portion 2093. The pivotable member 2090 comprises a cylindrical opening 2090A formed therethrough in the width direction 12. A cylindrical shaft 2082 passes through the opening 2090A and extends in the width direction 12 from one of the pair of sidewalls 21 to the other of sidewalls 21. The pivotable member 2090 is supported by the shaft 2082 so as to pivot about the center axis of the shaft 2082 extending in the width direction 12, i.e., the center axis of the shaft 2082 is the center of the pivotal movement of the pivotable member 2090. The pivotable member 2090 is pivotable in the ink chamber 11 according to a position of the ink surface L in the ink chamber 11 in a plane substantially parallel with the depth direction 13 and the height direction 14.

[0220] The first portion 2092 comprises a bulky portion 2092A having a substantially circular plate shape and a connection portion 2092B having a substantially sector shape in a side view. The second portion 2093 comprises a light blocking portion 2093A and a connection portion 2093B. The light blocking portion 2093A is positioned in the inner space 75 of the protrusion 70. The connection portion 2092B and the connection portion 2093B are connected to each other, and the opening 2090A is formed at the boundary between the connection portion 2092B and the connection portion 2093B.

[0221] The volume of the first portion 2092 is greater than the volume of the second portion 2093. In the second embodiment, the center of gravity of the pivotable member 2090 and a center of buoyancy 2091 of the pivotable

member 2090 submerged in ink stored in the ink chamber 11 are in the first portion 2092. In the embodiment, the pivotable member 2090 has a uniform density distribution, and ink stored in the ink chamber 11 also has a uniform density distribution. Thus, the center of buoyancy 2091 of the pivotable member 2090 submerged in ink stored in the ink chamber 11 coincide with the center of gravity of the pivotable member 2090. However, the center of buoyancy 2091 and the center of gravity of the pivotable member 2090 may not coincide with each other in another embodiment.

[0222] When the mounting portion 300 is in the first position, the ink cartridge 10 is mounted to the mounting portion 300 along a mounting direction 2360 extending from up to down. The mounting direction 2360 is a direction which is inclined 135 degrees with respect to the horizontal plane. While the ink cartridge 10 is mounted to the mounting portion 300, the depth direction 13 of the ink cartridge 10 becomes parallel with the mounting direction 2360. The ink cartridge 10 is mounted to the mounting portion 300 from the front surface 22 side of the frame 20. When the ink cartridge 10 is mounted to the mounting portion 300, the center of the pivotal movement of the pivotable member 2090 is positioned below the center of buoyancy 2091 of the pivotable member 90 submerged in ink in the ink chamber 11 with respect to the mounting direction 2360.

[0223] As shown in Fig. 33, when the ink cartridge 10 is mounted to the mounting portion 300 and the mounting portion 300 is in the first position, an angle formed between the bottom surface 25 of the frame 20 and the horizontal plane indicated by alternate long and short lines is 135 degrees. The center of buoyancy 2091 is positioned on a line extending from the center of the pivotal movement of the pivotable member 2090 perpendicular to the ink surface L. When the mounting portion 300 is in the first position, the light blocking portion 2093A of the pivotable member 2090 does not cross the optical path 342D of the optical detector 342, and light emitted from the light emitter 342B passes the pair of sidewalls 72 of the protrusion 70 and reaches the light receiver 342C. In other words, when light is emitted from the light emitter 342B, the light receiver 342C is determined to be in the ON state.

[0224] As shown in Fig. 34, when the mounting portion 300 is in the second position, the bottom surface 25 of the frame 20 and the horizontal plane become parallel. The light blocking portion 2093A crosses the optical path 342D. When the movement of the pivotable member 2090 is not restricted, the center of buoyancy 2091 is positioned on the line extending from the center of the pivotal movement of the pivotable member 2090 perpendicular to the ink surface L. However, as the light blocking portion 2093A contacts the first contact portion 74A, such that the movement of the pivotable member 2090 is restricted, a first angle formed between: (a) a line segment that connects the center of the pivotal movement of the pivotable member 2090 and the center of buoyancy 2091; and (b) a line that is parallel to the direction of gravity and passes the center of the pivotal movement of the pivotable member 2090 becomes 125 degrees. A distance between the center of buoyancy 2091 and the ink surface L is greater than a distance between the center of the pivotal movement of the pivotable member 2090 and the ink surface L.

[0225] In the ink ejecting system having above configuration, the controller 400 executes the process shown in Fig. 29 and determines whether or not the ink cartridge 10 is normal.

[0226] In the embodiment, the first angle is an obtuse angle. Thus, when the mounting portion 300 moves from the first position to the second position, the change in the angle of the mounting portion 300 with respect to the horizontal plane is an obtuse angle. Thus, a space required for moving the mounting portion 300 is relatively large. On the other hand, because the first angle is an acute angle in the first embodiment, the change in the angle of the mounting portion 300 with respect to the horizontal plane is an acute angle. Thus, in the first embodiment, the mounting portion 300 can move in a relatively small space, and the inkjet printer 100 can become smaller in size.

[0227] In the first and second embodiments, the center of buoyancy 91, 2091 coincides with the center of gravity of the pivotable member 90, 2090. Even when the center of buoyancy 91, 2091 does not coincide with the center of gravity of the pivotable member 90, 2090, if an offset between the center of buoyancy 91, 2091 and the center of gravity of the pivotable member 90, 2090 is relatively small, the mounting portion 300 needs to be moved by an angle equal to about the first angle with respect to the horizontal plane, in order for the controller 400 to determine the state of the ink cartridge 10. Thus, a space required for moving the mounting portion 300 becomes relatively large in the second embodiment, and the space required for moving the mounting portion 300 becomes relatively small in the first embodiment.

[0228] <Third embodiment> A third embodiment of an ink ejecting system of the invention will be described with reference to Figs. 35 and 36. It is noted that elements similar to or identical with those described in the first embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the first embodiment.

[0229] The third embodiment is different from the first embodiment in that the mounting portion 300 is moved by a motor, the position detector comprises an encoder connected to the motor instead of limit switches, and the ink supply device 30 does not comprise the optical detector 344 as an example of a mount detector. In addition, the third embodiment is different from the first embodiment in a determination process executed by the controller 400.

[0230] The inkjet printer 100 comprises a motor 3002 for moving the mounting portion 300, and a motor driving

circuit 3004 for driving the motor 3002. The motor driving circuit 3004 is electrically connected to the ASIC 410 and the motor 3002, and is configured to receive signals from the ASIC 410 and drive the motor 3002. The inkjet printer 100 comprises a movement detector that detects the movement of the mounting portion 300. More specifically, the movement detector comprises a position detector that detects the position of the mounting portion 300. The position detector comprises an encoder 3006 connected to the motor 3002. The encoder 3006 is electrically connected to the ASIC 410. The encoder 3006 is an absolute-type encoder, and is configured to output signals varying based on a rotational angle of the motor 3002, that is, based on the position of the mounting portion 300. The controller 400 determines the rotational angle of the motor 3002, that is, the position of the mounting portion 300 based on the signal input from the encoder 3006. The inkjet printer 100 comprises a mount completion button (not shown) electrically connected to the ASIC 410.

[0231] The determination process shown in Fig. 36 is started when the user completely mounts the ink cartridge 10 to the mounting portion 300 and presses the mount completion button.

[0232] When the determination process is started, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light, determines the state of the light receiver 342C, and stores the determined state of the light receiver 342C in the storage area I in S 11. Because the ink cartridge 10 is mounted to the mounting portion 300 positioned in the first position, the state of the light receiver 342C stored in S11 is the state of the light receiver 342C when the mounting portion 300 is in the first position. The controller 400 finds that the mounting portion is positioned in the first position based on the signal inputted from the encoder 3006 in S11. Then, the controller 400 causes the light emitter 342B to stop light emission, and starts to drive the motor 3002 to move the mounting portion 300 from the first position to the second position in S12. The controller 400 determines whether the mounting portion 300 reached the second position based on the signal inputted from the encoder 3006 in S13. When the controller 400 determines that the mounting portion 300 has not reach the second position, the controller 400 repeats S13. When the controller 400 determines that the mounting portion 300 reached the second position, the controller 400 stops the motor 3002 in S14. Then, the controller 400 causes the light emitter 342B to emit light, determines the state of the light receiver 342C and stores the determined state of the light receiver 342C in the storage area J in S15. Then, the controller 400 causes the light emitter 342B to stop light emission, and compares the state of the light receiver 342C stored in the storage area I and the state of the light receiver 342C stored in the storage area J in S16. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from that stored in the storage area J in S16, the controller 400 determines that the ink cartridge 10 is normal in S 17, and ends the process. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J in S16, the controller 400 determines that the ink cartridge 10 is abnormal in S18, and ends the process.

[0233] The controller 400 may cause the light emitter 342B to emit light all the time from S11 to S15. The controller 400 may cause the light emitter 342B to emit light at least in S11 and S15.

[0234] In the third embodiment, the movement of the mounting portion 300 is detected by the movement detector comprising the position detector comprising the encoder 3006. The controller 400 can determine whether the state of the light receiver 342C has changed during the period of time in which the movement of the mounting portion 300 is detected, by comparing the state of the light receiver 342C when it is detected that the mounting portion 300 is in the first position and the state of the light receiver 342C when it is detected that the mounting portion 300 is in the second position. As a result, the controller 400 does not need to monitor the state of the light receiver 342C during the period of time in which the movement of the mounting portion 300 is detected. In other words, the controller 400 does not need to periodically determine the state of the light receiver 342C over and over again. The controller 400 determines the state of the light receiver 342C only when the mounting portion 300 is in the first position and the second position. Thus, the load on the controller 400 during the process is low. The light emitter 342B emits light at least when it is detected that the mounting portion 300 is in the first position and when it is detected that the mounting portion 300 is in the second position. The light emitter 342B does not need to continue emitting light during the period of time in which the movement of the mounting portion 300 is detected. Thus, the rate of deterioration of the light emitter 342B due to light emission can be slowed down and the useful life of the light emitter 342B can be increased. In addition, the controller 400 finds the state of the light receiver 342C when the mounting portion 300 is standing still. Thus, the controller 400 can determine whether the ink cartridge 10 is normal more reliably in comparison with a case where the controller 400 determines the change of the state of the light receiver 342C by monitoring the state of the light receiver 342C while the mounting portion 300 moves.

[0235] When the determination process shown in Fig. 36 is performed without the ink cartridge 10 mounted to the mounting portion 300, the state of the light receiver 342C stored in the storage area I and the state of the light receiver 342C stored in the storage area J are both the ON state, and the controller 400 determines that the ink cartridge 10 is abnormal. In other words, because the ink supply device 30 does not comprise a mount detector, it is impossible to distinguish between a case where the ink cartridge 10 is not mounted to the mounting portion 300 and a case where the movement of the pivotable

member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90. Thus, in the third embodiment, the controller 400 determines that the ink cartridge 10 is abnormal in any of the both cases. However, in the first embodiment, the ink cartridge 10 comprises the optical detector 344 as an example of a mount detector, it is possible to distinguish between the case where the ink cartridge 10 is not mounted to the mounting portion 300 and the case where the movement of the pivotable member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90. Thus, in the first embodiment, the controller 400 can determine the abnormality of the ink cartridge 10 with precision.

[0236] The motor 3002 may a stepping motor. In this case, the position detector may not have the encoder 3006, and the position of the mounting portion 300 may be detected indirectly from the number of pulses given to the stepping motor.

[0237] <Fourth embodiment> A fourth embodiment of an ink ejecting system of the invention will be described with reference to Fig. 37. It is noted that elements similar to or identical with those described in the first embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the first embodiment.

[0238] The fourth embodiment is different from the first embodiment in that the ink supply device 30 does not have the optical detector 344 as an example of a mount detector. In addition, the fourth embodiment is different from the first embodiment in a determination process executed by the controller 400.

[0239] The controller 400 monitors the state of the first limit switch 346. When the state of the first limit switch 346 changed from the ON state to the OFF state, the determination process shown in Fig. 37 is started. In other words, the determination process is started when it is detected that the mounting portion 300 is moved from the first position and is not in the first position. When the state of the first limit switch 346 changed from the OFF state to the ON state in the middle of the determination process, the controller 400 stops the determination process.

[0240] When the determination process is started, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light, determines the state of the light receiver 342C, and stores the determined state of the light receiver 342C in the storage areas I and J in S21. Then, the controller 400 compares the state of the light receiver 342C stored in the storage area I and the state of the light receiver 342C stored in the storage area J in S22. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J in S22, the controller 400 determines whether the second limit switch 348 is in the ON state, that is, determines whether the mounting portion 300 reached the second position in S23. When the controller 400 determines that the second limit switch 348 is not in the ON state in S23, the controller 400 stores the state of the light receiver 342C stored in the storage area I in the storage area J in S24. The controller 400 determines the state of the light receiver 342C and stores the determined state of the light receiver 342C in the storage area I in S25. Then, the controller 400 returns to S22. As such, after it is detected that the mounting portion 300 was moved from the first position and is not in the first position, the controller 400 periodically determines the state of the light receiver 342C in accordance with the loop from S22 to S25. In other words, after it is detected that the mounting portion 300 was moved from the first position and is not in the first position, the controller 400 monitors the state of the light receiver 342C. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S22, the controller 400 determines that the ink cartridge 10 is normal in S26, and ends the determination process. When the controller 400 determines that the second limit switch 348 is in the ON state in S23, the controller 400 determines that the ink cartridge is abnormal in S27, and ends the determination process. During the determination process, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light in all steps.

[0241] When the ink cartridge 10 mounted to the mounting portion 300 is brand-new and normal, that is, when the ink cartridge 10 has the pivotable member 90 and the pivotable member 90 pivots normally, the state of the light receiver 342C changes while the mounting portion 300 moves from the first position to the second position. Thus, before the second limit switch 348 becomes the ON state, the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S22, and determines that the ink cartridge 10 is normal 6. When the ink cartridge 10 mounted to the mounting portion 300 is abnormal, for example, when the movement of the pivotable member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90, the state of the light receiver 342C does not change even when the mounting portion 300 moves from the first position to the second position. In this case, the state of the light receiver 342C stored in the storage area I is always the same as the state of the light receiver 342C stored in the storage area J, and the controller 400 determines that the ink cartridge 10 is abnormal.

[0242] In the fourth embodiment, the controller 400 determines that the ink cartridge 10 is normal before it is detected that the mounting portion 300 reaches the second position. Thus, the controller 400 can determine the normal state of the ink cartridge 10 at an early stage without having to wait until the mounting portion 300 reaches the second position.

[0243] In the fourth embodiment, the ink supply device 30 does not have a mount detector as in the third em-

bodiment. Therefore, it is impossible to distinguish between a case where the ink cartridge 10 is not mounted to the mounting portion 300 and a case where the movement of the pivotable member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90. Thus, in the fourth embodiment, the controller 400 determines that the ink cartridge 10 is abnormal in any of the both cases.

[0244] <Fifth embodiment> A fifth embodiment of an ink jet system of the invention will be described with reference to Fig. 38. It is noted that elements similar to or identical with those described in the fourth embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the fourth embodiment.

[0245] The fifth embodiment is partially different from the fourth embodiment in a determination process executed by the controller 400.

[0246] Because the determination process shown in Fig. 38 is similar to the determination process in the fourth embodiment, the following description will be made mainly as to different points.

[0247] When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S32, the controller 400 sets a flag in a particular storage area in the RAM 406 in S36, and proceeds to S33. When the controller 400 determines that the second limit switch 348 is in the ON state in S33, the controller 400 determines whether a flag is set in the particular storage area in the RAM 406 in S37. When a flag is set in the particular storage area in S37, the controller 400 determines that the ink cartridge 10 is normal in S38. When a flag is not set in S37, the controller 400 determines that the ink cartridge 400 is abnormal in S39.

[0248] <Sixth embodiment> A sixth embodiment of an ink ejecting system of the invention will be described with reference to Fig. 39. It is noted that elements similar to or identical with those described in the fourth embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the first embodiment.

[0249] The sixth embodiment is different from the first embodiment in that the ink supply device 30 does not have the optical detector 344 as an example of a mount detector, the position detector of the movement detector does not have the second limit switch 348 and has the first limit switch 346 only, and the controller 400 comprises a timer as an example of a time measure. In addition, the sixth embodiment is different from the first embodiment in a determination process executed by the controller 400.

[0250] In the sixth embodiment, the controller 400 comprises a timer for measuring a predetermined period of time.

[0251] The movement detector, which comprises the position detector comprising the first limit switch 346, can detect the mounting portion 300 started to move by detecting that the mounting portion 300 was moved from the first position. Thus, the period of time in which the movement of the mounting portion 300 is detected corresponds to a period of time in which the mounting portion is not in the first position.

[0252] The controller 400 monitors the state of the first limit switch 346. When the state of the first limit switch 346 changed from the ON state to the OFF state, the determination process shown in Fig. 39 is started. In other words, the determination process is started when it is detected that the mounting portion 300 moved from the first position and is not in the first position. When the state of the first limit switch 346 changed from the OFF state to the ON state in the middle of the determination process, the controller 400 stops the determination process.

[0253] When the determination process is started, the controller 400 causes the timer to start to measure a predetermined period of time in S41. The controller 400 causes the light emitter 342B of the optical detector 342 to emit light, determines the state of the light receiver 342C, and stores the determined state of the light receiver 342C in the storage areas I and J in S42. Then, the controller 400 compares the state of the light receiver 342C stored in the storage area I and the state of the light receiver 342C stored in the storage area J in S43. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J in S43, the controller 400 determines whether a the predetermined period of time measured by the timer has elapsed in S44. When the controller 400 determines that the predetermined period of time measured by the timer has not elapsed in S44, the controller 400 stores the state of the light receiver 342C stored in the storage area I in the storage area J in S45. The controller 400 determines the state of the light receiver 342C and stores the determined state of the light receiver 342C in the storage area I in S46. Then, the controller 400 returns to S43. As such, after it is detected that the mounting portion 300 was moved from the first position and is not in the first position, the controller 400 periodically determines the state of the light receiver 342C in accordance with the loop from S43 to S46. In other words, after it is detected that the mounting portion 300 was moved from the first position and is not in the first position, the controller 400 monitors the state of the light receiver 342C. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S43, the controller 400 determines that the ink cartridge 10 is normal in S47, and ends the determination process. When the controller 400 determines that the predetermined period of time measured by the timer has elapsed in S44, the controller 400 determines that the ink cartridge 10 is abnormal in S48, and

ends the determination process. During the determination process, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light in steps from S42 to S46.

[0254] The predetermined period of time is set to be sufficiently long to allow a user to operate the link mechanism 310 and move the mounting portion 300 from the first position to the second position. Thus, when the ink cartridge 10 mounted to the mounting portion 300 is brand-new and normal, that is, when the ink cartridge 10 has the pivotable member 90 and the pivotable member 90 pivots normally, the state of the light receiver 342C changes within the predetermined period of time after the mounting portion 300 moved from the first position. Thus, before the period of time elapses, the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S43, and determines that the ink cartridge 10 is normal in S47. When the ink cartridge 10 mounted to the mounting portion 300 is abnormal, for example, when the movement of the pivotable member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90, the state of the light receiver 342C does not change even when the predetermined period of time elapses. In this case, the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J, and the controller 400 determines that the ink cartridge 10 is abnormal in S48.

[0255] According to the inkjet printer 100 in the sixth embodiment, the controller 400 can determine the state of the ink cartridge 10 without the second limit switch 348. As a result, the number of physical elements of the inkjet printer 100 is reduced. In addition, even when the state of the light receiver 342C is unchanged because the mounting portion 300 is out of order and is immovable, the controller 400 determines that the ink cartridge 10 is abnormal after the predetermined period of time elapses. Thus, a user can effectively deal with a failure in the mounting portion 300.

[0256] In the sixth embodiment, the mounting portion 300 in the second position is not detected. Therefore, in contrast to the first embodiment, ink is allowed to be ejected from the recording head 132 regardless of the position of the mounting portion 300.

[0257] <Seventh embodiment> A seventh embodiment of an ink ejecting system of the invention will be described with reference to Fig. 40. It is noted that elements similar to or identical with those described in the first embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the first embodiment.

[0258] The seventh embodiment is different from the first embodiment in that the position detector of the movement detector does not have the second limit switch 348 and comprises the first limit switch 346 only. In addition, the seventh embodiment is different from the first embodiment in a determination process executed by the controller 400.

[0259] The controller 400 causes the light emitter 344B of the optical detector 344 to emit light and monitors the state of the light receiver 344C. When the state of the light receiver 344C changed from ON state to OFF state, the controller 400 starts the determination process shown in Fig. 40. In other words, the determination process shown in Fig. 40 is started when it is detected that the ink cartridge 10 was mounted to the mounting portion 300. When the state of the light receiver 344C changes from the OFF state to the ON state in the middle of the process, the controller 400 causes the display portion (not shown) of the inkjet printer 100 to display a message and prompts a user to re-mount the ink cartridge 10 in the mounting portion 300.

[0260] When the determination process is started, the controller 400 causes the light emitter 342B of the optical detector 342, determines the state of the light receiver 342C, and stores the determined state of the light receiver 342C in the storage areas I and J in S51. Because the ink cartridge 10 is mounted to the mounting portion 300 positioned in the first position, the state of the light receiver 342C stored in S51 is the state of the light receiver 342C when the mounting portion 300 is in the first position. Then, the controller 400 compares the state of the light receiver 342C stored in the storage area I and the state of the light receiver 342C stored in the storage area J in S52. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J in S52, the controller 400 determines whether the second limit switch is in the ON state in S53. In other words, the controller 400 determines whether the mounting portion 300 reached the second position. When the controller 400 determines that the second limit switch 346 is not in the ON state, the controller 400 stores the state of the light receiver 342C stored in the storage area I in the storage area J in S54. Then, the controller 400 determines the state of the light receiver 342C and stores the determined state of the light receiver 342C in the storage area I in S55. Then, the controller 400 returns to S52. As such, after it is detected that the ink cartridge 10 was mounted to the mounting portion 300, the controller 400 periodically determines the state of the light receiver 342C in accordance with the loop from S52 to S55. In other words, after it is detected that the ink cartridge 10 was mounted to the mounting portion 300, the controller 400 monitors the state of the light receiver 342C. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S52, the controller 400 determines that the ink cartridge 10 is normal in S56, and ends the determination process. When the controller 400 determines that the second limit switch 348 is in the ON state in S53, the controller 400 determines that the ink cartridge 10 is abnormal in S57, and ends the determination proc-

ess. During the determination process, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light in all steps.

[0261] When the ink cartridge 10 mounted to the mounting portion 300 is brand-new and normal, that is, when the ink cartridge 10 has the pivotable member 90 and the pivotable member 90 pivots normally, the state of the light receiver 342C changes while the mounting portion 300 moves from the first position to the second position. Thus, before the second limit switch 348 becomes the ON state, the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S52, and determines that the ink cartridge 10 is normal in S56. When the ink cartridge 10 mounted to the mounting portion 300 is abnormal, for example, when the movement of the pivotable member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90, the state of the light receiver 342C does not change even when the mounting portion 300 moves from the first position to the second position. In this case, the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J, and the controller 400 determines that the ink cartridge 10 is abnormal in S57.

[0262] In the seventh embodiment, the controller 400 determines that the ink cartridge 10 is normal before it is detected that the mounting portion 300 reaches the second position. Thus, the controller 400 can determine the normal state of the ink cartridge 10 at an early stage without having to wait until the mounting portion 300 reaches the second position.

[0263] <Eighth embodiment> An eighth embodiment of an ink ejecting system of the invention will be described with reference to Fig. 41. It is noted that elements similar to or identical with those described in the seventh embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the seventh embodiment.

[0264] The eighth embodiment is different from the seventh embodiment in a determination process executed by the controller 400.

[0265] Because the determination process shown in Fig. 41 is similar to the determination process in the seventh embodiment, the following description will be made mainly as to different points.

[0266] When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S62, the controller 400 sets a flag in a particular storage area in the RAM 406 in S66, and proceeds to S63. When the controller 400 determines that the second limit switch 348 is in the ON state in S63, the controller 400 determines whether a flag is set in the particular storage area in the RAM 406 in S67. When a flag is set in the particular storage area in S67, the controller 400 determines that the ink cartridge 10 is normal in S68. When a flag is not set in S67, the controller 400 determines that the ink cartridge 400 is abnormal in S69.

[0267] <Ninth embodiment> A ninth embodiment of an ink ejecting system of the invention will be described with reference to Fig. 42. It is noted that elements similar to or identical with those described in the first embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the first embodiment.

[0268] The ninth embodiment is different from the first embodiment in that the inkjet printer 100 does not have a movement detector, and the controller 400 comprises a timer for measuring a predetermined period of time. In addition, the ninth embodiment is different from the first embodiment in a determination process executed by the controller 400.

[0269] The controller 400 monitors the state of the light receiver 344C of the optical detector 344. When the state of the light receiver 344C changed from ON state to OFF state, the controller 400 starts the determination process shown in Fig. 42. In other words, the determination process shown in Fig. 42 is started when it is detected that the ink cartridge 10 was mounted to the mounting portion 300. When the state of the light receiver 344C changes from the OFF state to the ON state in the middle of the process, the controller 400 causes the display portion (not shown) of the inkjet printer 100 to display a message and prompts a user to re-mount the ink cartridge 10 in the mounting portion 300.

[0270] When the determination process is started, the controller 400 causes the timer to start to measure a predetermined period of time in S71. The controller 400 causes the light emitter 342B of the optical detector 342 to emit light, determines the state of the light receiver 342C, and stores the determined state of the light receiver 342C in the storage areas I and J in S72. Because the ink cartridge 10 is mounted to the mounting portion 300 positioned in the first position, the state of the light receiver 342C stored in S72 is the state of the light receiver 342C when the mounting portion 300 is in the first position. Then, the controller 400 compares the state of the light receiver 342C stored in the storage area I and the state of the light receiver 342C stored in the storage area J in S73. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J in S73, the controller 400 determines whether the period of time measured by the timer has elapsed in S74. When the controller 400 determines that the period of time measured by the timer has not elapsed in S74, the controller 400 stores the state of the light receiver 342C stored in the storage area I in the storage area J in S75. Then, the controller 400 determines the state of the light receiver 342C and stores the determined state of the light receiver 342C in the storage area I in

S76. Then, the controller 400 returns to S73. As such, after it is detected that the ink cartridge 10 was mounted to the mounting portion 300, the controller 400 periodically determines the state of the light receiver 342C in accordance with the loop from S73 to S76. In other words, after it is detected that the ink cartridge 10 was mounted to the mounting portion 300, the controller 400 monitors the state of the light receiver 342C. When the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S73, the controller 400 determines that the ink cartridge 10 is normal in S77, and ends the determination process. When the controller 400 determines that the period of time measured by the timer has elapsed in S74, the controller 400 determines that the ink cartridge 10 is abnormal in S78, and ends the determination process. During the determination process, the controller 400 causes the light emitter 342B of the optical detector 342 to emit light in steps from S72 to S76.

[0271] The predetermined period of time is set to be sufficiently long to allow a user to operate the link mechanism 310 after the ink cartridge 10 is mounted to the mounting portion 300 and move the mounting portion 300 from the first position to the second position. Thus, when the ink cartridge 10 mounted to the mounting portion 300 is brand-new and normal, that is, when the ink cartridge 10 has the pivotable member 90 and the pivotable member 90 pivots normally, the state of the light receiver 342C changes within the predetermined period of time after the ink cartridge 10 is mounted to the mounting portion 300. Thus, before the predetermined period of time elapses, the controller 400 determines that the state of the light receiver 342C stored in the storage area I is different from the state of the light receiver 342C stored in the storage area J in S73, and determines that the ink cartridge 10 is normal in S77. When the ink cartridge 10 mounted to the mounting portion 300 is abnormal, for example, when the movement of the pivotable member 90 is hampered or the ink cartridge 10 does not have the pivotable member 90, the state of the light receiver 342C does not even when the predetermined period of time elapses. In this case, the state of the light receiver 342C stored in the storage area I is the same as the state of the light receiver 342C stored in the storage area J, and the controller 400 determines that the ink cartridge 10 is abnormal in S78.

[0272] According to the inkjet printer 100 in the ninth embodiment, the controller 400 can determine the state of the ink cartridge 10 without the movement detector. As a result, the number of physical elements of the inkjet printer 100 is reduced. In addition, even when the state of the light receiver 342C is unchanged because the mounting portion 300 is out of order and is immovable, the controller 400 determines that the ink cartridge 10 is abnormal after the predetermined period of time elapses. Thus, a user can effectively deal with a failure in the mounting portion 300.

[0273] In the ninth embodiment, the mounting portion 300 in the second position is not detected. In contrast to the first embodiment, ink is allowed to be ejected from the recording head 132 regardless of the position of the mounting portion 300.

[0274] <Tenth embodiment> A tenth embodiment of an ink ejecting system of the invention will be described with reference to Figs. 43 and 44. In Figs. 43 and 44, the first cover 15, the second cover 16, a portion of the ink supply portion 50, and a portion of the air communication portion 60 are omitted for convenience of illustration. It is noted that elements similar to or identical with those described in the first embodiment are designated by similar numerals, and thus the description thereof can be omitted for the sake of brevity. The following description will be made mainly as to different points from the first embodiment.

[0275] The tenth embodiment is different from the first embodiment in that the ink cartridge 10 comprises a floating member 1090 instead of the pivotable member 90, internal shape of a frame, and the angles of the mounting portion 300 in the first and second positions with respect to the horizontal plane are different from those in the first embodiment.

[0276] In the tenth embodiment, the ink cartridge 10 comprises the floating member 1090. The floating member 1090 is positioned in the ink chamber 11.

[0277] The specific gravity of the floating member 1090 is less than the specific gravity of ink stored in the ink chamber 11. The floating member 1090 is formed of a resin material similar to that used for the pivotable member 90 of the first embodiment. The floating member 1090 is configured to block light.

[0278] The floating member 1090 comprises a spherical portion 1092 and a light blocking portion 1093 having a substantially rectangular parallelepiped shape and extending from the spherical portion 1092. A plurality of first guide walls 1094 extends from one of the pair of sidewalls 21 to the other of the pair of sidewalls 21 in the width direction 12. The first guide walls 1094 are aligned in a line at regular intervals in the depth direction 13. A plurality of second guide walls 1095 extends from one of the pair of sidewalls 21 to the other of the pair of sidewalls 21 in the width direction 12. The second guide walls 1095 are aligned in a line at regular intervals in the depth direction 13. The floating member 1090 is positioned between the line of first guide walls 1094 and the line of second guide walls 1095. The floating member 1090 is movable between the two lines according to a position of the ink surface L in the ink chamber 11.

[0279] When the mounting portion 300 is in the first position, the ink cartridge 10 is mounted to the mounting portion 300 along a mounting direction 1360 from down to up. The mounting direction 1360 is a direction which is inclined minus 60 degrees with respect to the horizontal plane. When the ink cartridge 10 is mounted to the mounting portion 300, the depth direction 13 of the ink cartridge 10 becomes parallel with the mounting direction 1360.

The ink cartridge 10 is mounted to the mounting portion 300 from the front surface 22 side of the frame 20.

[0280] As shown in Fig. 43, when the ink cartridge 10 is mounted to the mounting portion 300 and the mounting portion 300 is in the first position, an angle formed between the bottom surface 25 of the frame 20 and the horizontal plane indicated by alternate long and short lines is minus 60 degrees. The ink surface L in the ink chamber 11 is positioned adjacent to the protrusion 70. The floating member 1090 is submerged in ink, and the light blocking portion 1093 crosses the optical path 342D of the optical detector 342.

[0281] As shown in Fig. 44, when the mounting portion 300 is in the second position, the angle formed between the bottom surface 25 of the frame 20 and the horizontal plane indicated by alternate long and short lines is 60 degrees. The ink surface L of ink is positioned adjacent to the rear surface 23 of the frame 20, and the floating member 1090 is submerged in ink adjacent to the rear surface 23. The light blocking portion 1093 does not cross the optical path 342D.

[0282] In the ink ejecting system configured above, the controller 400 can determine whether the ink cartridge 10 is normal by executing the determination process shown in Fig. 29.

[0283] In the first to tenth embodiments, a plurality of, e.g. four, ink cartridges 10 are supposed to be mounted to the mounting portions 300. The above determination processes shown in Figs. 29 and 36 - 42 to determine whether the ink cartridge 10 is normal are performed for each ink cartridge 10.

[0284] In the first to tenth embodiments, the storage areas I and J may be areas in a register of the CPU 402.

[0285] In the first to tenth embodiments, the pivotable member can be moved with respect to the ink chamber and the optical detectors without any contact with the pivotable member from the outside of the ink cartridge. Thus, the ink cartridge can minimize the chances of ink leakage from the ink chamber to the outside of the ink cartridge, compared with a case where the pivotable member is moved from the outside of the ink cartridge with contact with the pivotable member.

[0286] In the fourth to ninth embodiments, the controller 400 periodically monitors the state of the light receiver 342C to determine whether the state of the light receiver 342C has changed. However, the determination of whether the state of the light receiver 342C has changed may be performed by an interrupt processing caused by the change of the state of the light receiver 342C.

[0287] The ink ejecting systems of the above embodiments may be applied to not only a system for forming images on recording media by ink ejection but also a system for adhering liquid to an object by ejecting the liquid, for example, for forming wiring patterns on boards for printed wiring boards or manufacturing liquid crystal color filters.

Claims

1. A liquid ejecting apparatus (100) comprising:

a mounting portion (300) configured to move such that an inclination of the mounting portion with respect to a horizontal plane changes, wherein a liquid cartridge (10) is configured to be removably mounted to the mounting portion (300), the liquid cartridge (10) comprising a liquid chamber (11) configured to store liquid therein and a movable member (90) positioned in the liquid chamber (11), wherein the specific gravity of at least a portion of the movable member (90) is less than the specific gravity of the liquid stored in the liquid chamber (11), wherein the movable member (90) is configured to move according to a position of a surface of the liquid in the liquid chamber (11);

an optical detector (342) fixed to the mounting portion (300) and comprising a light emitter (342B) and a light receiver (342C), wherein the light emitter (342B) is configured to emit light in a direction crossing a path along which a portion of the movable member (90) of the liquid cartridge (10) mounted to mounting portion (300) moves relative to the liquid chamber (11), and the light receiver (342C) is configured to assume two predetermined states according to a position of the portion of the movable member (90) in the path; and

a state determiner (400) configured to determine a change in the state of the light receiver (342C), wherein the state determiner (400) is configured to determine that:

the liquid cartridge (10) is normal when the state determiner (400) determines that the state of the light receiver (342C) has changed; and

the liquid cartridge (10) is abnormal when the state determiner (400) determines that the state of the light receiver (342C) has not changed.

2. The liquid ejecting apparatus (100) of claim 1, further comprising a movement detector (346, 348, 3006) configured to detect a movement of the mounting portion (300),

wherein the state determiner (400) is configured to determine that:

the liquid cartridge (10) is normal when the state determiner (400) determines that the state of the light receiver (342C) has changed during a period of time in which the movement of the mounting portion (300) is detected; and

the liquid cartridge (10) is abnormal when the

state determiner (400) determines that the state of the light receiver (342C) has not changed during the period of time in which the movement of the mounting portion (300) is detected.

3. The liquid ejecting apparatus (100) of claim 2, wherein the mounting portion (300) is configured to move between at least a first position and a second position, and the first position and the second position have different inclinations with respect to the horizontal plane,
wherein the movement detector (346, 348, 3006) comprises a position detector (346, 348, 3006) configured to detect that the mounting portion (300) is in the first or second position,
wherein the state determiner (400) is configured to compare:

the state of the light receiver (342C) in a first detection state in which it is detected by the position detector (346, 348, 3006) that the mounting portion (300) is positioned in the first position; and
the state of the light receiver (342C) in a second detection state in which it is detected by position detector (346, 348, 3006) that the mounting portion (300) is positioned in the second position,

wherein the state determiner (400) is configured to determine that:

the liquid cartridge (10) is normal when the state determiner (400) determines that the state of the light receiver (342C) in the first detection state is different from the state of the light receiver (342C) in the second detection state; and
the liquid cartridge (10) is abnormal when the state determiner (400) that the state of the light receiver (342C) in the first detection state is the same as the state of the light receiver (342C) in the second detection state.

4. The liquid ejecting apparatus (100) of claim 3, further comprising a mount detector (344) configured to detect that the liquid cartridge (10) is mounted to the mounting portion (300),
wherein the first detection state is a state in which it is detected by the mount detector (344) that the liquid cartridge (10) is mounted to the mounting portion (300) and it is detected by position detector (346, 348, 3006) that the mounting portion (300) is in the first position, and
wherein the second detection state is a state in which it is detected by the mount detector (344) that that the liquid cartridge (10) is mounted to the mounting portion (300) and it is detected by position detector (346, 348, 3006) that the mounting portion (300) is in the second position.

5. The liquid ejecting apparatus (100) of one of claims 2 to 4, wherein the mounting portion (300) is configured to move between at least a first position and a second position, and the first position and the second position have different inclinations with respect to the horizontal plane,
wherein the movement detector (346, 348, 3006) comprises a position detector (346, 348, 3006) configured to detect that the mounting portion (300) is in the first or second position, and
wherein the state determiner (400) is configured to:

(a) start to monitor the state of the light receiver (342C) when it is detected by the position detector (346, 348, 3006) that the mounting portion (300) moved from the first position;
(b) determine whether the state of the light receiver (342C) has changed during a period of time from when it is detected by the position detector (346, 348, 3006) that the mounting portion (300) moved from first position to when it is detected by the position detector (346, 348, 3006) that the mounting portion (300) reaches the second position; and
(c) determine that:

the liquid cartridge (10) is normal when the state determiner (400) determines that the state of the light receiver (342C) has changed during the period of time; and
the liquid cartridge (10) is abnormal when the state determiner (400) determines that the state of the light receiver (342C) has not changed during the period of time.

6. The liquid ejecting apparatus (100) of claim 5, wherein when the state determiner (400) determines that the state of the light receiver (342C) has changed, the state determiner (400) determines that the liquid cartridge (10) is normal before it is detected that the mounting portion (300) reaches the second position.

7. The liquid ejecting apparatus (100) of one to claims 2 to 4, further comprising a time measure configured to measure a period of time,
wherein the mounting portion (300) is configured to move between at least a first position and a second position, and the first position and the second position have different inclinations with respect to the horizontal plane,
wherein the movement detector (346, 348, 3006) comprises a position detector (346, 3006) configured to detect that the mounting portion (300) is in the first position,
wherein the time measure is configured to start to measure a predetermined period of time when it is detected by the position detector (346, 3006) that the mounting portion (300) moved from the first po-

sition,
wherein the state determiner (400) is configured to:

(a) start to monitor the state of the light receiver (342C) when it is detected by the position detector (346, 3006) that the mounting portion (300) moved from the first position;
(b) determine whether the state of the light receiver (342C) has changed during the predetermined period of time; and
(c) determine that:

the liquid cartridge (10) is normal when the state determiner (400) determines that the state of the light receiver (342C) has changed during the predetermined period of time; and
the liquid cartridge (10) is abnormal when the state determiner (400) determines that the state of the light receiver (342C) has not changed during the predetermined period of time.

8. The liquid ejecting apparatus (100) of any one of claims 3 to 6, further comprising:

a liquid ejection portion (132) configured to eject liquid;
an ejection controller (133, 400) configured to control the liquid ejection portion; and
a connection portion (326, 350) configured to allow communication between the liquid chamber (11) and the liquid ejection portion (132) when the liquid cartridge (10) is mounted to the mounting portion (300),

wherein the liquid cartridge (10) is mountable to the mounting portion (300) when the mounting portion (300) is in the first position, and
wherein the ejection controller (133, 400) is configured to allow the liquid ejecting portion (132) to eject liquid while it is detected that the mounting portion (300) is in the second position.

9. The liquid ejecting apparatus (100) of one of claims 1 to 8, further comprising:

a position detector (348); and
a mount detector (344) configured to detect that the liquid cartridge (10) is mounted to the mounting portion (300),

wherein the mounting portion (300) is movable between at least a first position in which the liquid cartridge (10) is removably mountable to the mounting portion (300) and a second position having a different inclination from a inclination of the first position with respect to the horizontal plane,
wherein the position detector (348) is configured to detect that the mounting portion (300) is in the second position,
wherein the state determiner (400) is configured to:

(a) start to monitor the state of the light receiver (342C) when the mount detector (344) detects that that the liquid cartridge (10) was mounted to the mounting portion (300);
(b) determine whether the state of the light receiver (342C) has changed during a period of time from when the mount detector (344) detects that the liquid cartridge (10) was mounted to the mounting portion (300) to when the position detector (348) detects that that the mounting portion (300) reaches the second position; and
(c) determine that:

the liquid cartridge (10) is normal when the state determiner determines that the state of the light receiver (342C) has changed during the period of time; and
the liquid cartridge (10) is abnormal when the state determiner determines that the state of the light receiver (342C) has not changed during the period of time.

10. The liquid ejecting apparatus (100) of claim 9, wherein when the state determiner (400) determines that the state of the light receiver (342C) has changed, the state determiner (400) determines that the liquid cartridge (10) is normal before the position detector (348) detects that the mounting portion (300) reaches the second position.

11. The liquid ejecting apparatus (100) of one of claims 1 to 10, further comprising:

a mount detector (344) configured to detect that the liquid cartridge (10) is mounted to the mounting portion (300); and
a time measure configured to start to measure a predetermined period of time when the mount detector (344) detects that the liquid cartridge (10) was mounted to the mounting portion (300),

wherein the mounting portion (300) is movable between at least a first position in which the liquid cartridge (10) is removably mountable to the mounting portion (300) and a second position having a different inclination from a inclination of the first position with respect to the horizontal plane,
wherein the state determiner (400) is configured to:

(a) start to monitor the state of the light receiver (342C) when the mount detector (344) detects that that the liquid cartridge (10) was mounted to the mounting portion (300);

(b) determine whether the state of the light receiver (342C) has changed during the predetermined period of time; and
(c) determine that:

the liquid cartridge (10) is normal when the state determiner (400) determines that the state of the light receiver (342C) has changed during the predetermined period of time; and
the liquid cartridge (10) is abnormal when determining that the state of the light receiver (342C) has not changed during the predetermined period of time.

12. The liquid ejecting apparatus (100) of claim 9 or 10, further comprising:

a liquid ejection portion (132) configured to eject liquid;
an ejection controller (133, 400) configured control the liquid ejection portion; and
a connection portion (326, 350) configured to allow communication between the liquid chamber (11) and the liquid ejection portion when the liquid cartridge (10) is mounted to the mounting portion (300),

wherein the ejection controller (133, 400)is configured to allow the liquid ejecting portion (132) to eject liquid while it is detected that the mounting portion (300) is in the second position.

13. A liquid ejecting system (1) comprising:

a liquid cartridge (10) comprising a liquid chamber (11) configured to store liquid therein, a pivotable member (90), and a contact portion (74A), wherein the specific gravity of at least a portion of the pivotable member (90) is less than the specific gravity of liquid stored in the liquid chamber (11), and the pivotable member (90) is configured to pivot according to a position of a surface of the liquid stored in the liquid chamber (11), wherein the contact portion is positioned such that the contact portion contacts the pivotable member when the pivotable member moves in a predetermined direction;
a mounting portion (300) configured to move between at least a first position and a second position having a different inclination from an inclination of the first position with respect to a horizontal plane, wherein the liquid cartridge (10) is removably mounted to the mounting portion (300) positioned in the first position along a mounting direction extending from up to down;
an optical detector (342) fixed to the mounting portion (300) and comprising a light emitter (342B) and a light receiver (342C), wherein the light emitter (342B) is configured to emit light in a direction crossing a path along which a portion of the pivotable member (90) of the liquid cartridge (10) mounted to mounting portion (300) moves relative to the liquid chamber (11), and the light receiver (342C) is configured to assume two predetermined states according to a position of the portion of the pivotable member (90) in the path; and
a state determiner (400) configured to determine a change in the state of the light receiver (342C), wherein the state determiner (400) is configured to determine that:

the liquid cartridge (10) is normal when the state determiner (400) determines that the state of the light receiver (342C) has changed; and
the liquid cartridge (10) is abnormal when the state determiner (400) determines that the state of the light receiver (342C) has not changed,

wherein, when the liquid cartridge (10) is mounted to the mounting portion (300) and the mounting portion (300) is positioned in the second position with the pivotable member (90) submerged in the liquid stored in the liquid chamber (11), the pivotable member (90) contacts the contact portion and a distance between the center of buoyancy of the pivotable member and the surface of liquid stored in the liquid chamber (11) is less than a distance between a center of a pivotal movement of the pivotable member and the surface of the liquid stored in the liquid chamber (11),
wherein, while the liquid cartridge (10) is mounted to the mounting portion (300) positioned in the first position along the mounting direction, the center of the pivotal movement of the pivotable member is positioned below the center of buoyancy of the pivotable member with respect to the mounting direction.

14. The liquid ejecting system of claim 13, wherein the center of buoyancy of the pivotable member coincides with the center of gravity of the pivotable member.

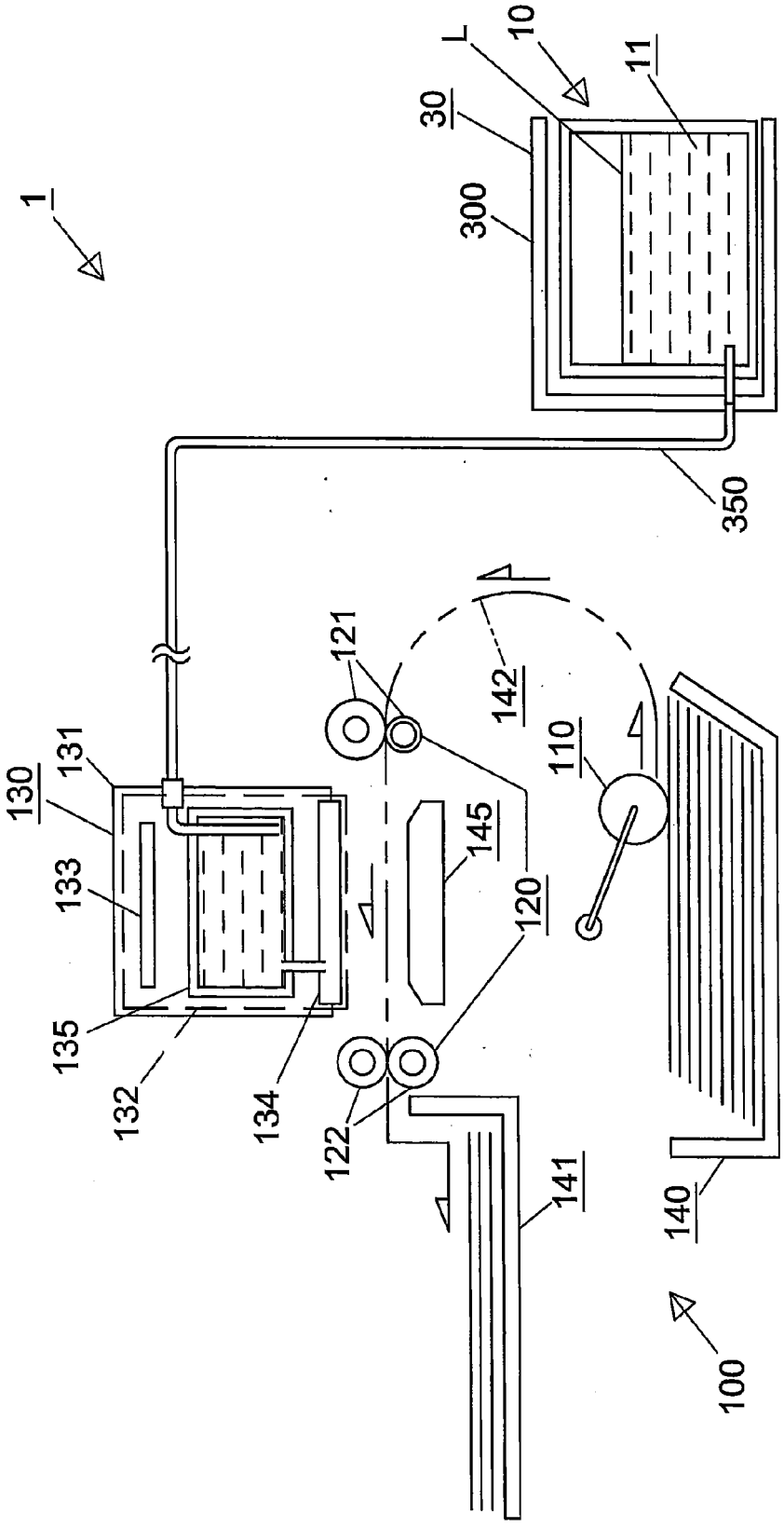

1
L
10
11
30
300
350
121
142
110
130
131
133
145
120
135
132
134
122
141
140
100

Fig. 1

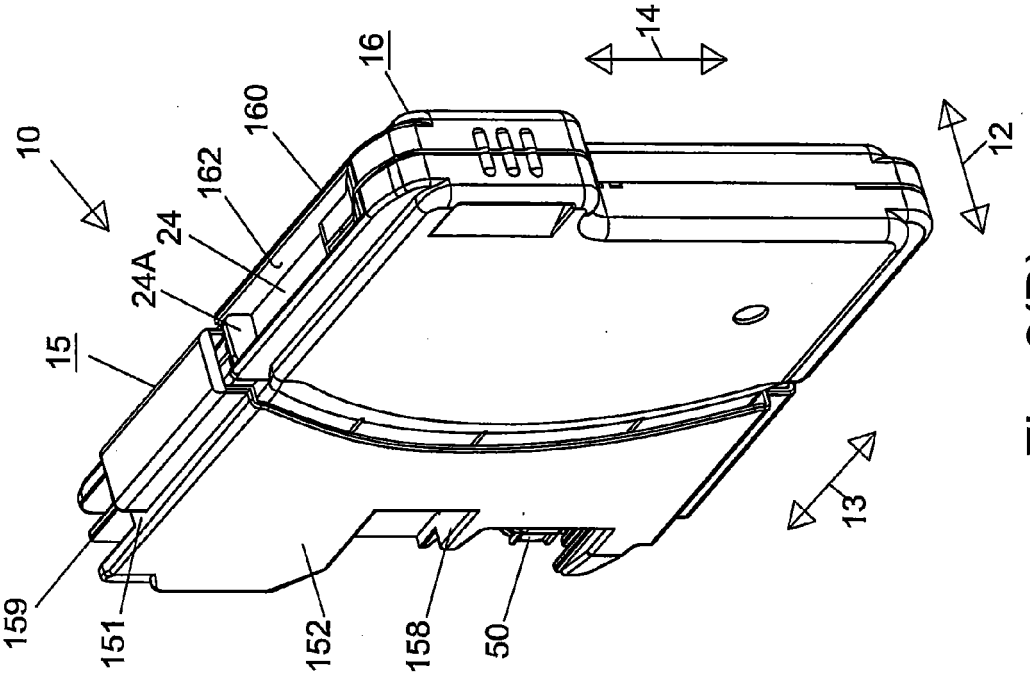
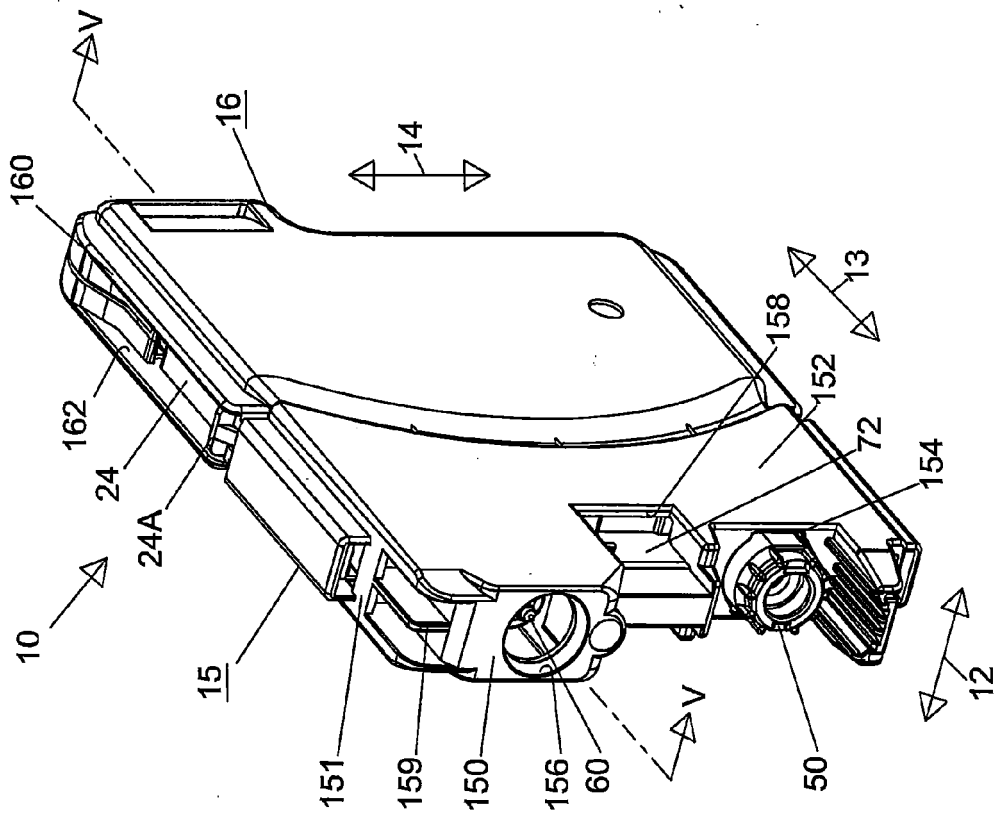

10
16
14
160
162
24
24A
15
12
13
159
151
152
158
50

Fig. 2(B)


V
16
14
160
162
24
24A
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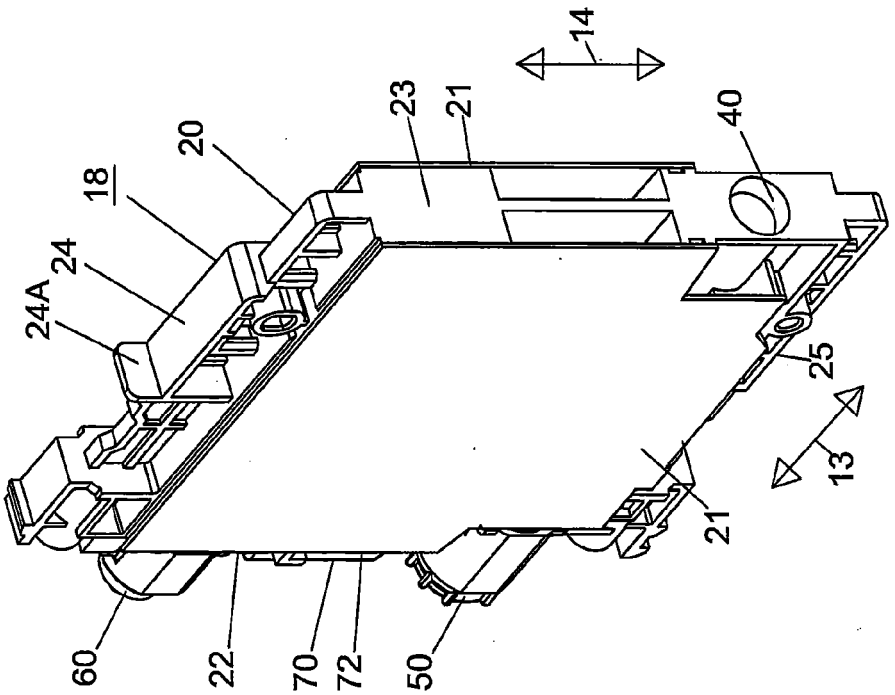
15
13
158
152
72
154
12
151
159
150
156
60
V
50

Fig. 2(A)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23
21
40
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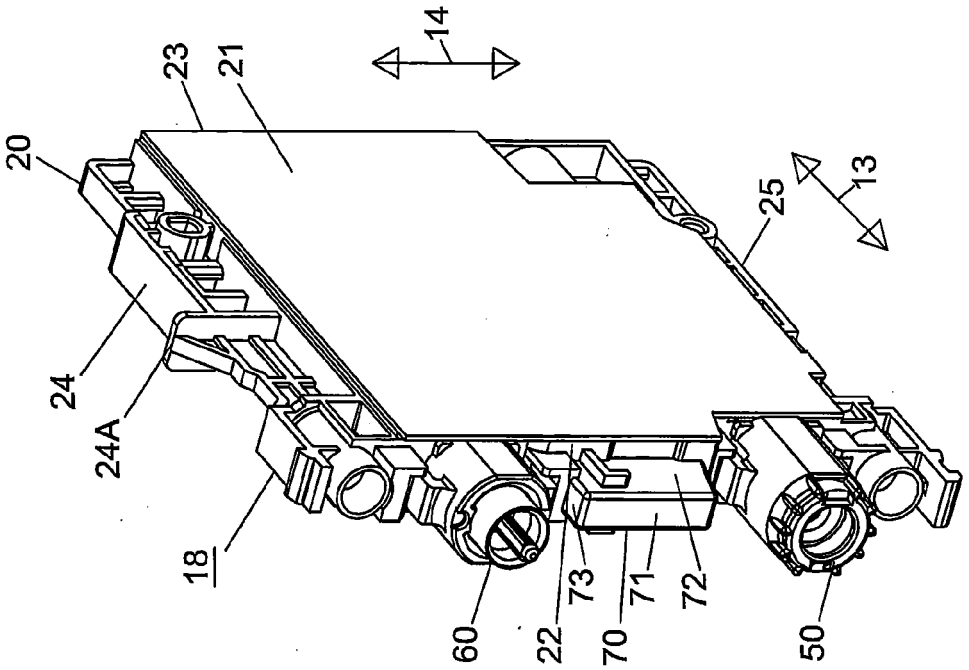
18
24
24A
12
25
13
21
60
22
70
72
50

Fig. 3(B)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23
21
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13
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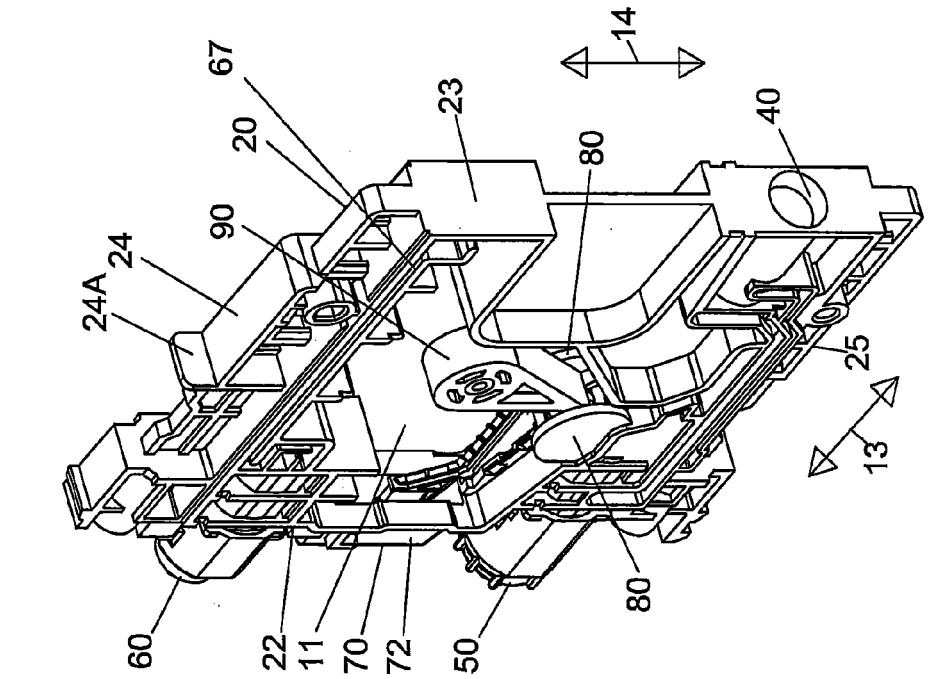
24A
18
12
60
22
73
70
71
72
50

Fig. 3(A)


14
67
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23
40
80
12
90
24
24A
25
13
60
22
11
70
72
50
80

Fig. 4(B)

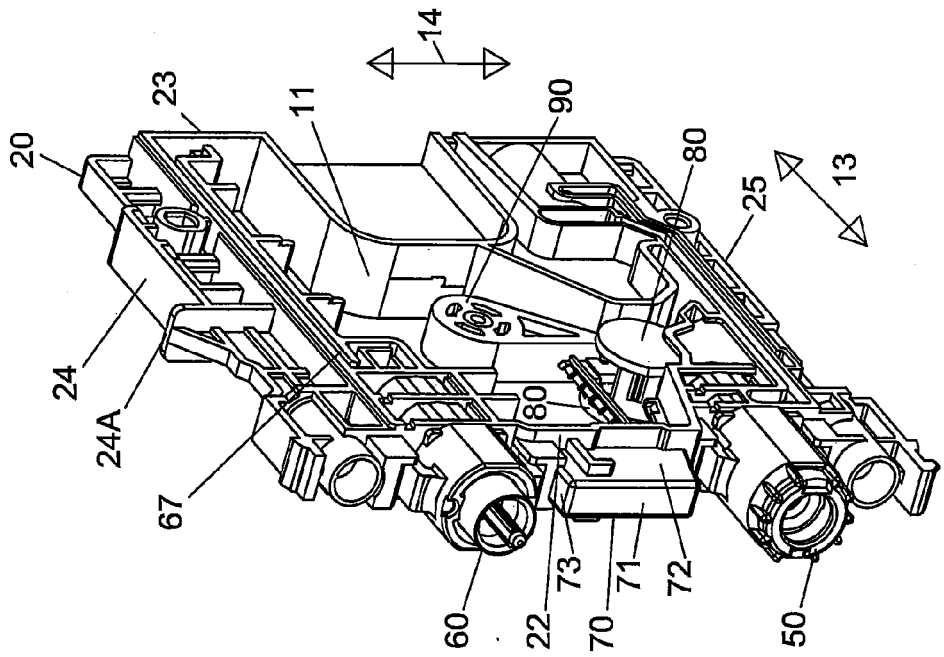

14
23
11
90
20
80
25
13
24
24A
80
67
60
22
73
71
70
72
50
12

Fig. 4(A)

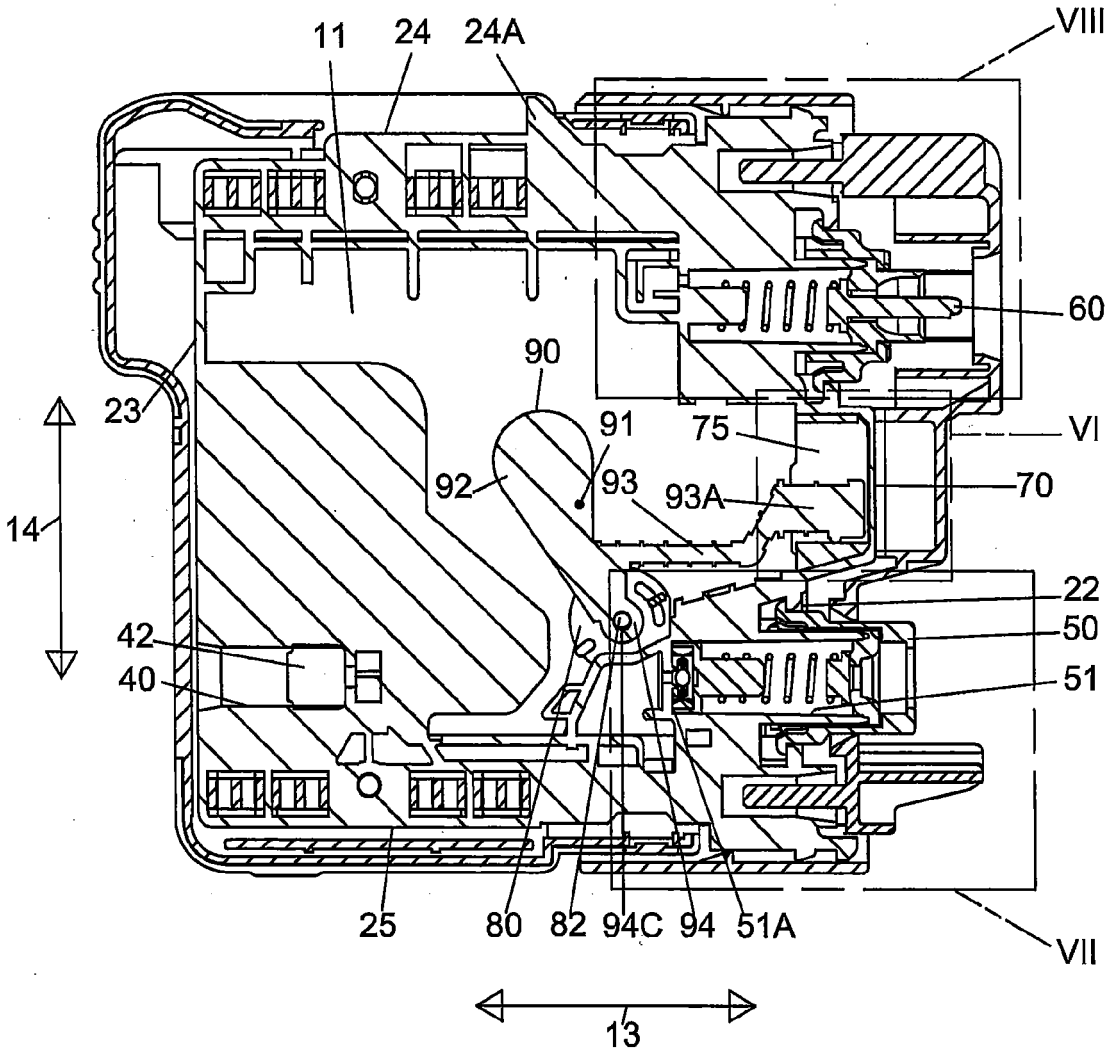

11
24
24A
VIII
60
90
23
91
75
VI
92
93
93A
70
14
22
42
50
40
51
25
80
82
94C
94
51A
VII
13

Fig. 5

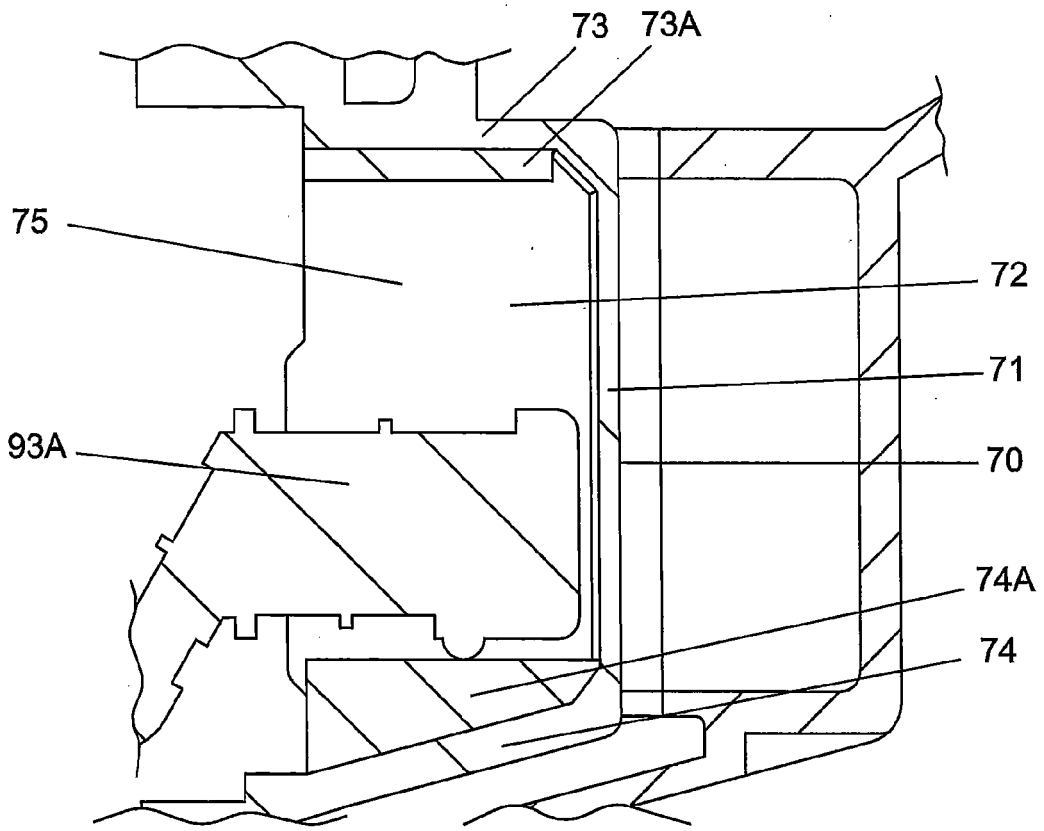


Fig. 6

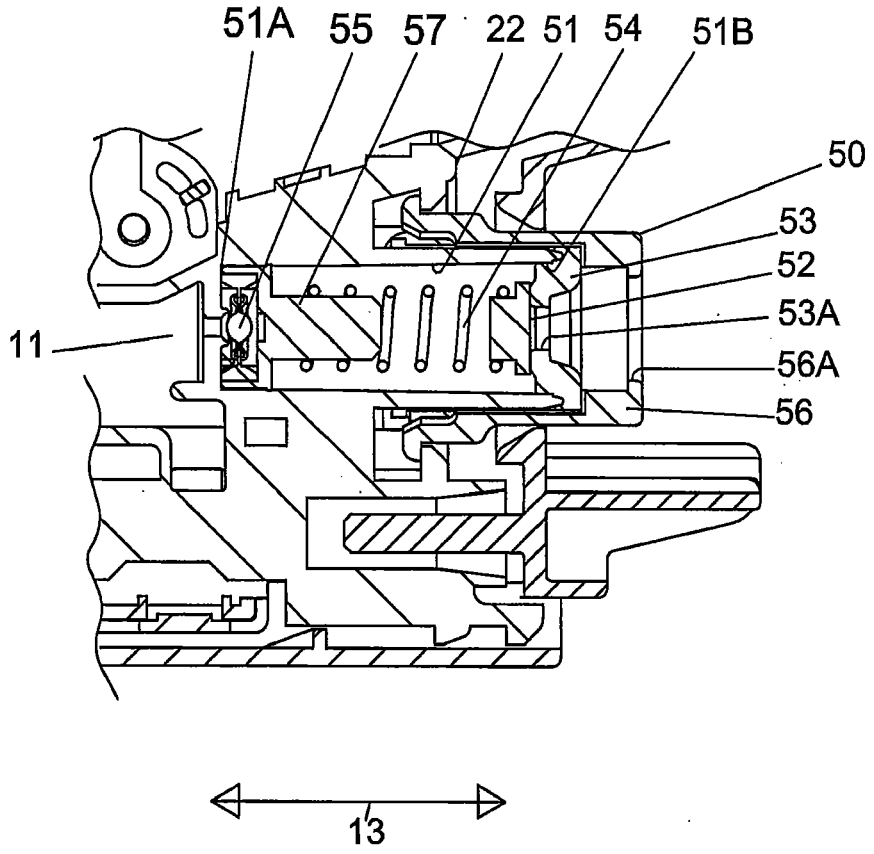


Fig. 7

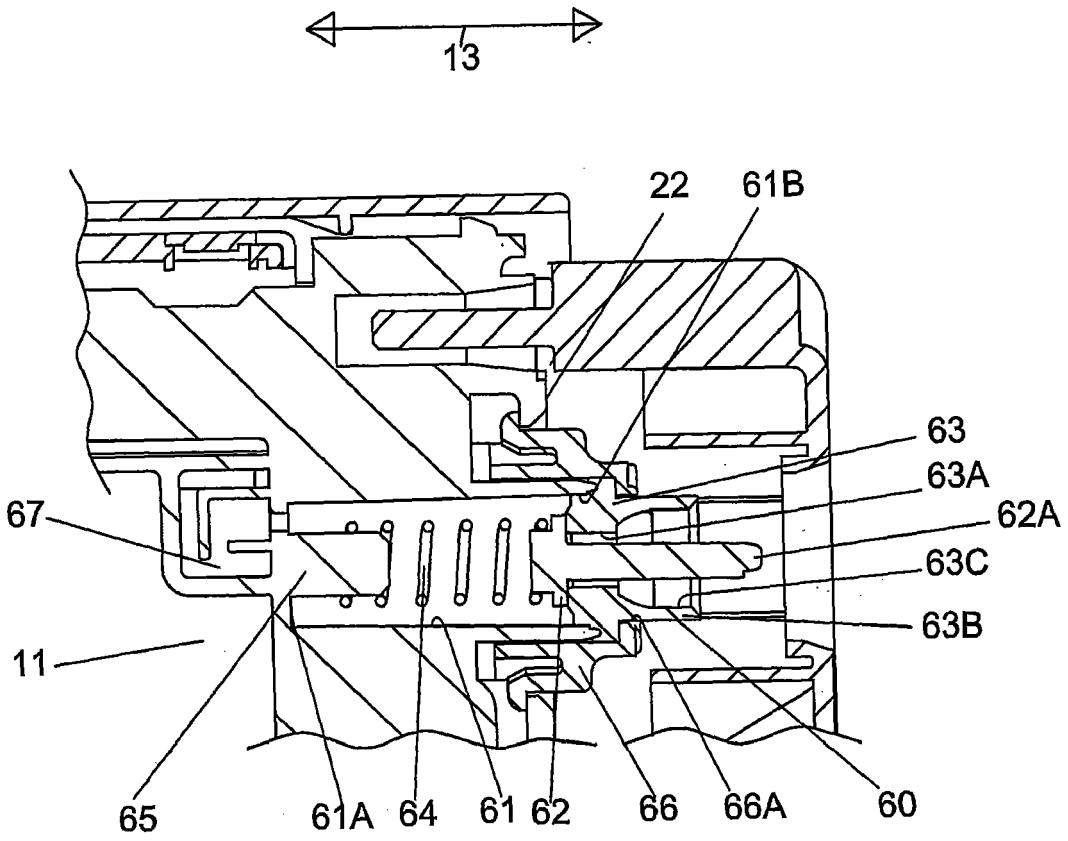


Fig. 8

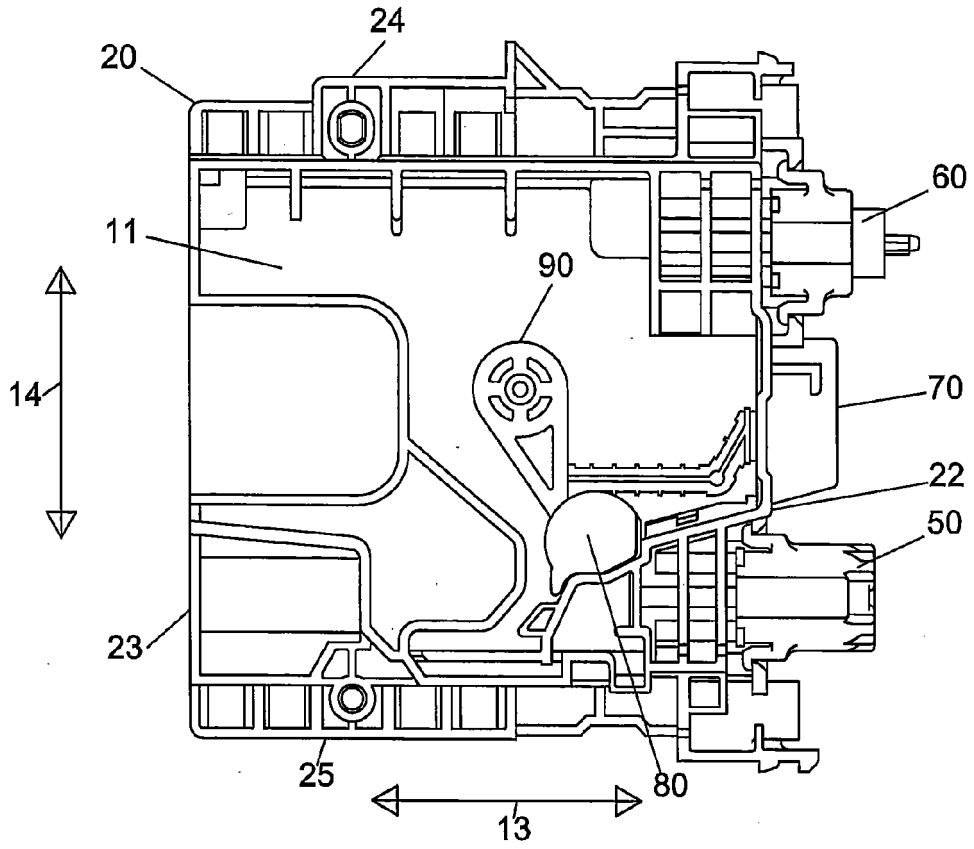


Fig. 9(A)

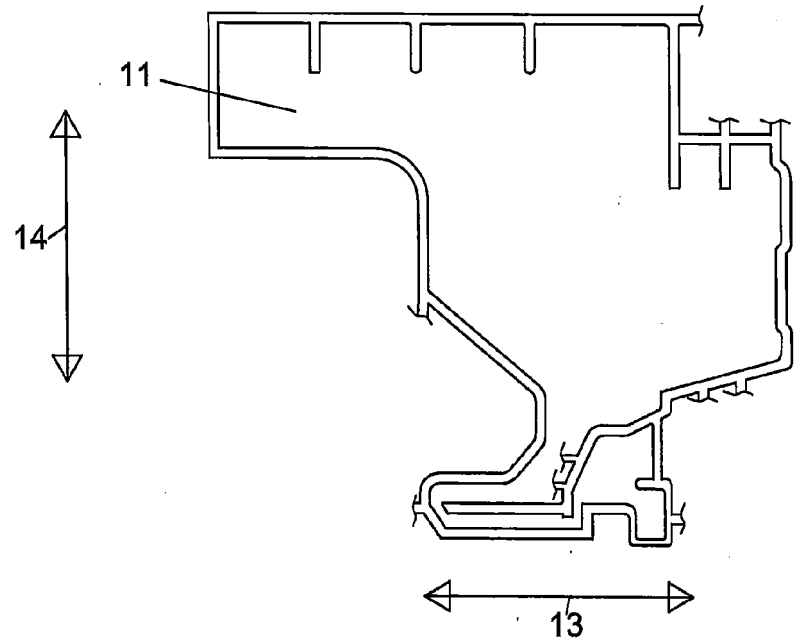


Fig. 9(B)

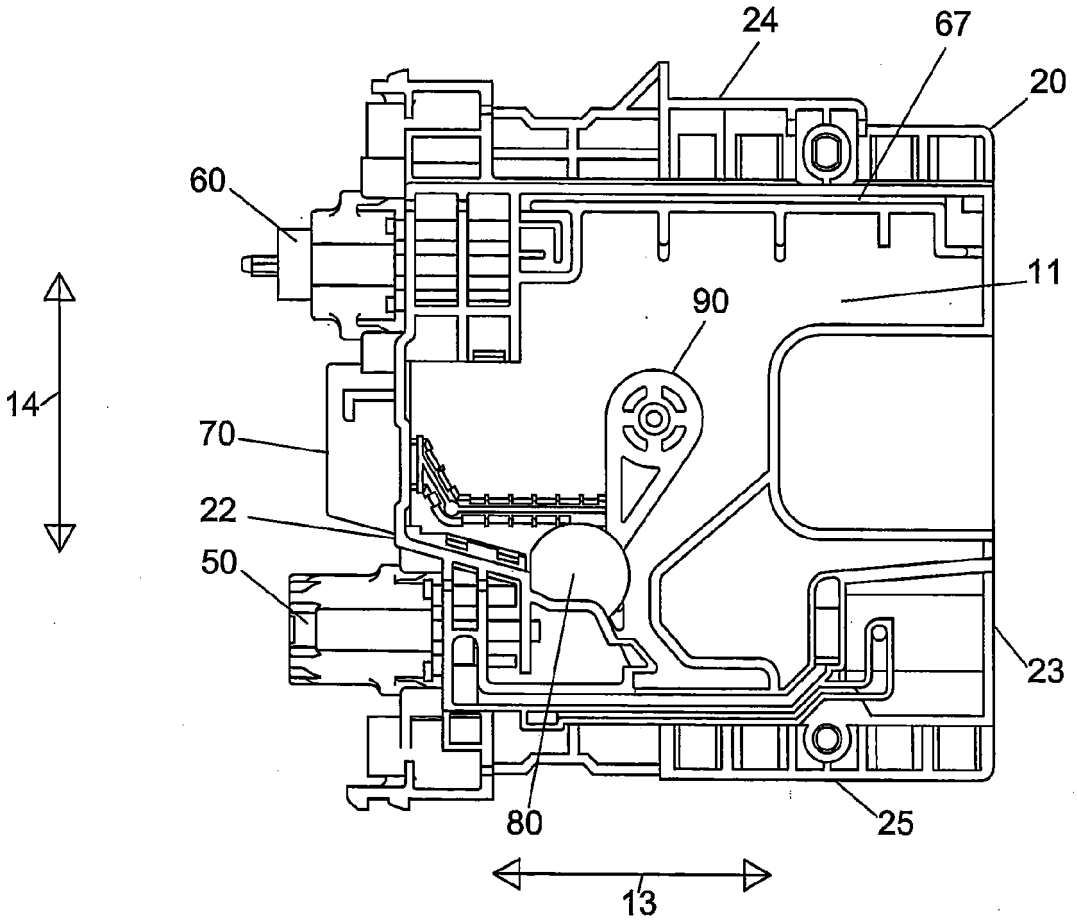


Fig. 10(A)

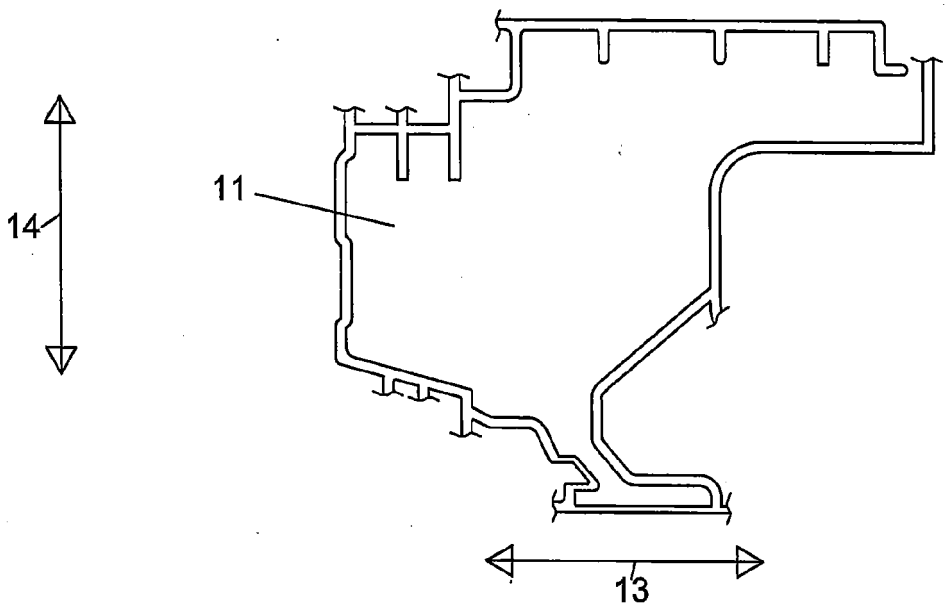


Fig. 10(B)

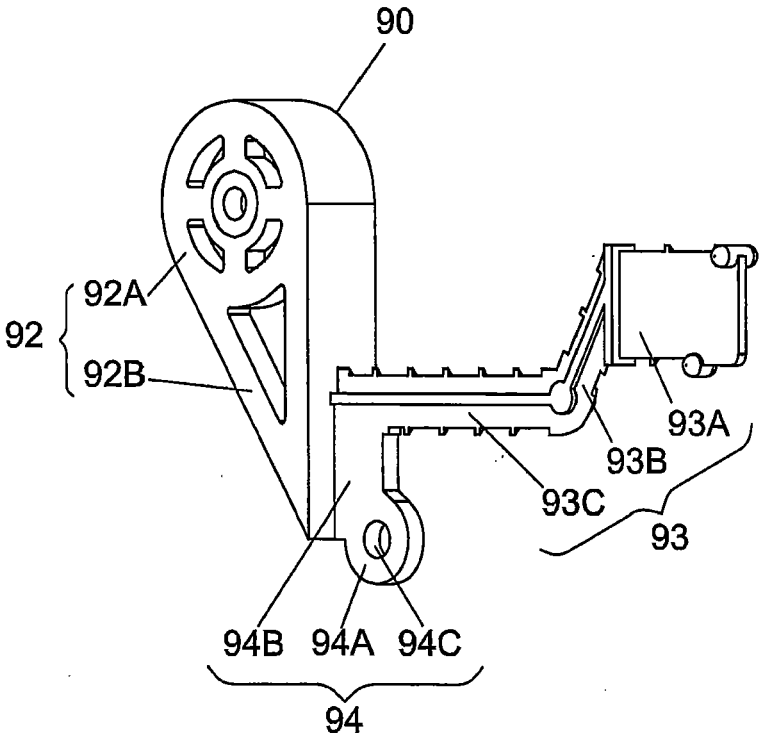


Fig. 11(A)

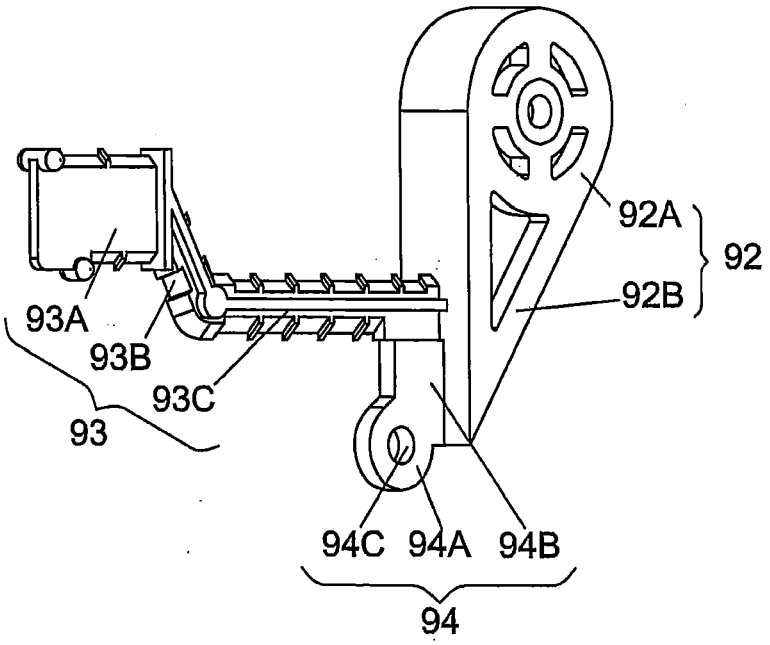
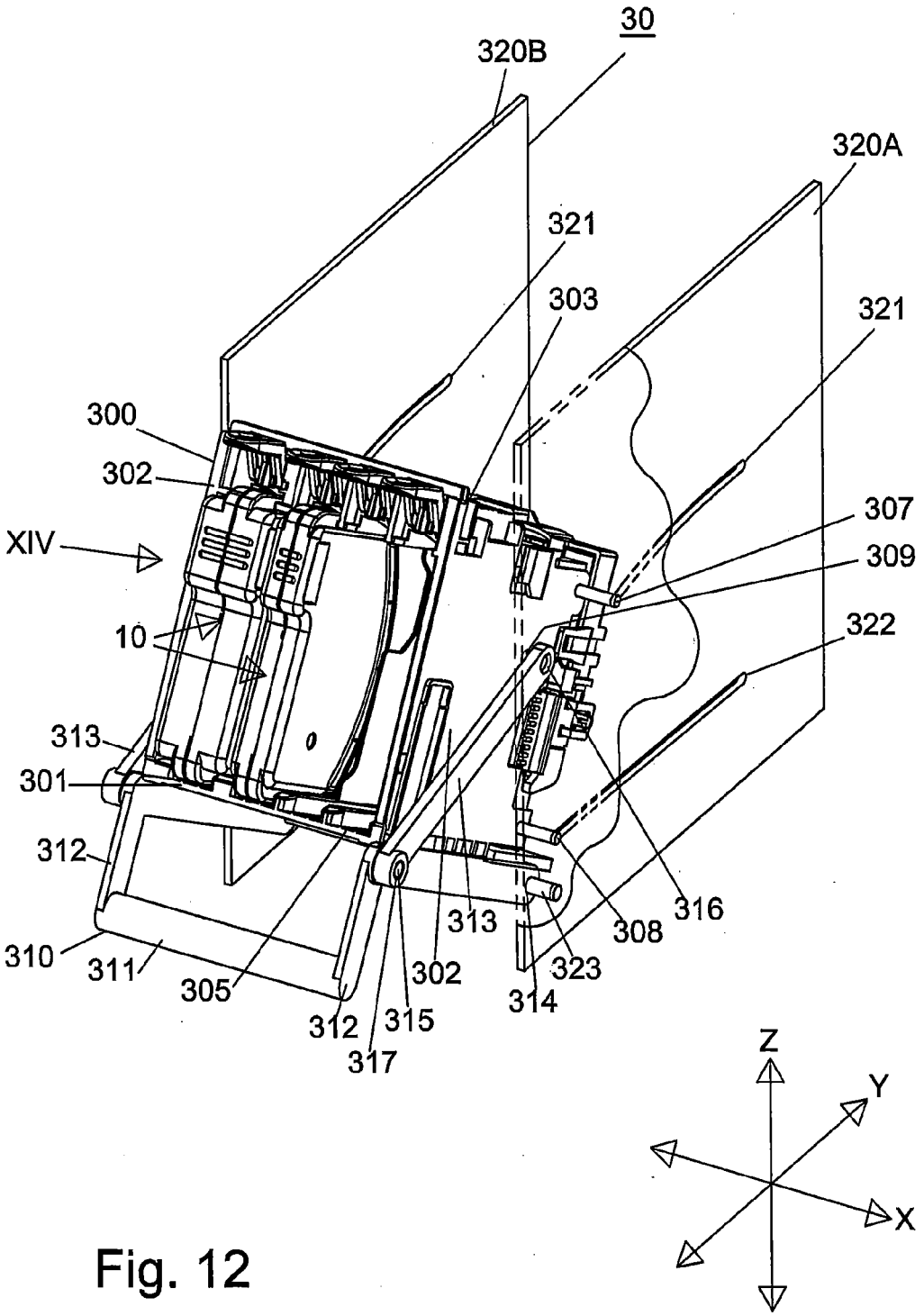


Fig. 11(B)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320B
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303
321
300
302
307
XIV
309
10
322
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301
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316
308
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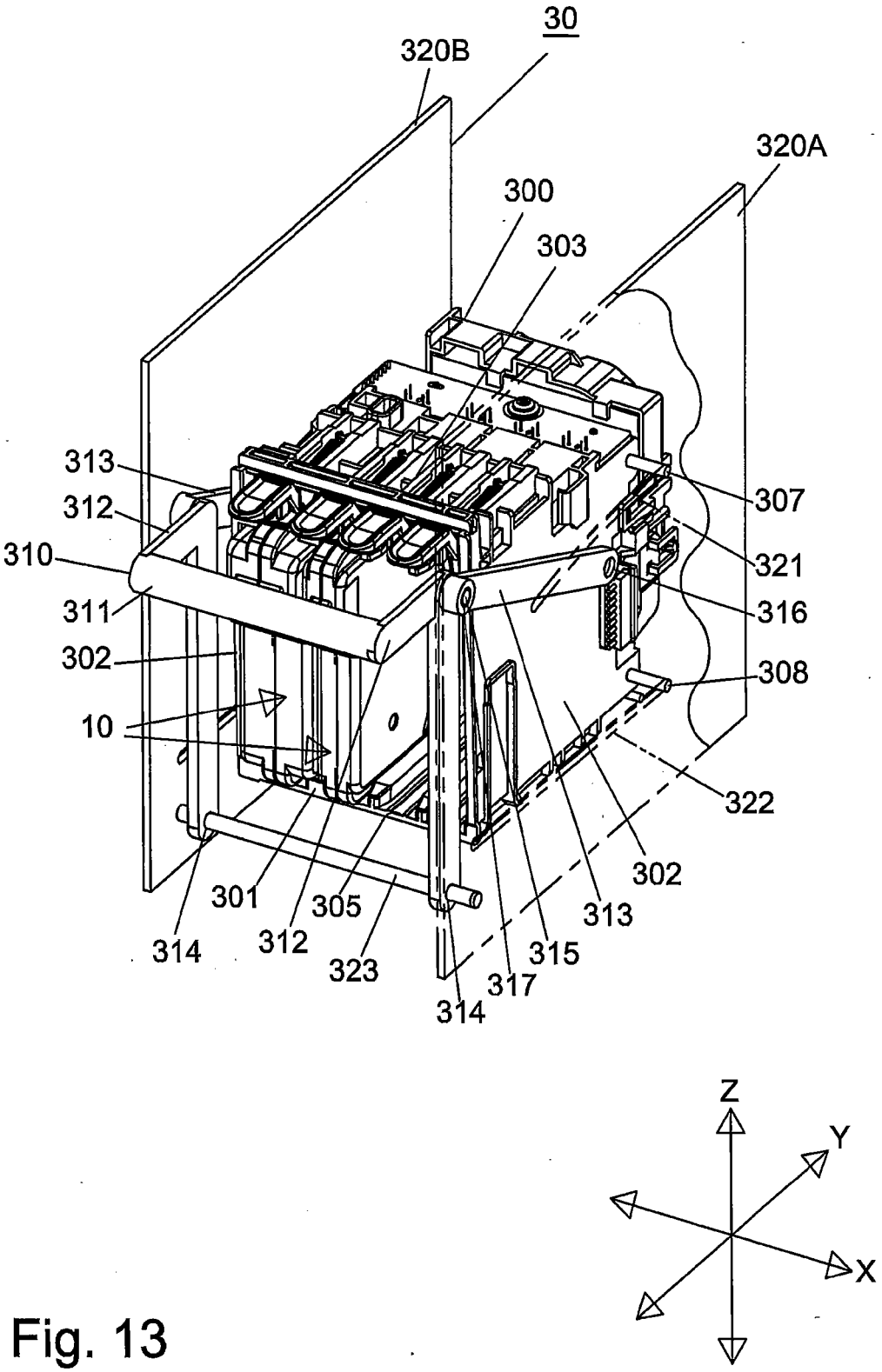
311
305
302
323
314
312
315
317
Z
Y
X

Fig. 12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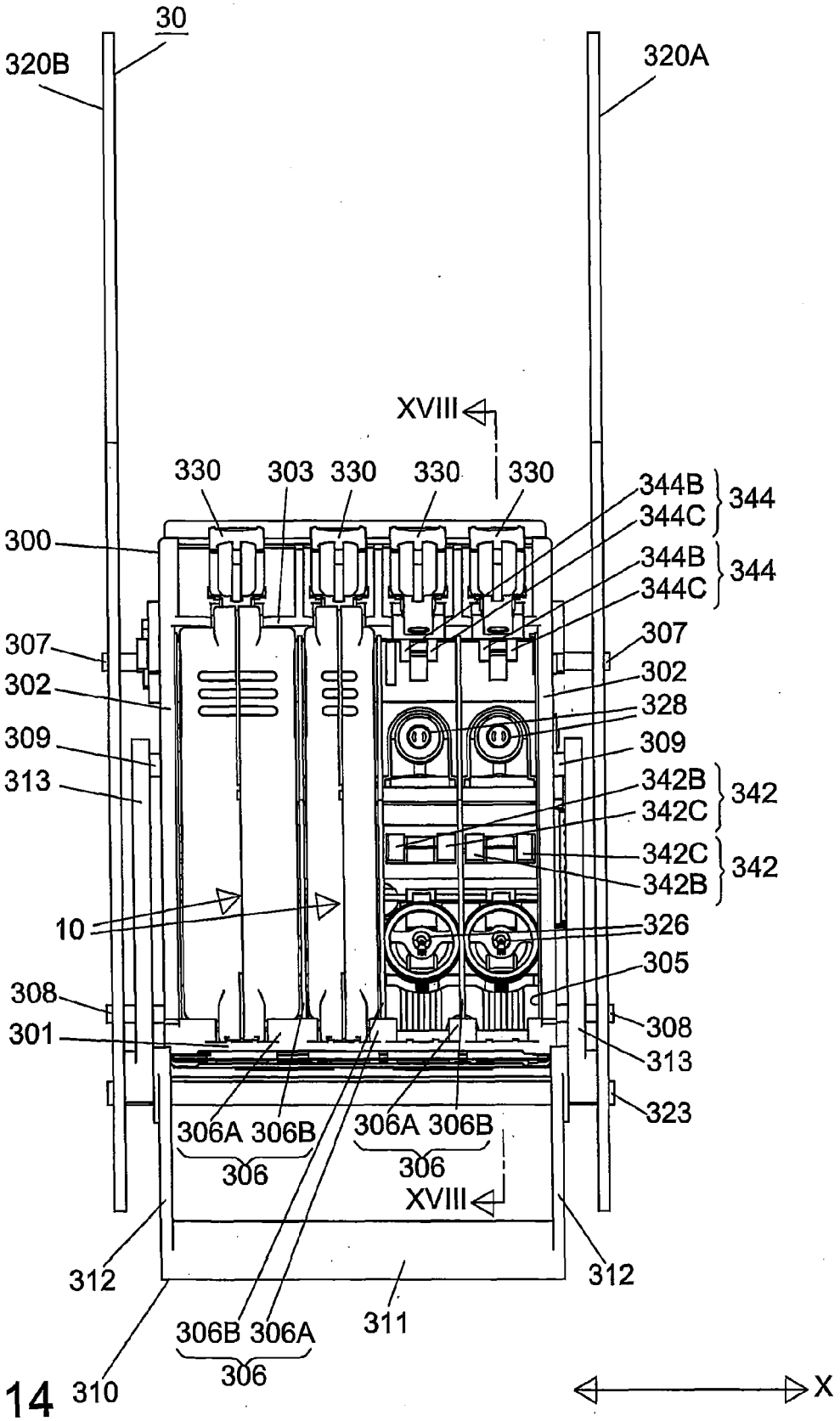
Z
Y
X

Fig. 13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XVIII
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303
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344B
344C
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344B
344C
344
300
307
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309
313
307
302
328
309
342B
342C
342
342C
342B
342
10
326
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308
301
308
313
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306B
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306B
306A
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311
310
X

Fig. 14

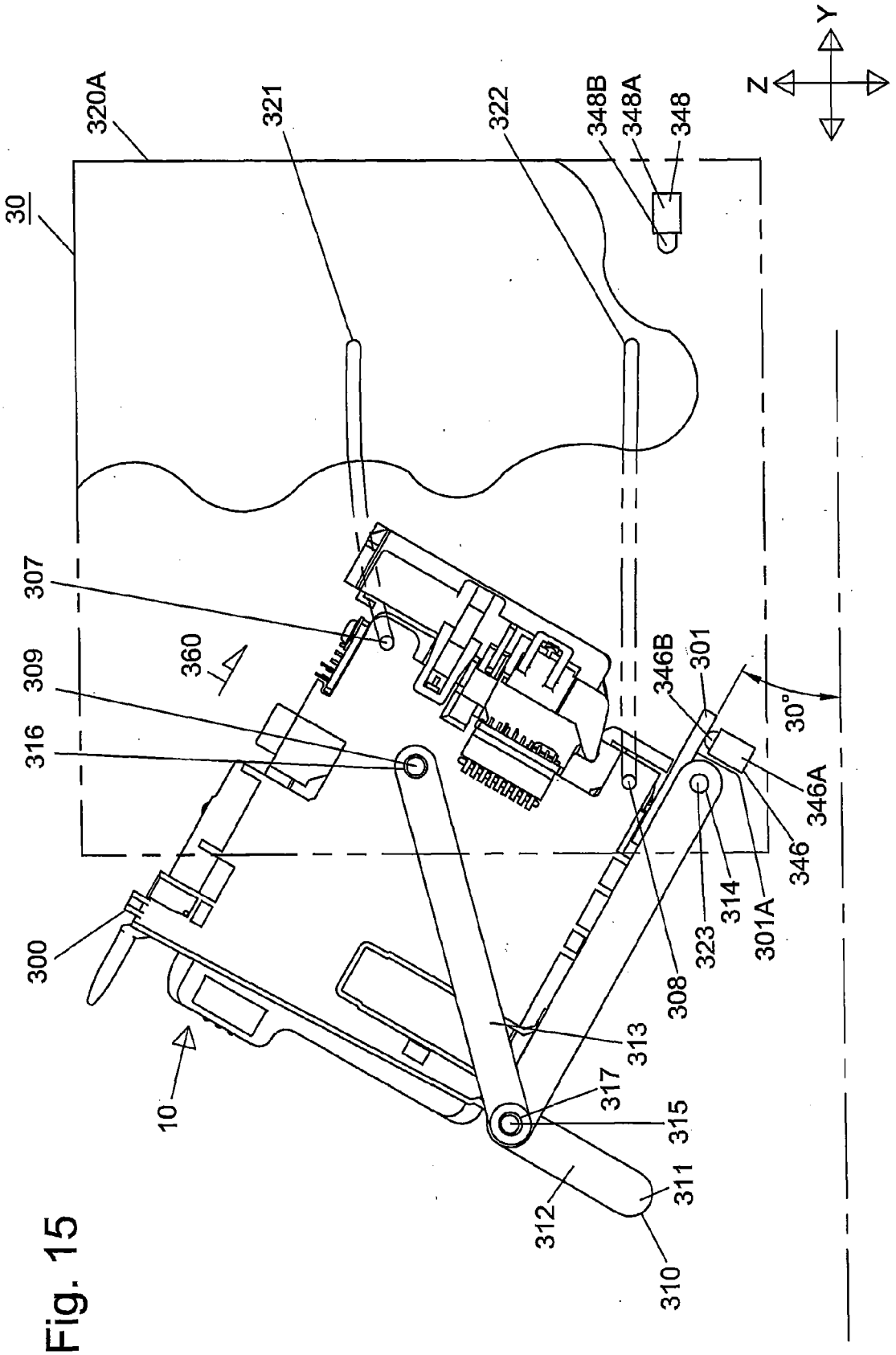
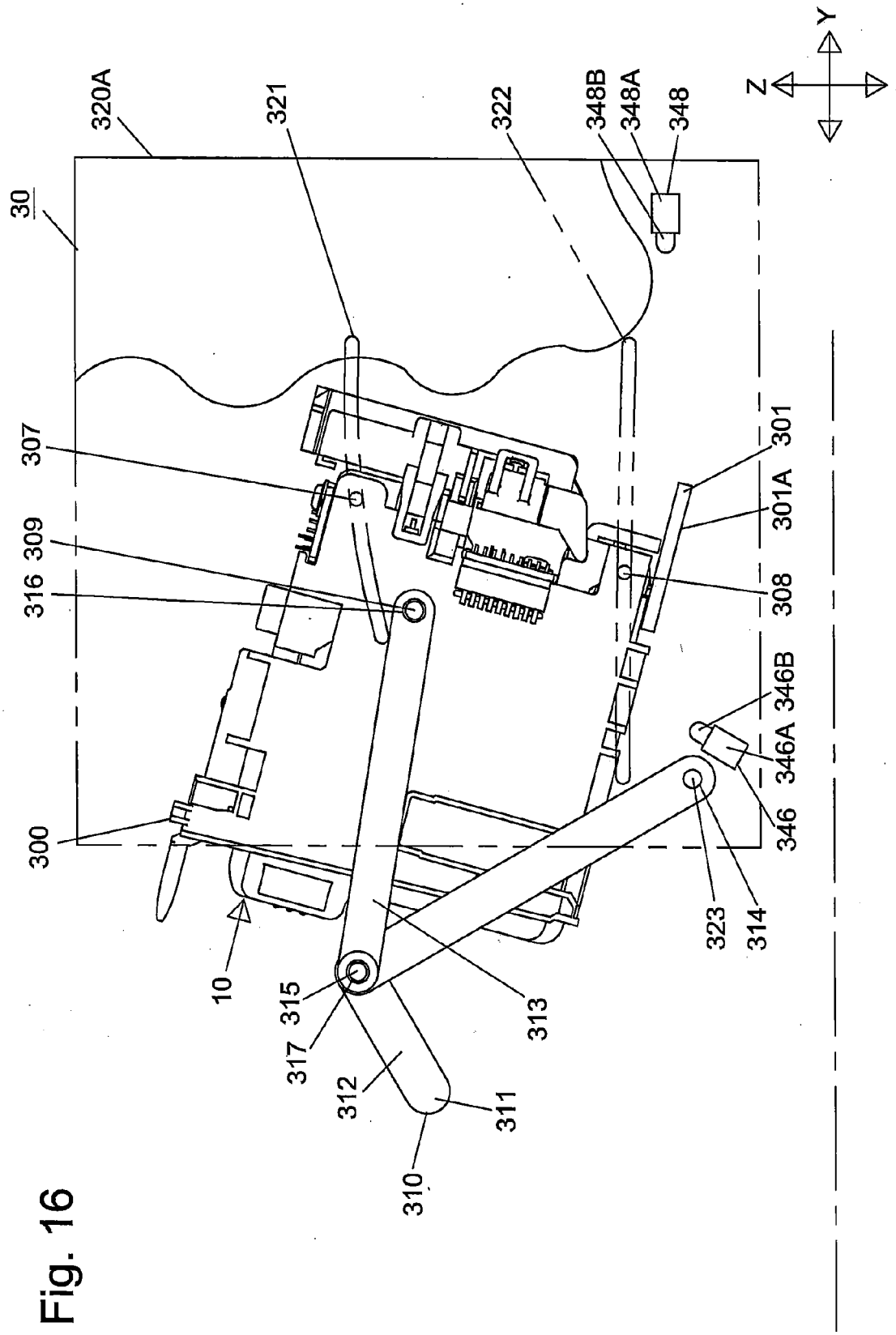

Y
Z
320A
321
322
348B
348A
348
30
307
309
316
360
346B
301
30°
346A
346
314
301A
323
308
313
317
315
311
312
310
300
10

Fig. 15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321
322
348B
348A
348
Z
Y
30
307
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316
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346
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10
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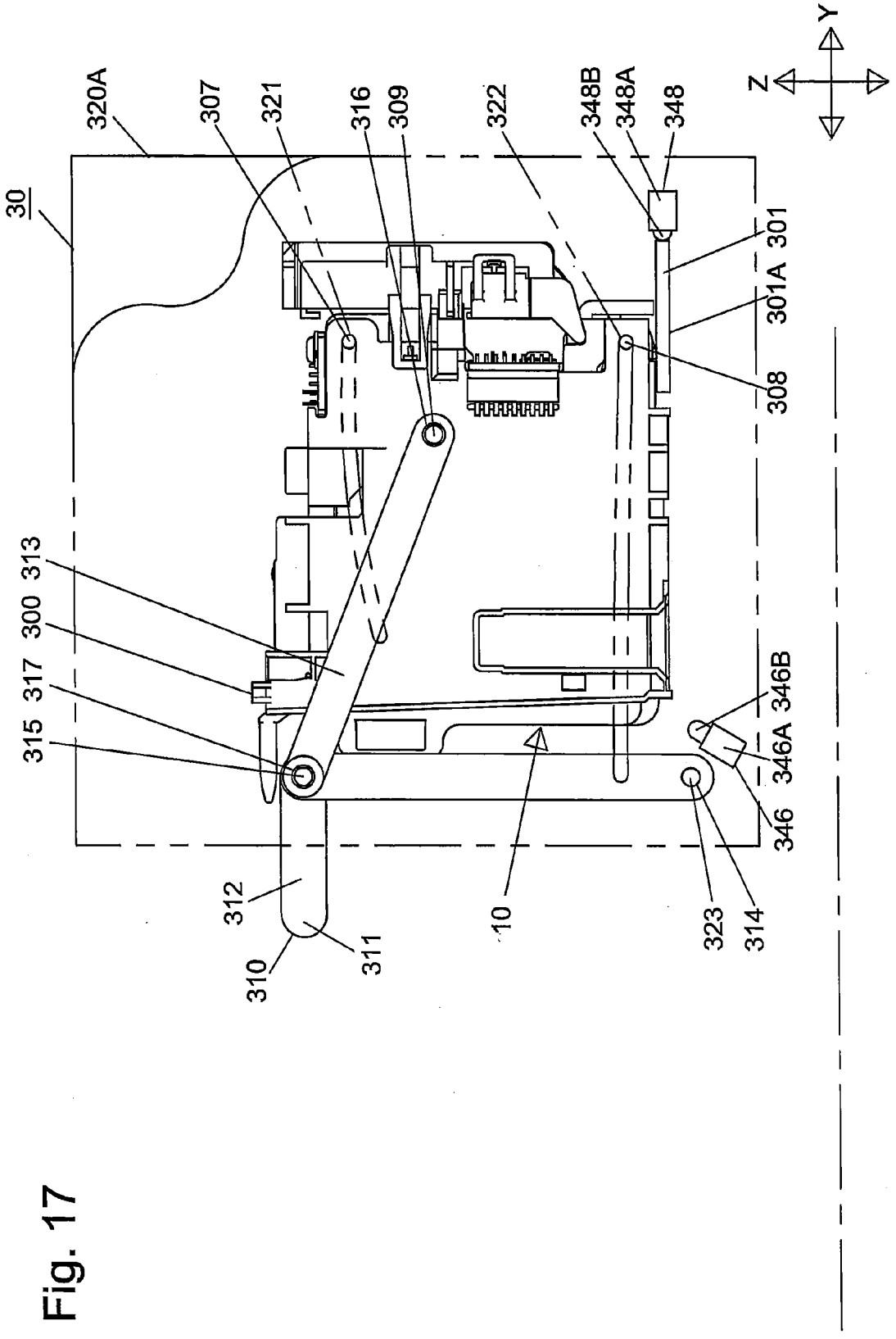
311
310
313

Fig. 16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Z
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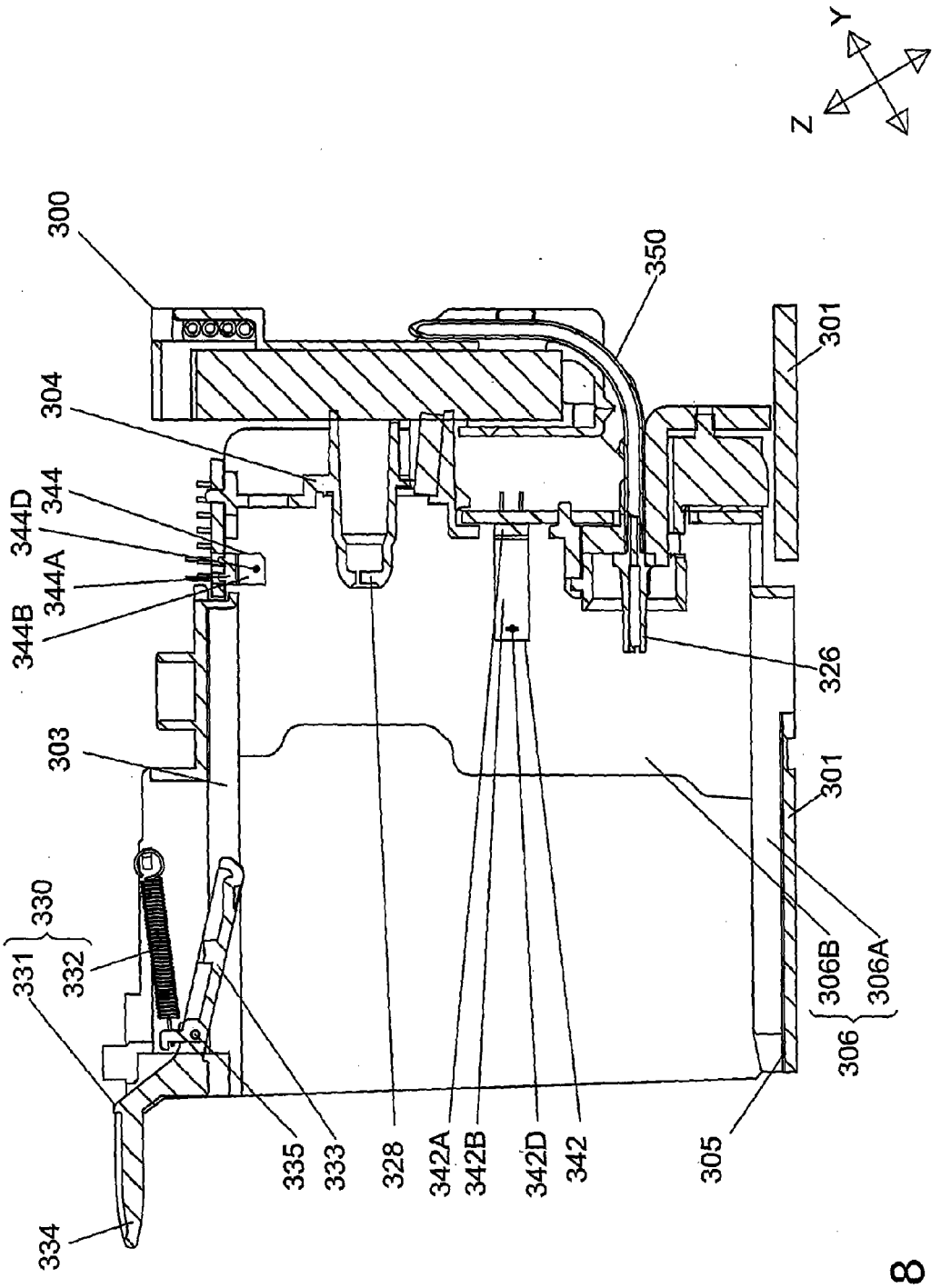
346B
346A
346
312
310
311
10
323
314

Fig. 17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Z
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301
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344D
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344B
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306
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342A
342B
342D
342
305
334

Fig. 18

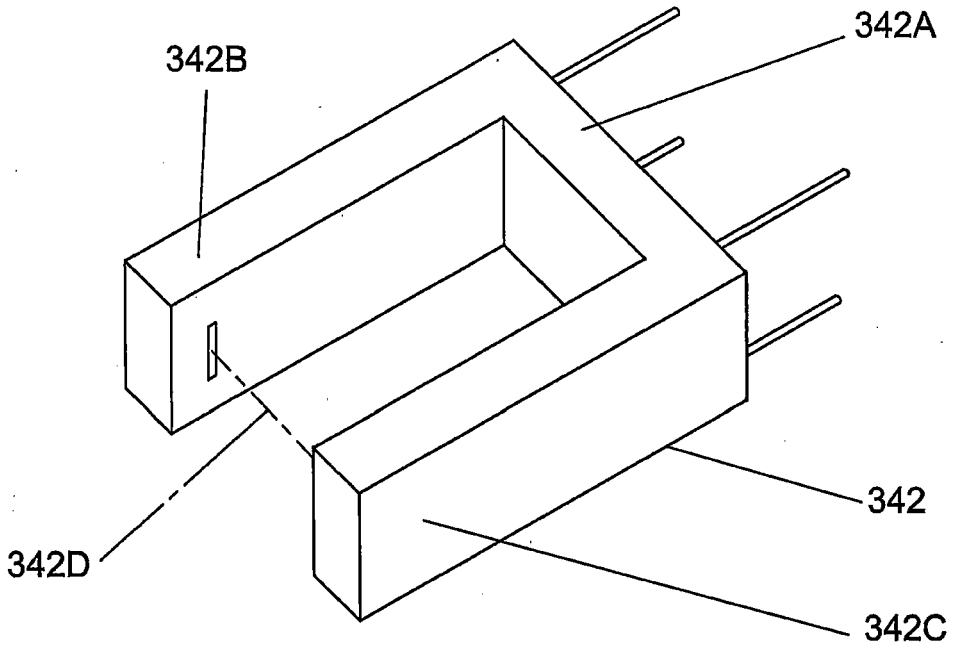


Fig. 19

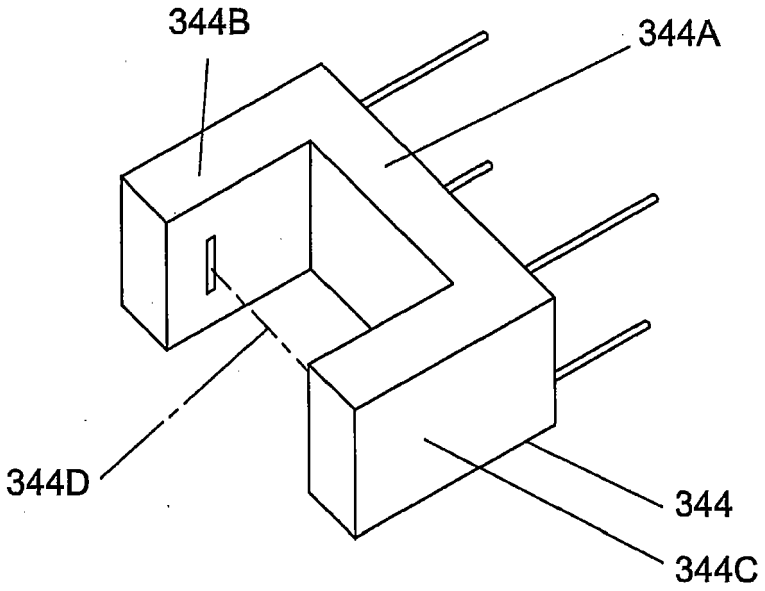
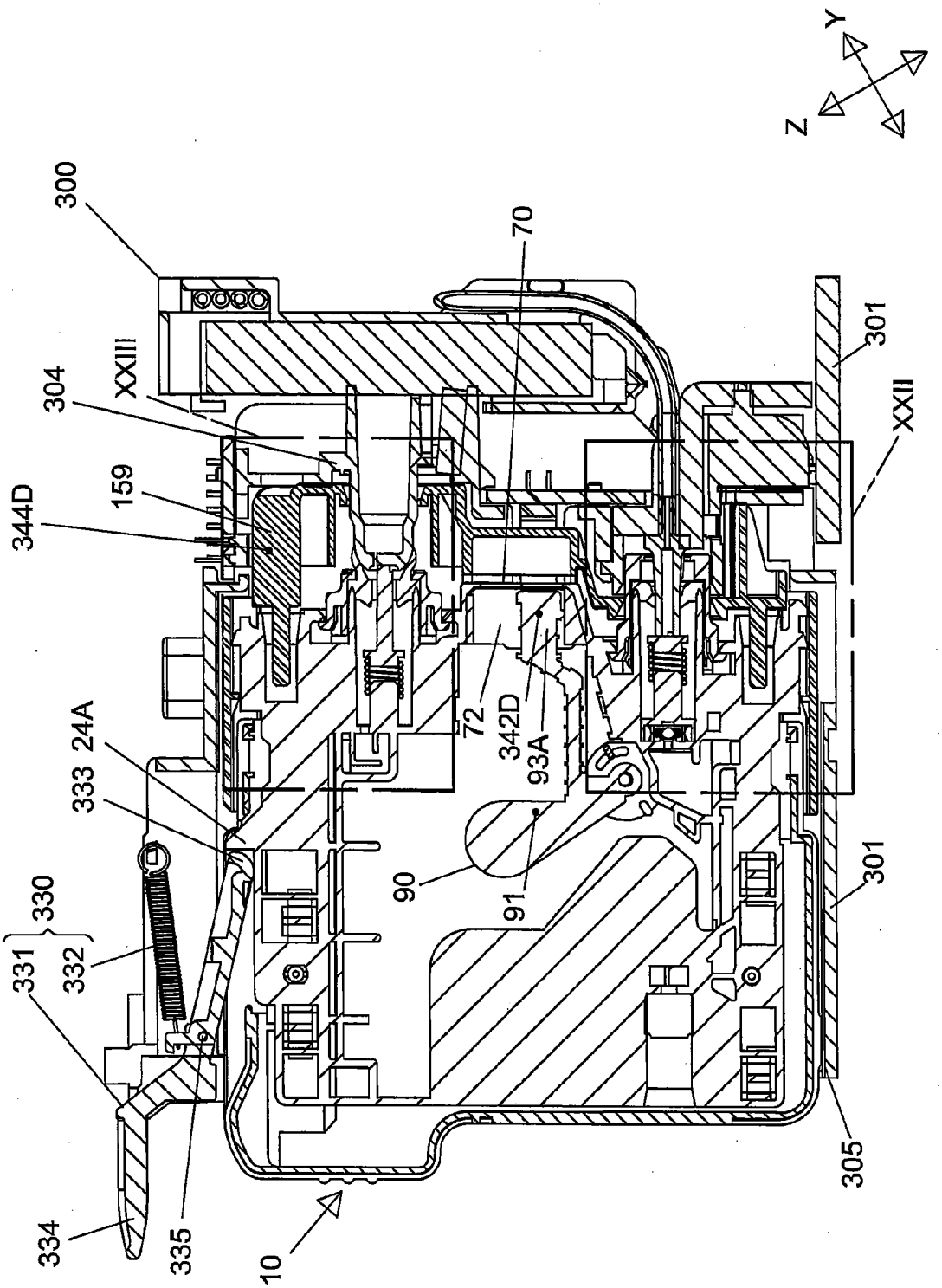


Fig. 20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XXII
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10
305

Fig. 21

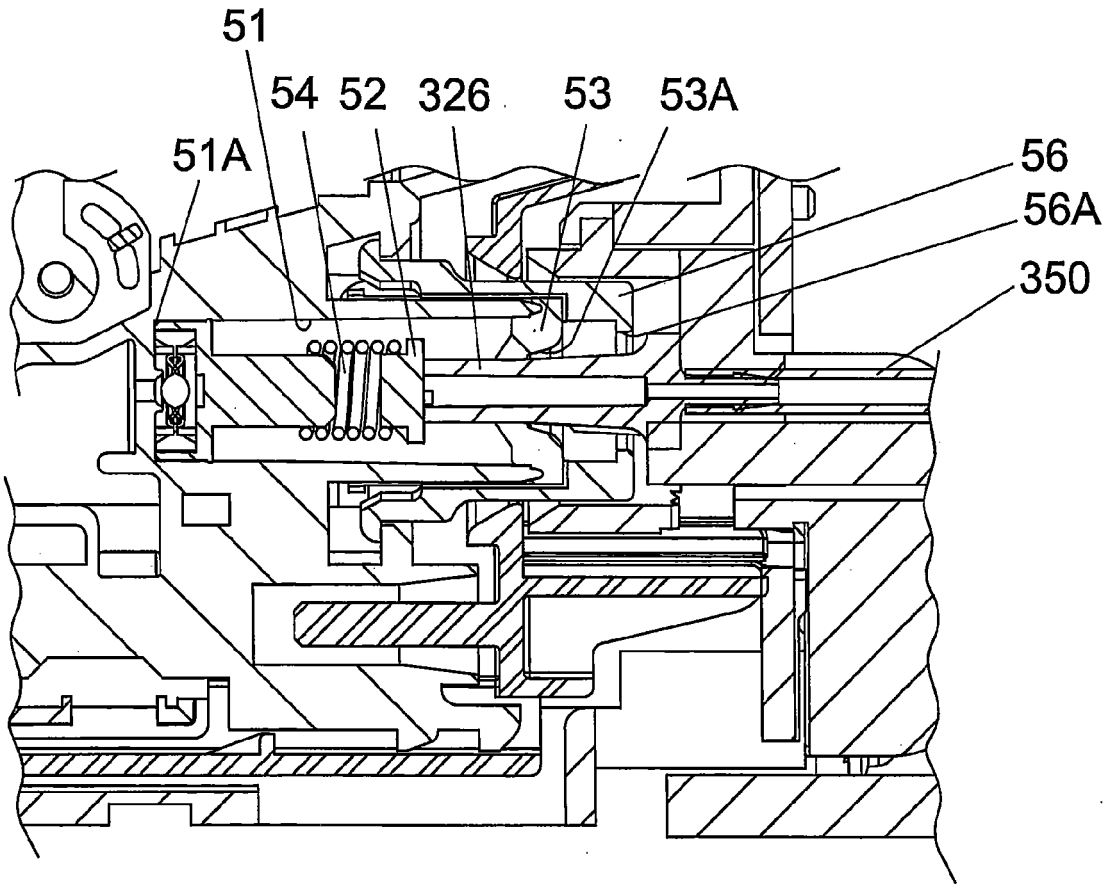


Fig. 22

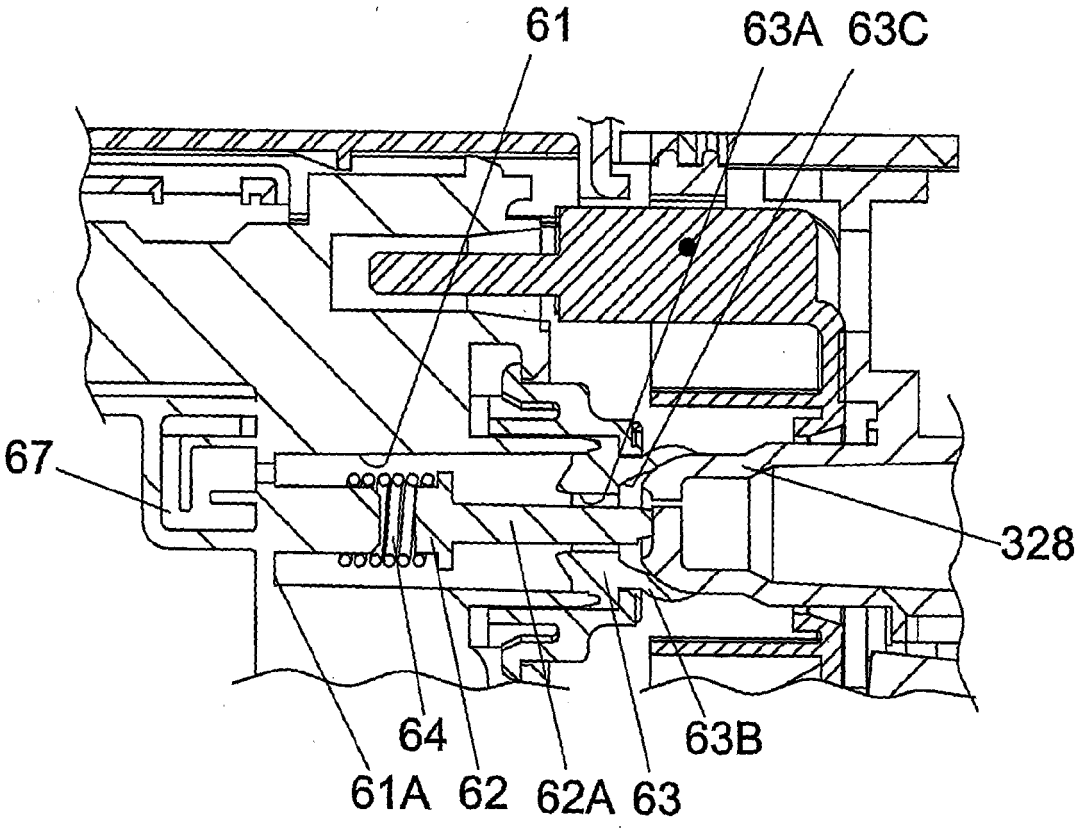
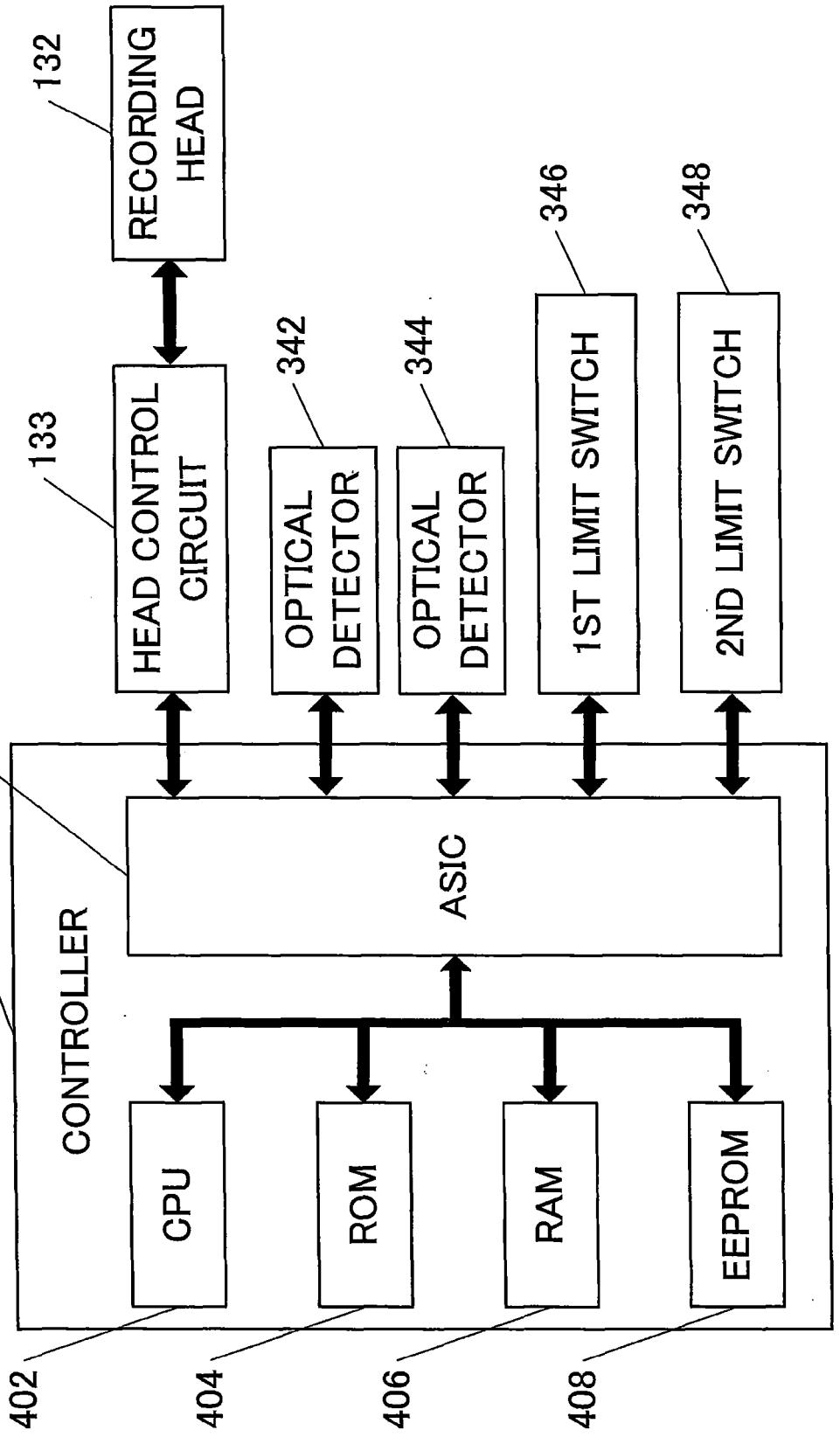


Fig. 23

Fig.24


RECORDING HEAD
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HEAD CONTROL CIRCUIT
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OPTICAL DETECTOR
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OPTICAL DETECTOR
344
1ST LIMIT SWITCH
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2ND LIMIT SWITCH
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CONTROLLER
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ASIC
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CPU
ROM
RAM
EEPROM
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404
406
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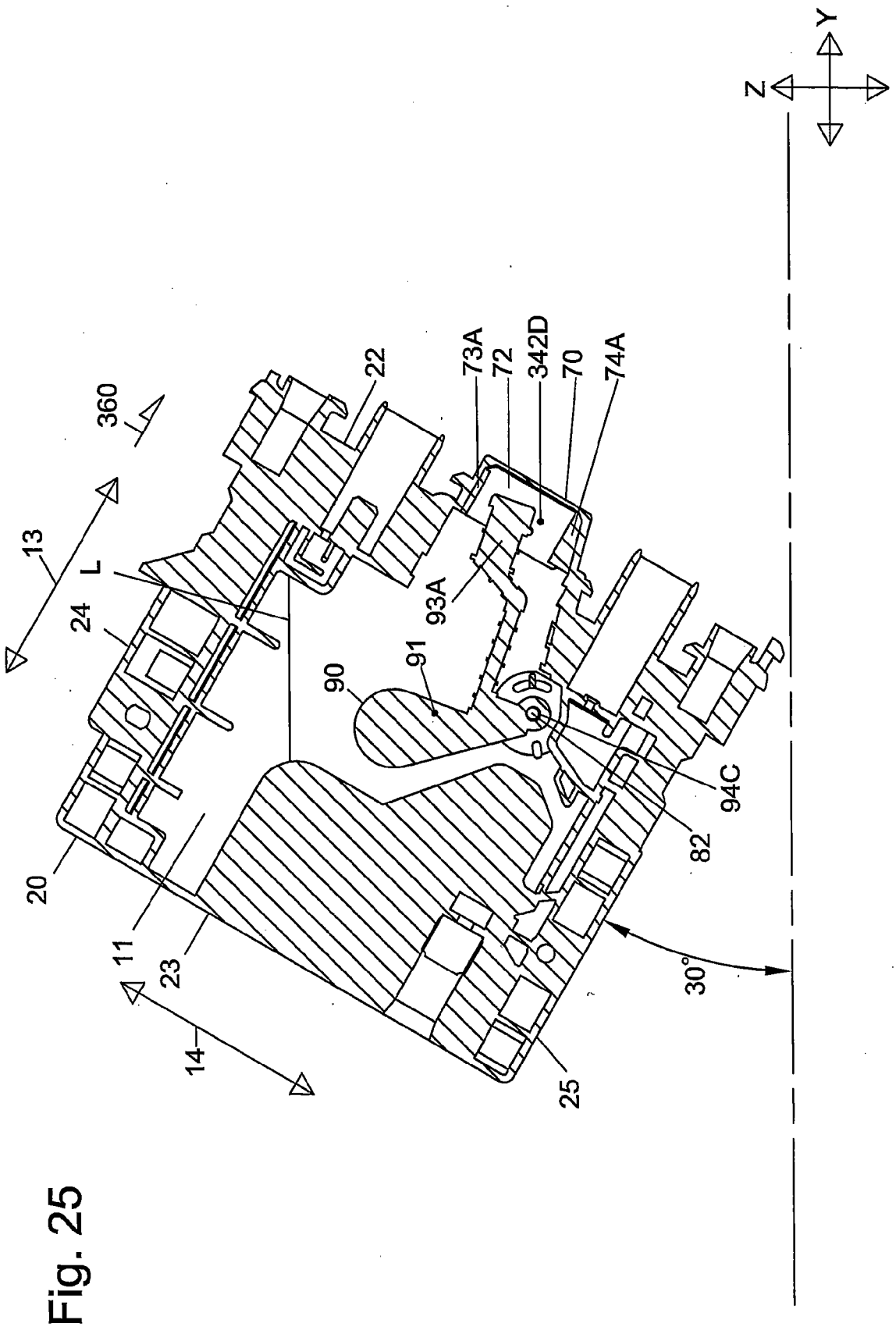
Y
Z
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73A
72
342D
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74A
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L
24
93A
91
90
94C
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Fig. 25

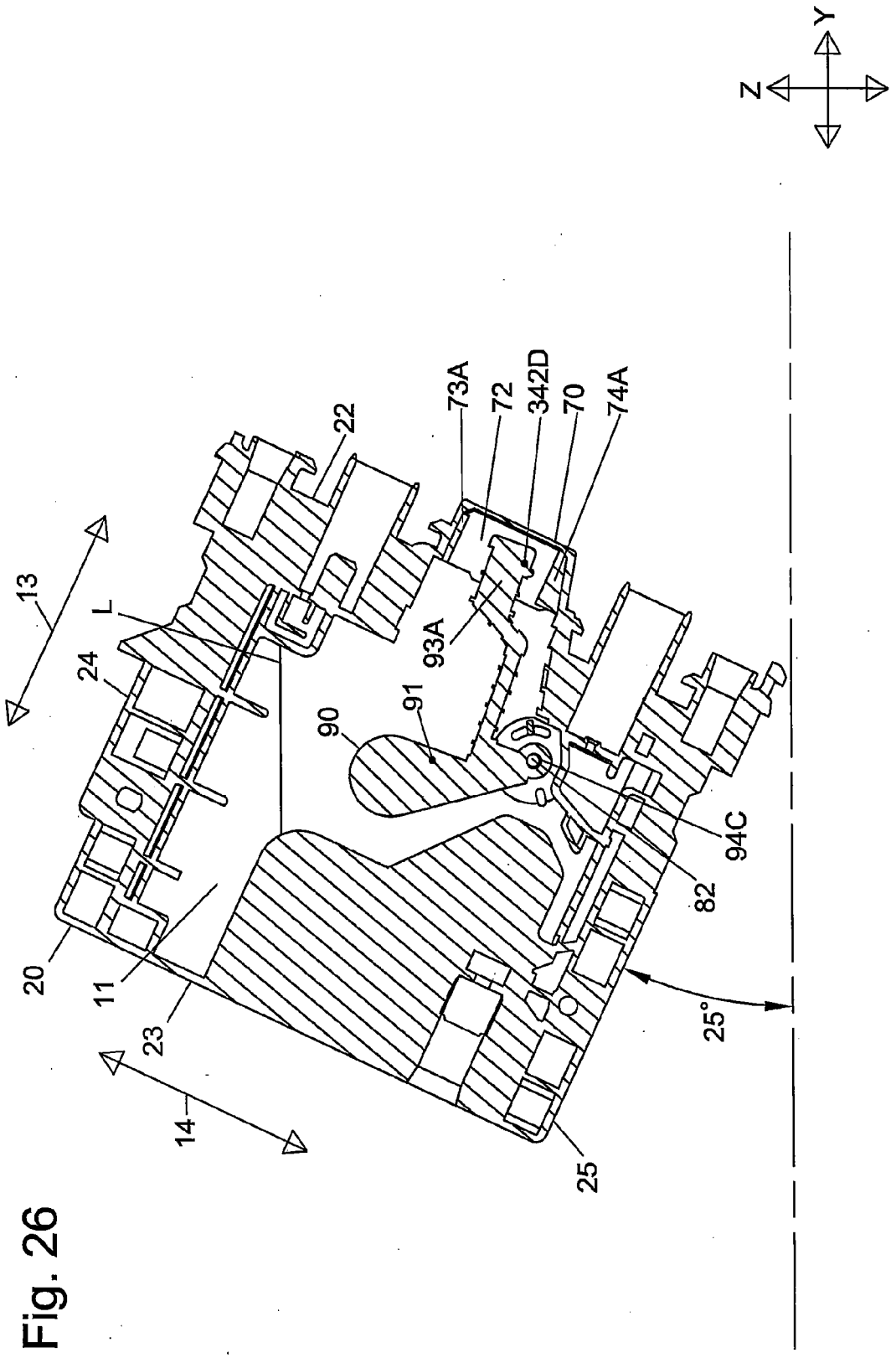


Fig. 26

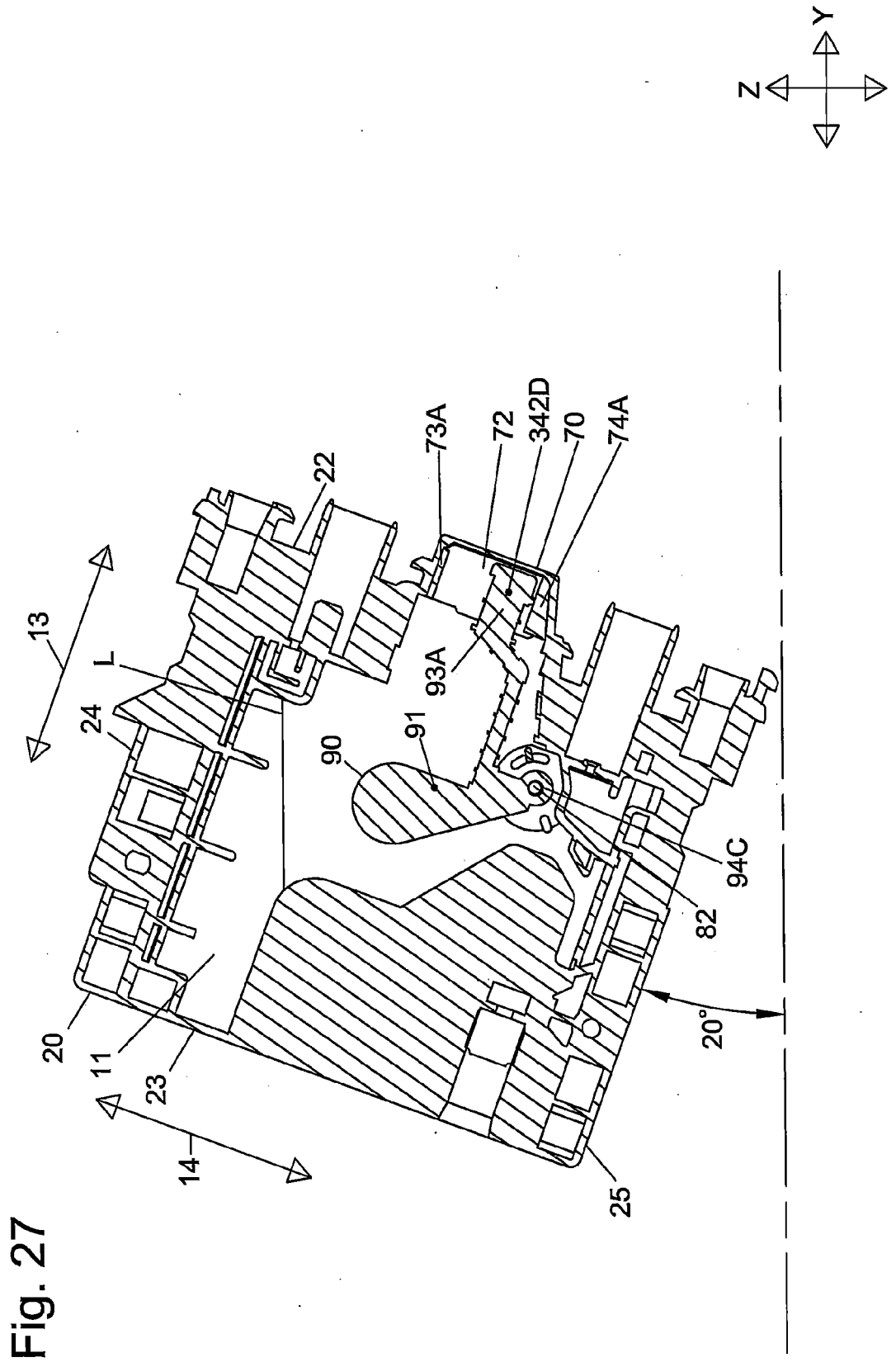


Fig. 27

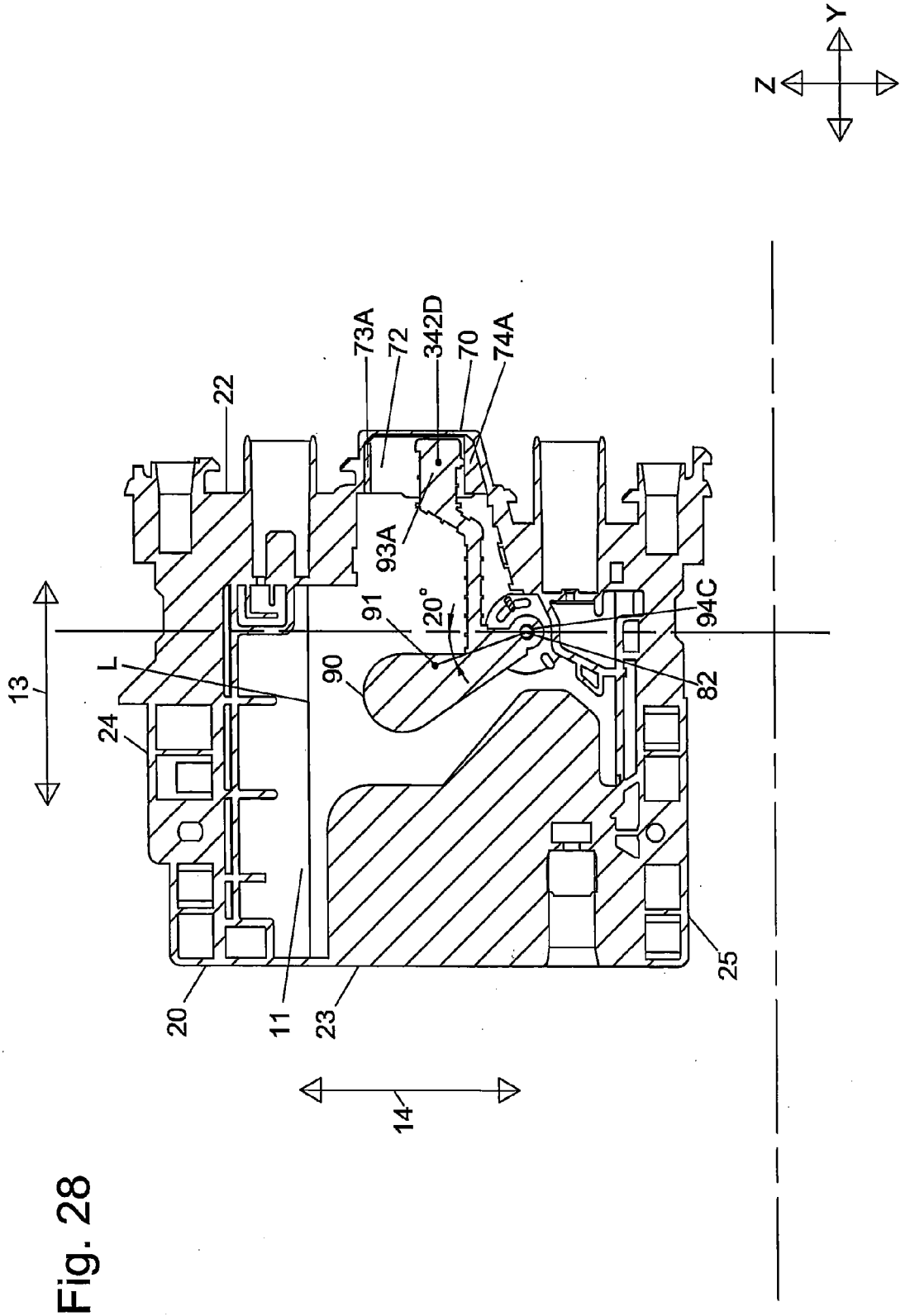


Fig. 28

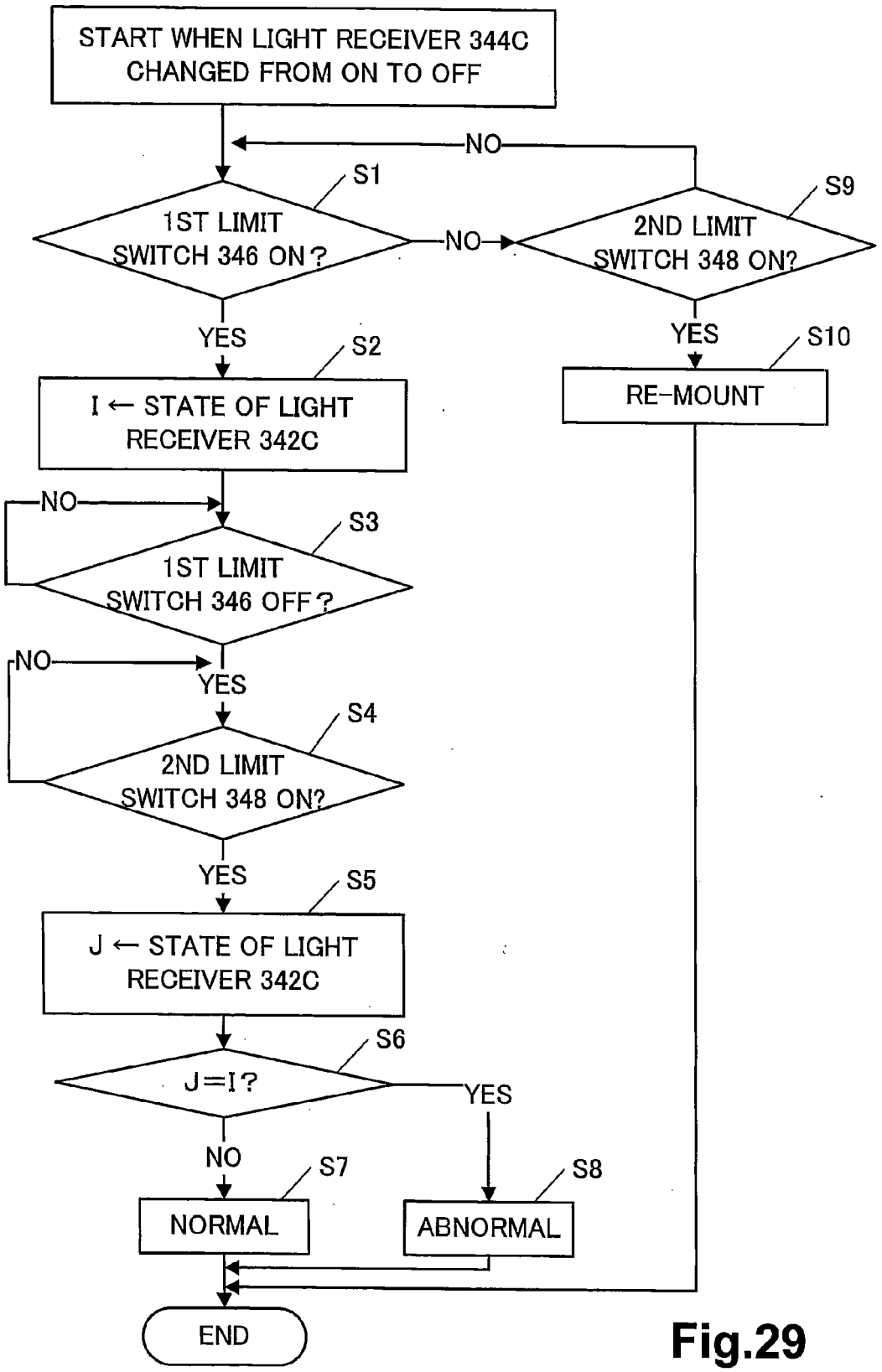
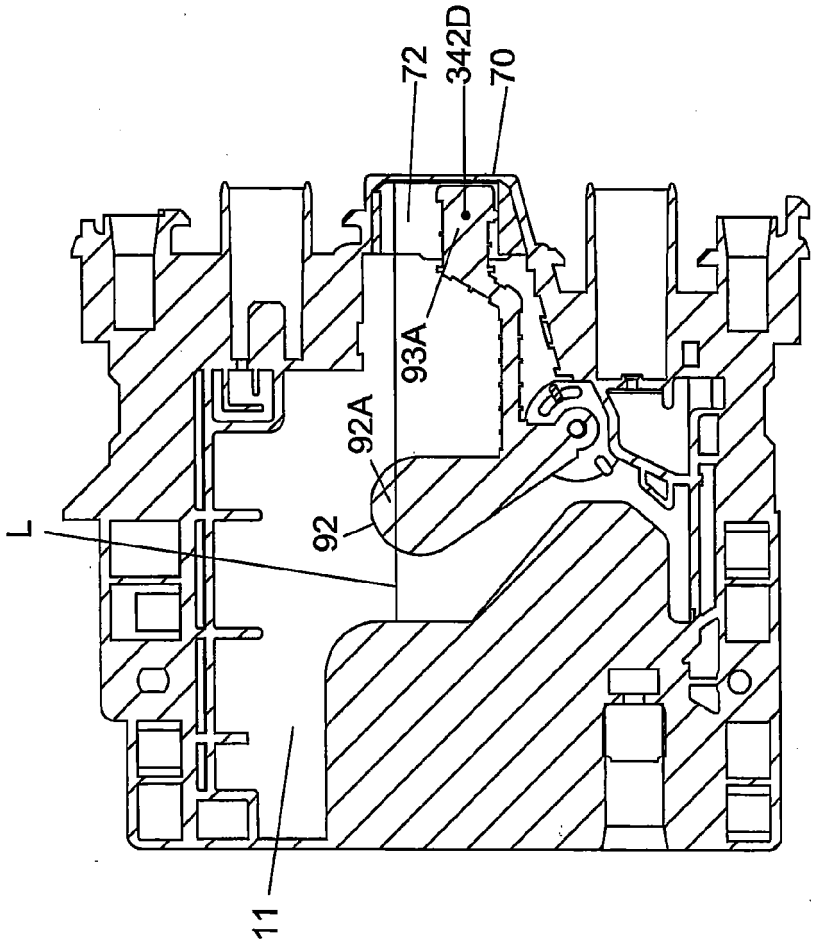

START WHEN LIGHT RECEIVER 344C CHANGED FROM ON TO OFF
NO
S1
1ST LIMIT SWITCH 346 ON?
NO
S9
2ND LIMIT SWITCH 348 ON?
YES
YES
S10
RE-MOUNT
S2
I ← STATE OF LIGHT RECEIVER 342C
NO
S3
1ST LIMIT SWITCH 346 OFF?
NO
YES
S4
2ND LIMIT SWITCH 348 ON?
YES
S5
J ← STATE OF LIGHT RECEIVER 342C
S6
J=I?
YES
NO
S7
S8
NORMAL
ABNORMAL
END

Fig.29



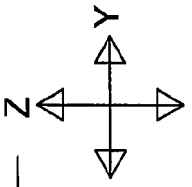
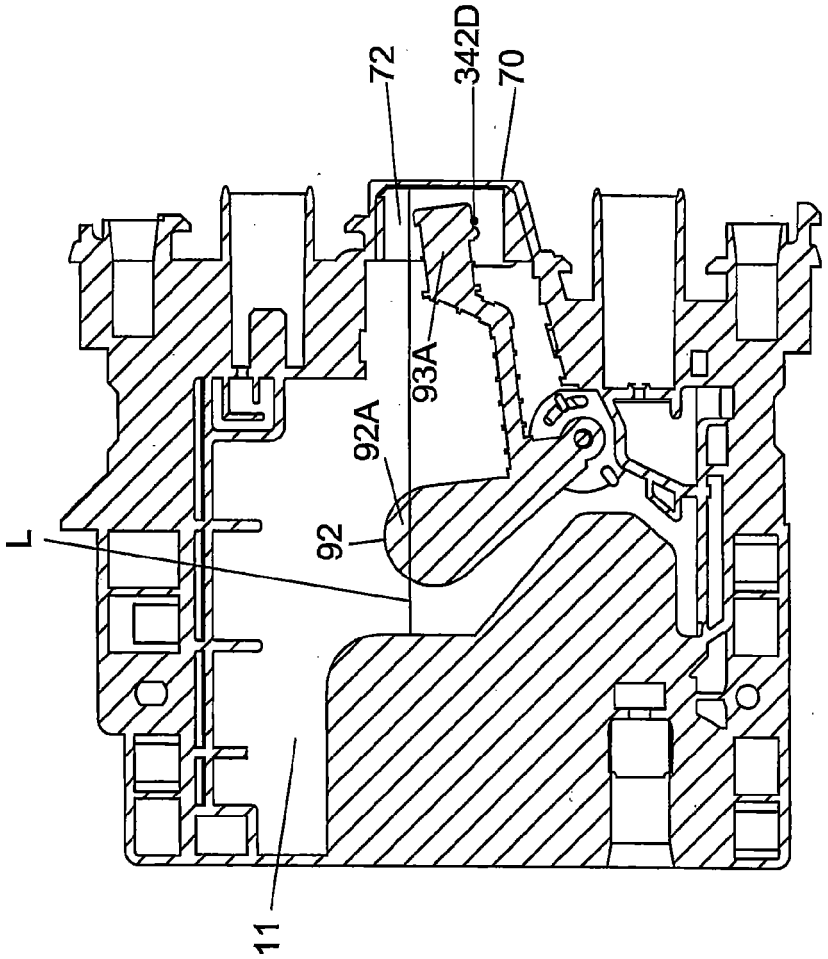


Fig. 30



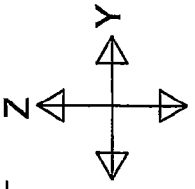


Fig. 31

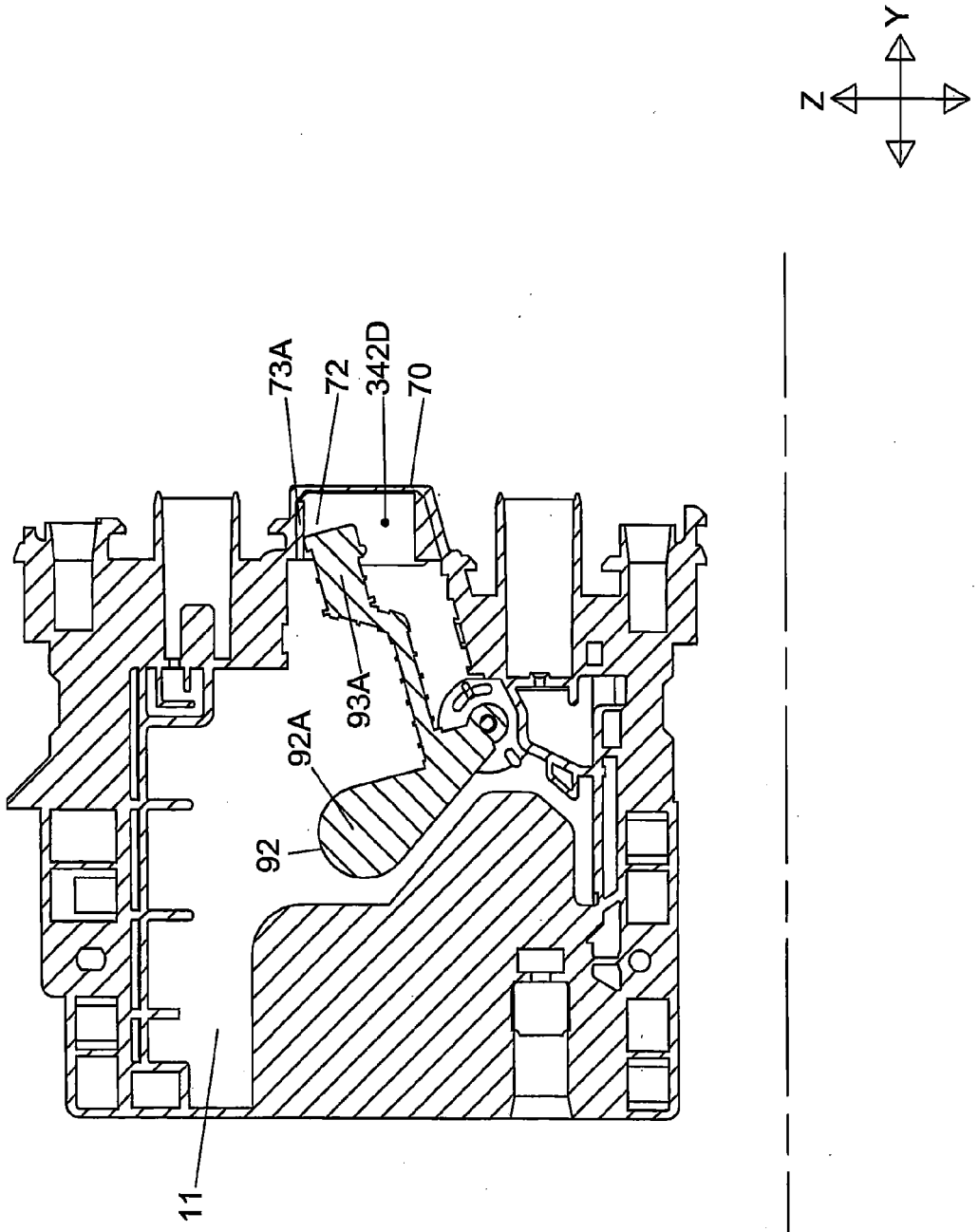


Fig. 32

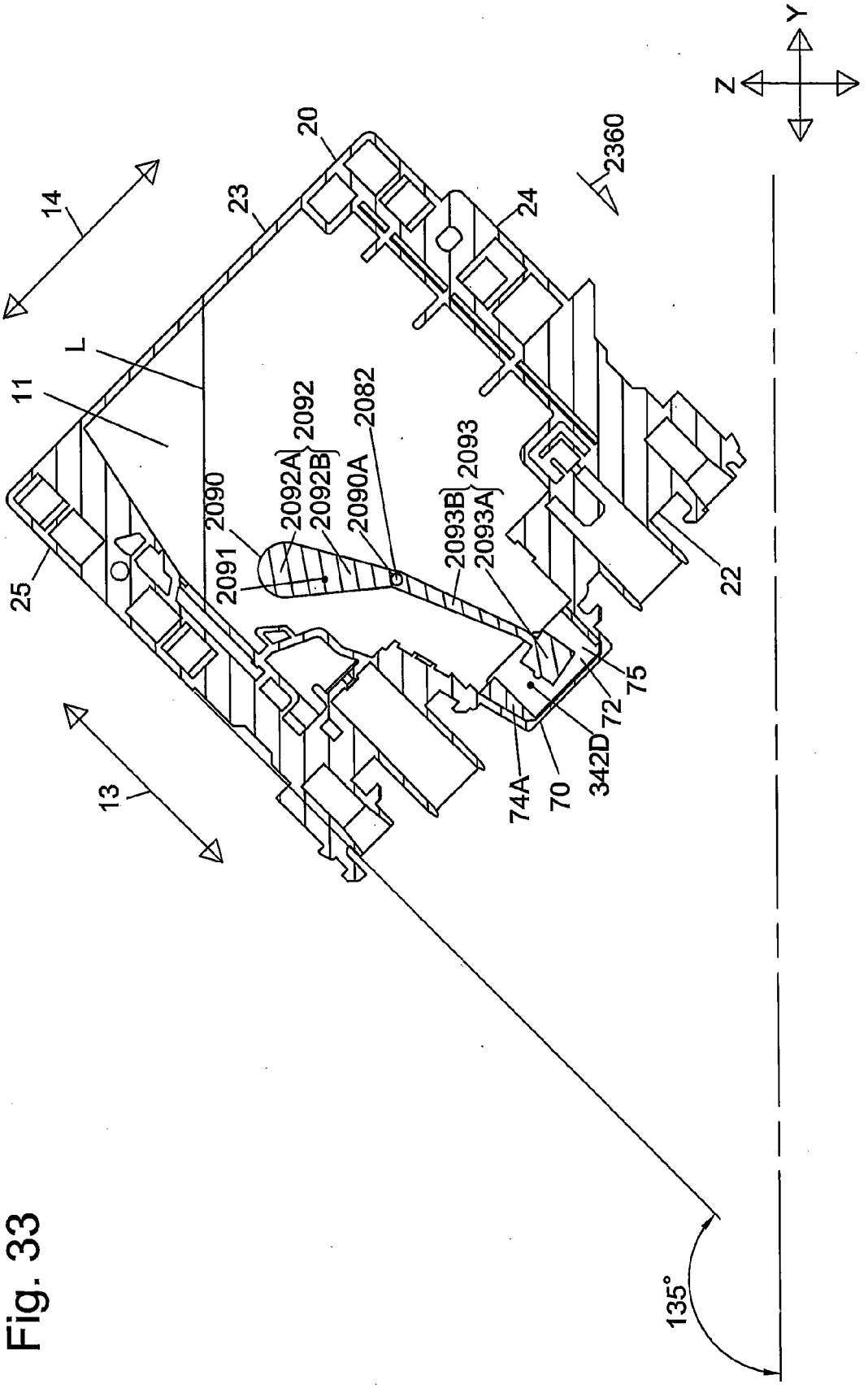

Y
Z
14
23
20
24
2360
L
11
2092
2092A
2092B
2082
2090
2090A
2091
2093
2093B
2093A
25
22
75
72
342D
74A
70
13
135°

Fig. 33

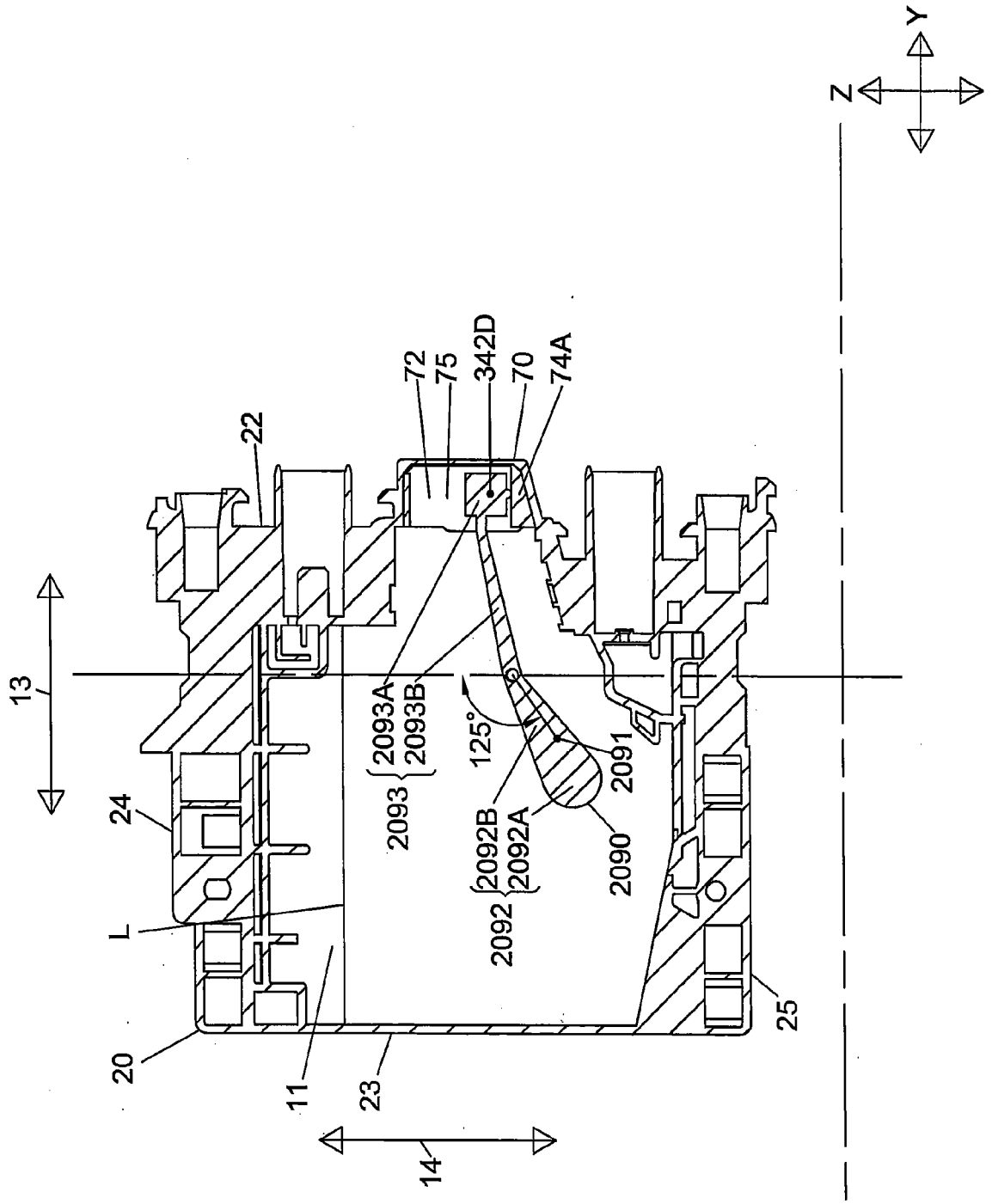

Y
Z
72
75
342D
70
74A
22
13
2093A
2093B
125°
2091
2093
2092B
2092A
2090
2092
24
L
20
11
23
14
25

Fig. 34

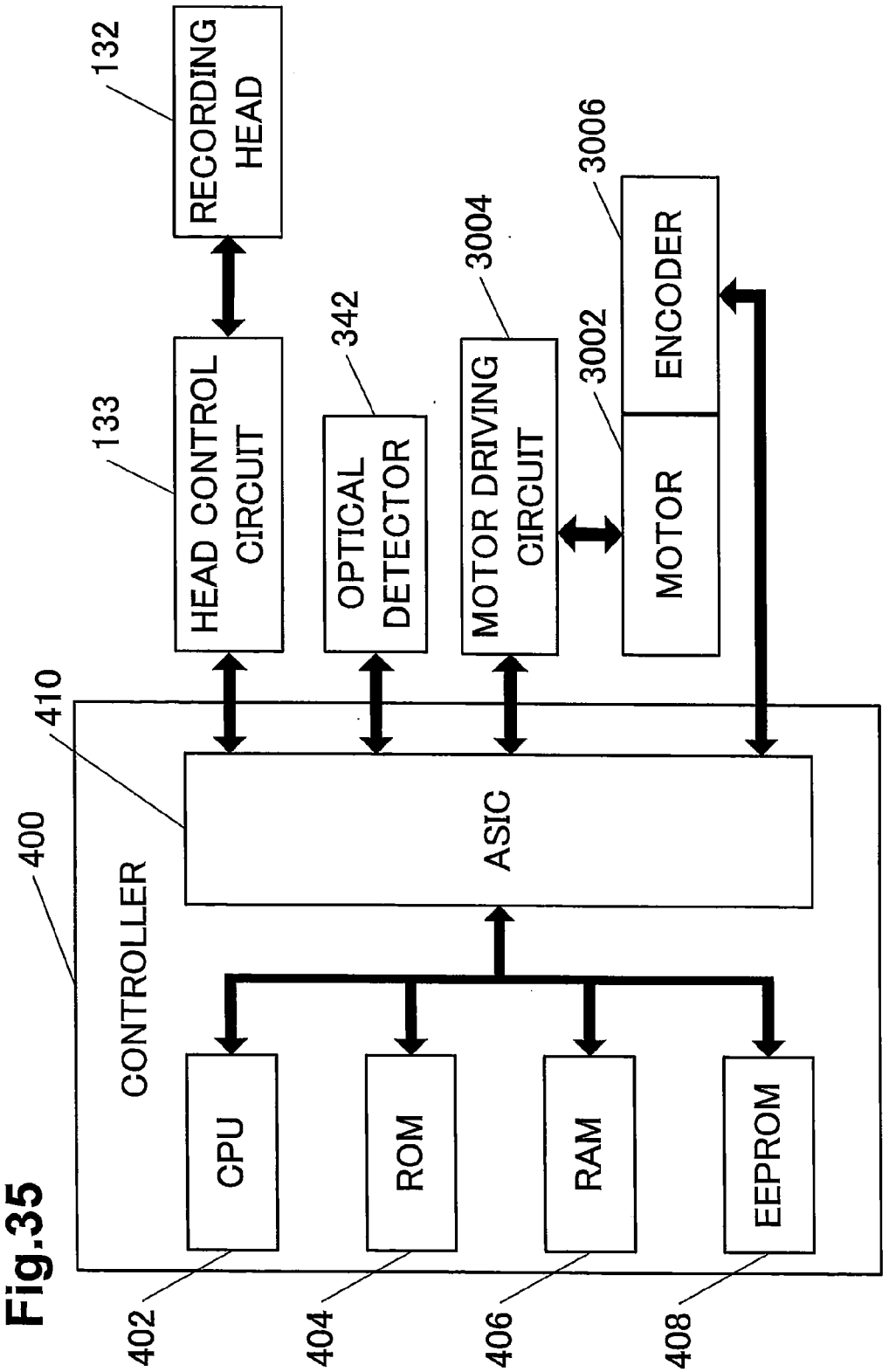

132
RECORDING HEAD
133
HEAD CONTROL CIRCUIT
342
OPTICAL DETECTOR
3004
MOTOR DRIVING CIRCUIT
3002
3006
ENCODER
MOTOR
410
ASIC
400
CONTROLLER
CPU
ROM
RAM
EEPROM
402
404
406
408

Fig.35

Fig.36

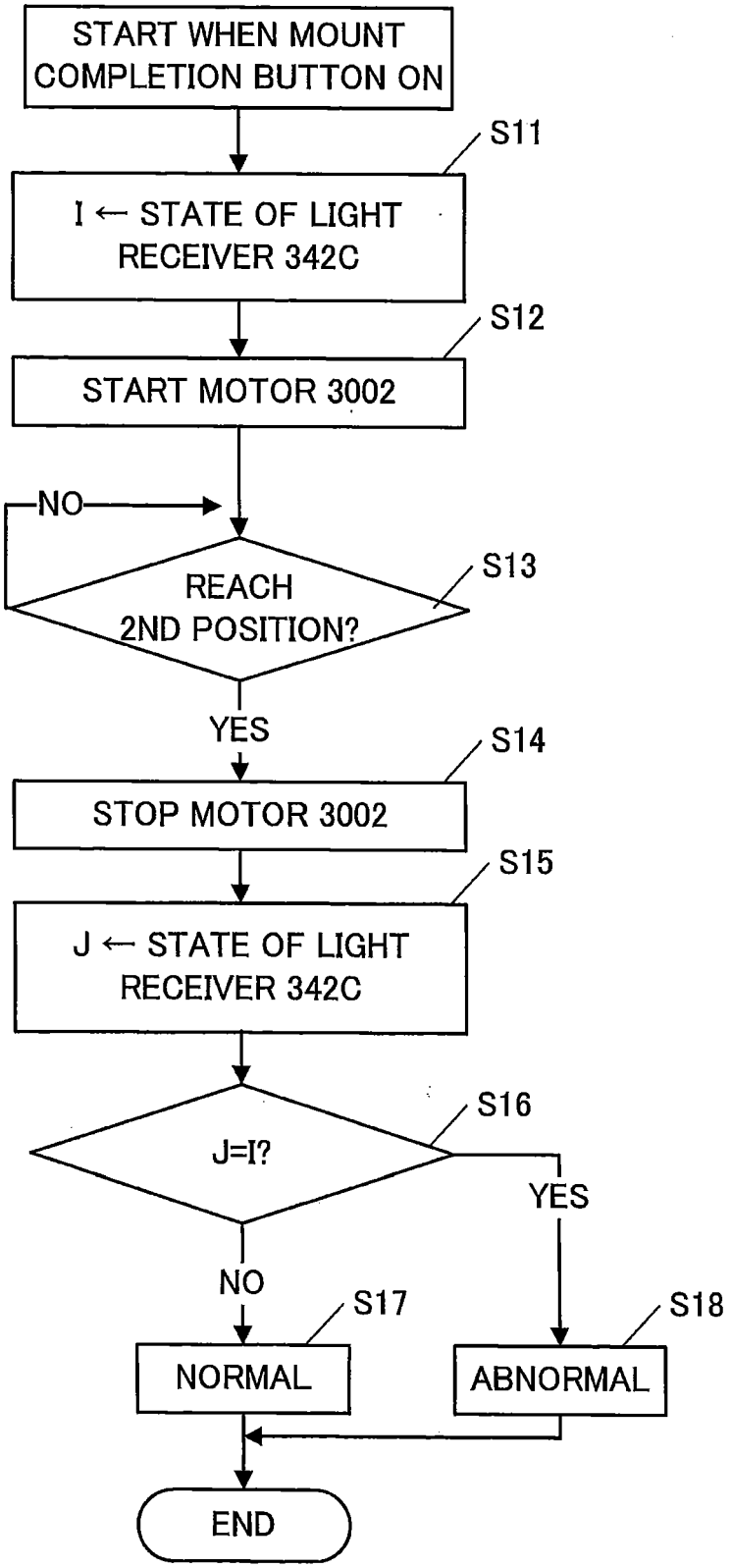

START WHEN MOUNT COMPLETION BUTTON ON
S11
I ← STATE OF LIGHT RECEIVER 342C
S12
START MOTOR 3002
NO
REACH 2ND POSITION?
S13
YES
S14
STOP MOTOR 3002
S15
J ← STATE OF LIGHT RECEIVER 342C
J=I?
S16
YES
NO
S17
NORMAL
S18
ABNORMAL
END

Fig.37

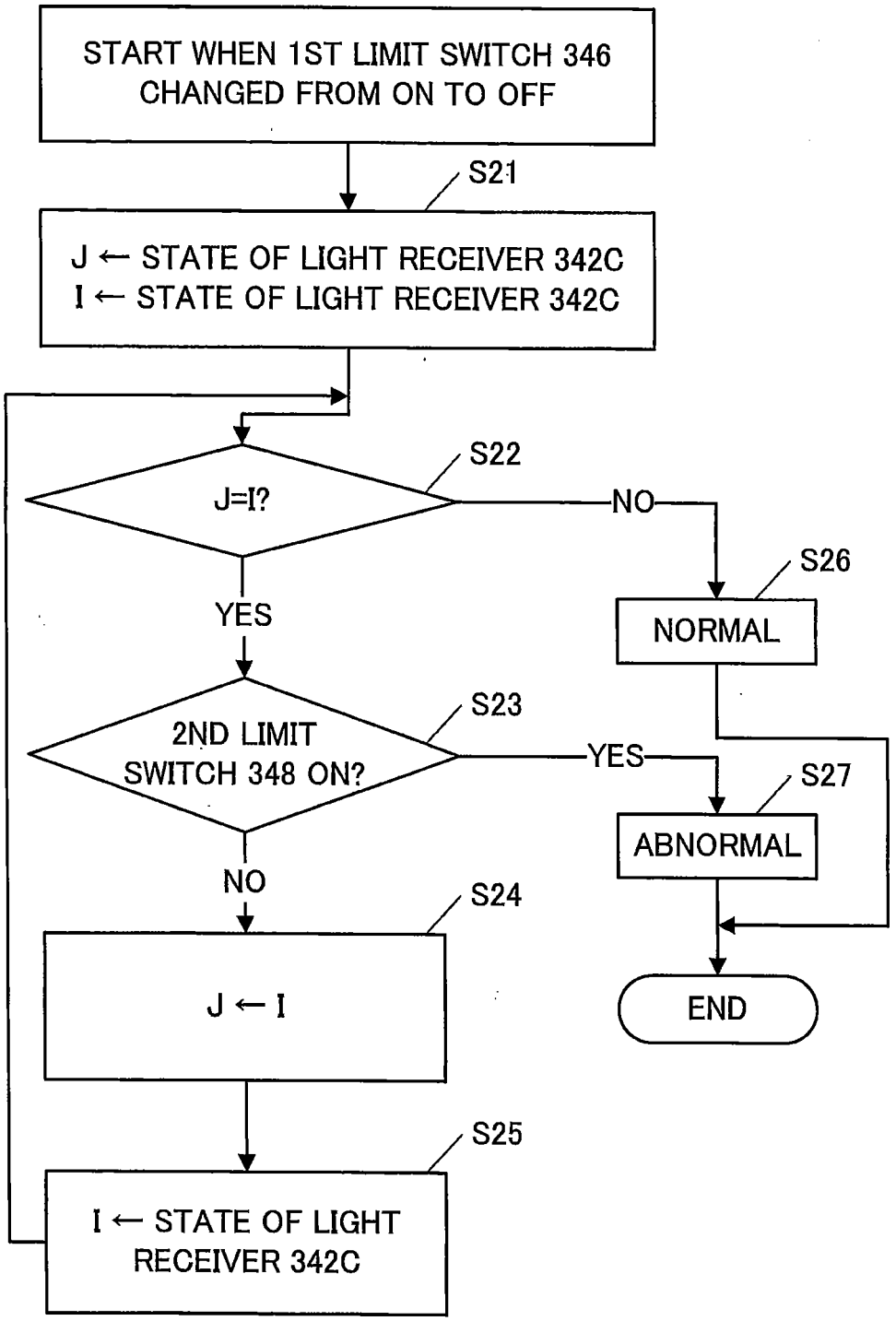

START WHEN 1ST LIMIT SWITCH 346 CHANGED FROM ON TO OFF
S21
J ← STATE OF LIGHT RECEIVER 342C
I ← STATE OF LIGHT RECEIVER 342C
S22
J=I?
NO
S26
NORMAL
YES
S23
2ND LIMIT SWITCH 348 ON?
YES
S27
ABNORMAL
NO
S24
J ← I
END
S25
I ← STATE OF LIGHT RECEIVER 342C

Fig.38

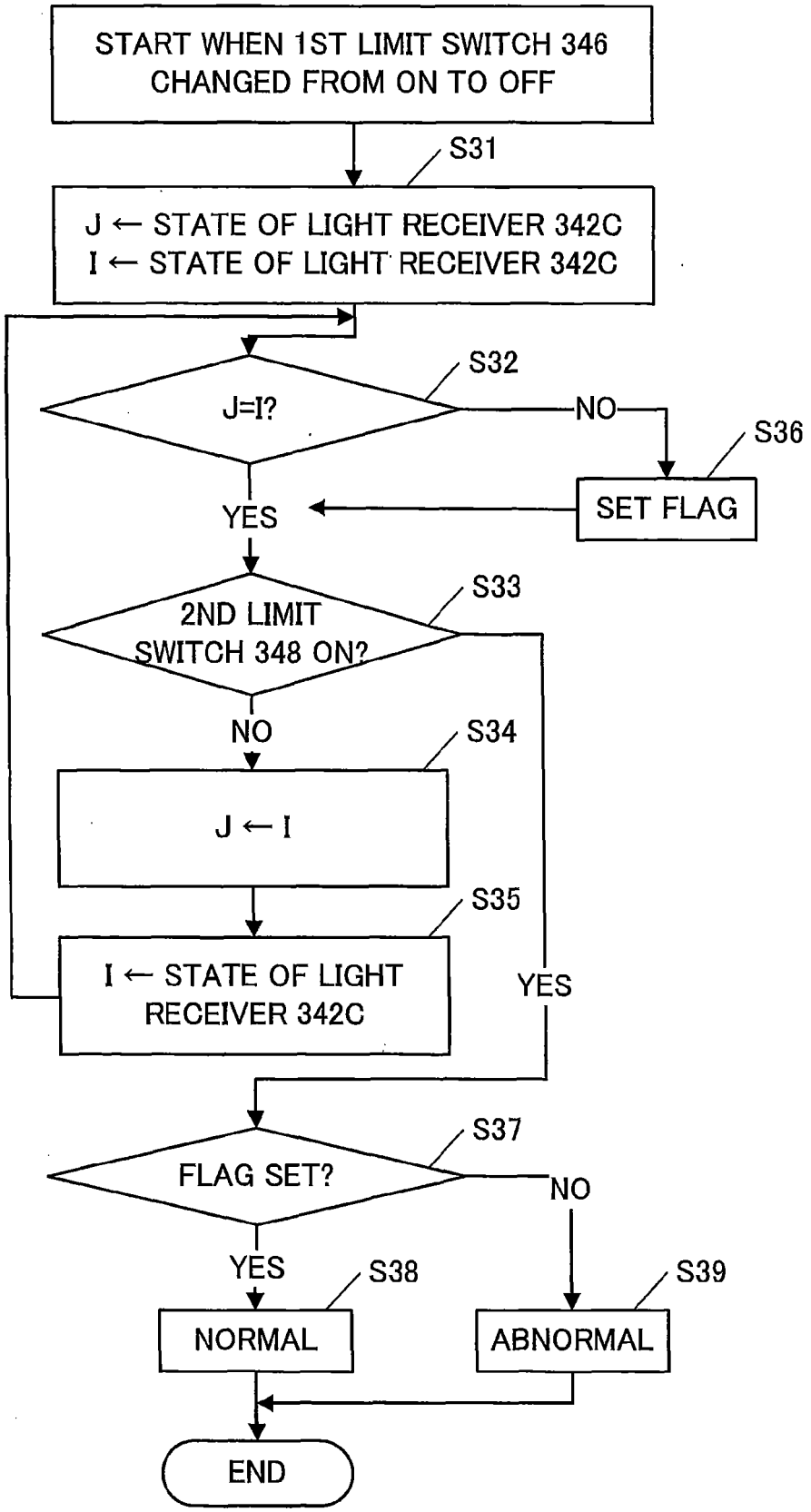

START WHEN 1ST LIMIT SWITCH 346 CHANGED FROM ON TO OFF
S31
J ← STATE OF LIGHT RECEIVER 342C
I ← STATE OF LIGHT RECEIVER 342C
S32
J=I?
NO
S36
SET FLAG
YES
S33
2ND LIMIT SWITCH 348 ON?
NO
S34
J ← I
S35
I ← STATE OF LIGHT RECEIVER 342C
YES
S37
FLAG SET?
NO
YES
S38
NORMAL
S39
ABNORMAL
END

Fig.39

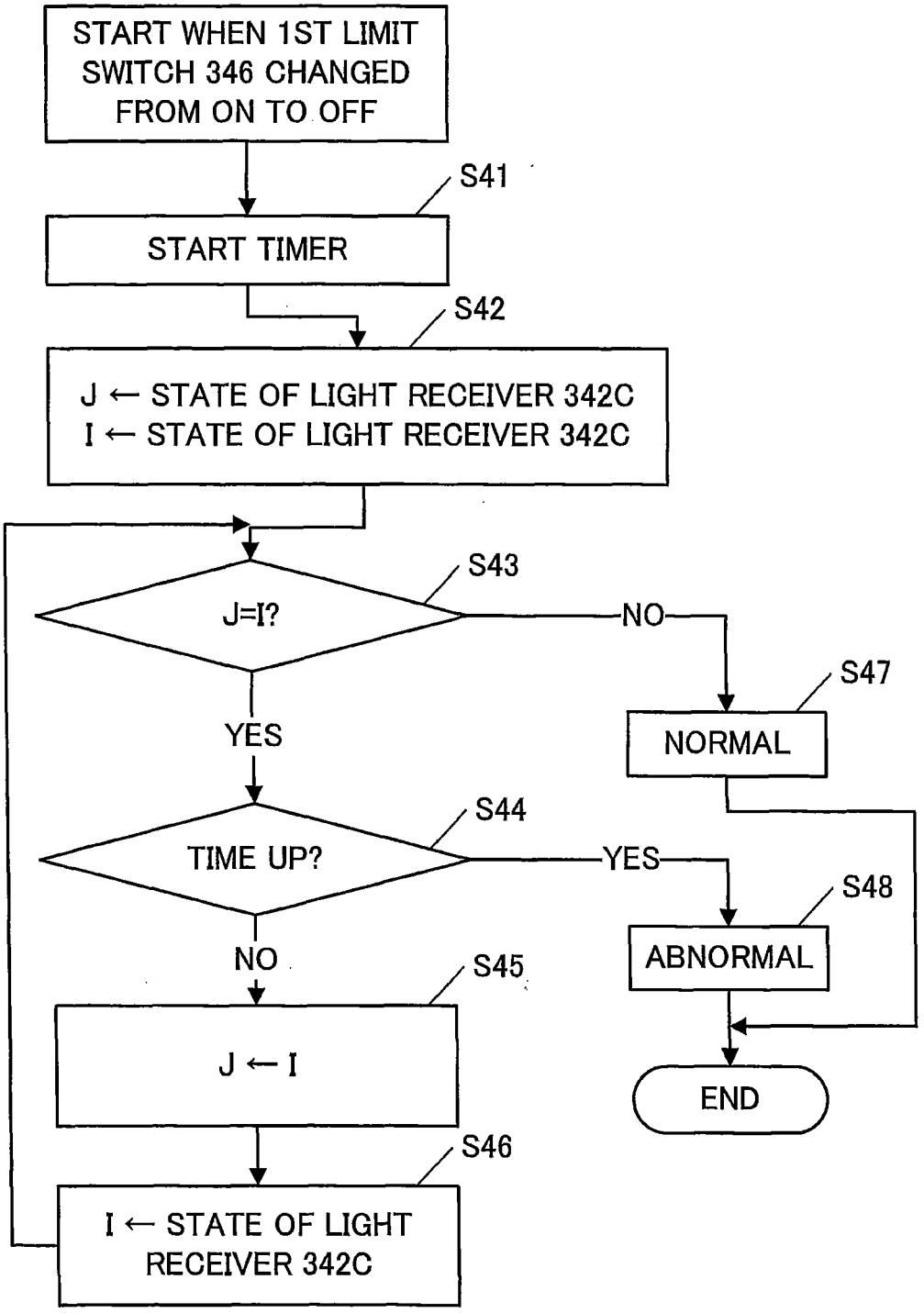

START WHEN 1ST LIMIT SWITCH 346 CHANGED FROM ON TO OFF
S41
START TIMER
S42
J ← STATE OF LIGHT RECEIVER 342C
I ← STATE OF LIGHT RECEIVER 342C
S43
J=I?
NO
S47
NORMAL
YES
S44
TIME UP?
YES
S48
ABNORMAL
NO
S45
J ← I
END
S46
I ← STATE OF LIGHT RECEIVER 342C

Fig.40

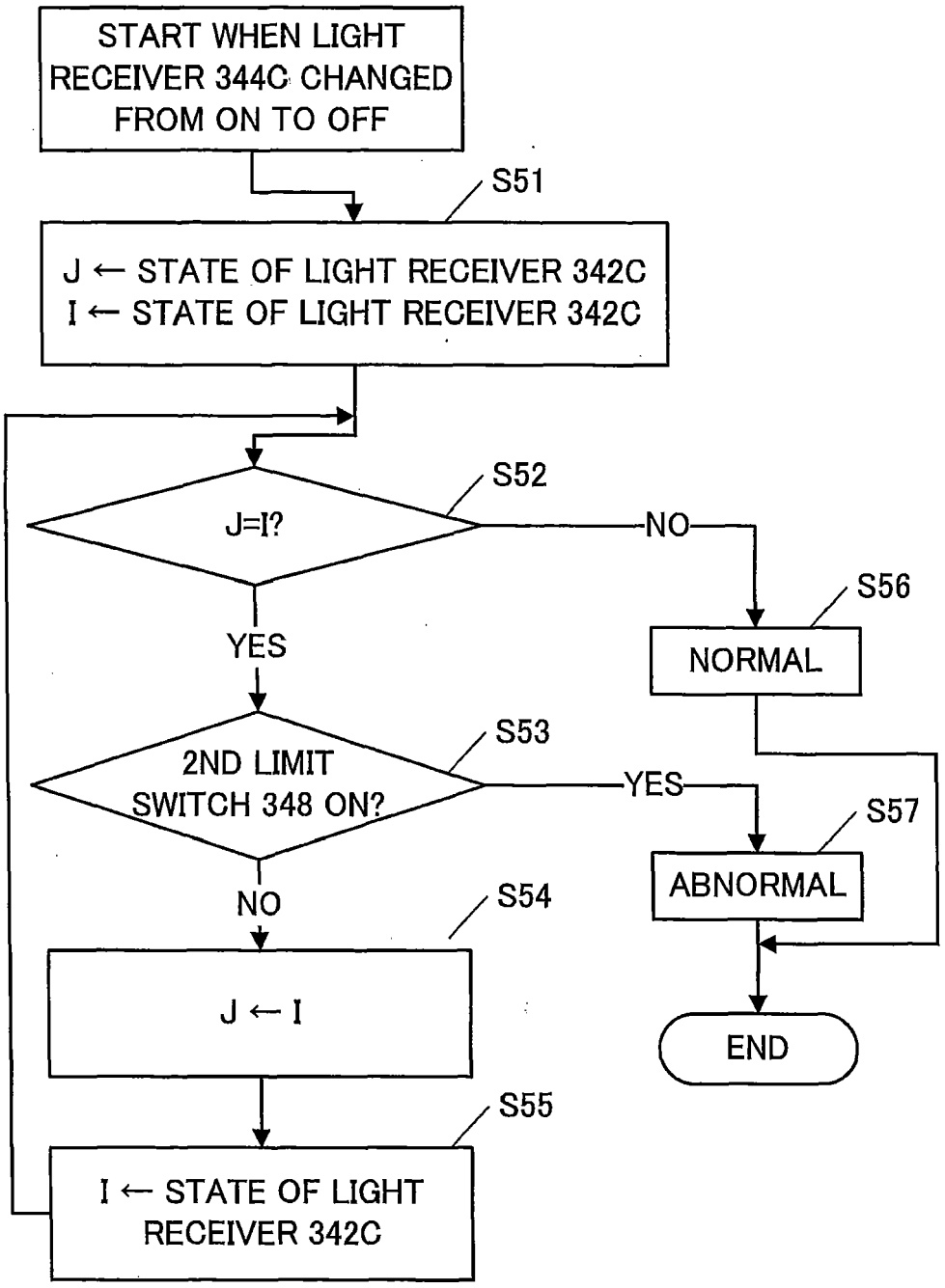

START WHEN LIGHT RECEIVER 344C CHANGED FROM ON TO OFF
S51
J ← STATE OF LIGHT RECEIVER 342C
I ← STATE OF LIGHT RECEIVER 342C
S52
J=I?
NO
S56
NORMAL
YES
S53
2ND LIMIT SWITCH 348 ON?
YES
S57
ABNORMAL
NO
S54
J ← I
END
S55
I ← STATE OF LIGHT RECEIVER 342C

Fig.41

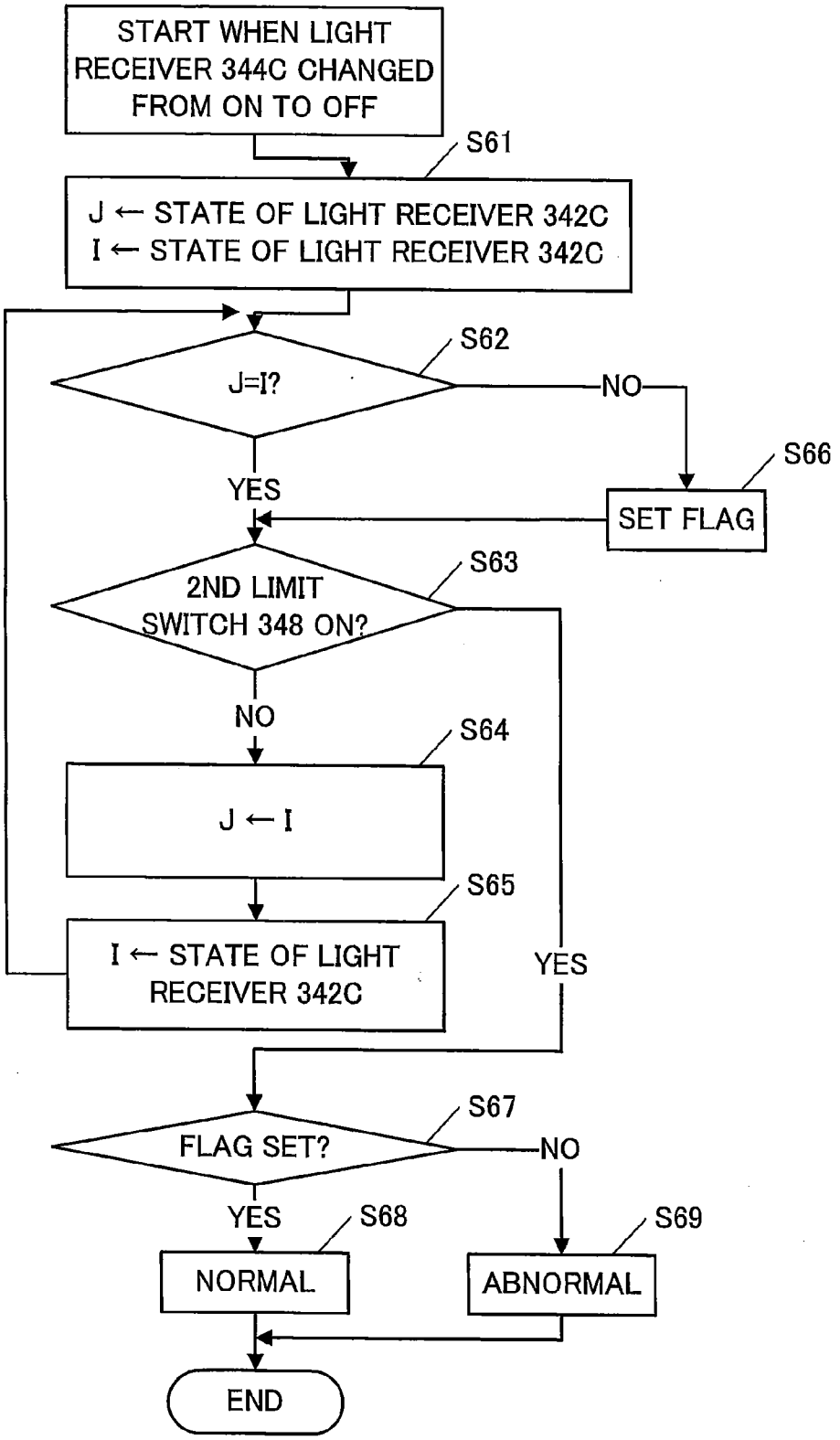
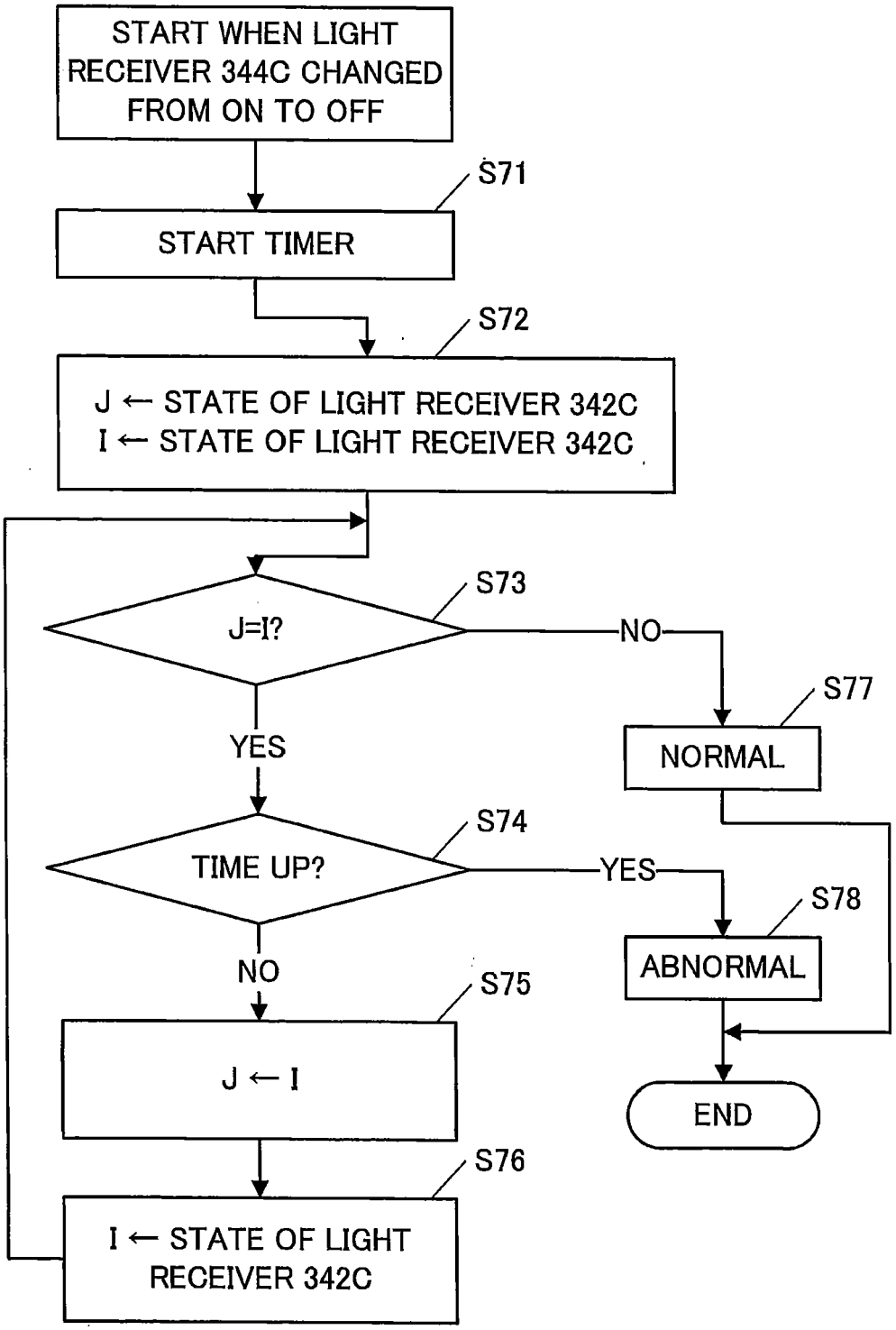

START WHEN LIGHT RECEIVER 344C CHANGED FROM ON TO OFF
S61
J ← STATE OF LIGHT RECEIVER 342C
I ← STATE OF LIGHT RECEIVER 342C
S62
J=I?
NO
S66
SET FLAG
YES
S63
2ND LIMIT SWITCH 348 ON?
NO
S64
J ← I
S65
I ← STATE OF LIGHT RECEIVER 342C
YES
S67
FLAG SET?
NO
YES
S68
NORMAL
S69
ABNORMAL
END

Fig.42


START WHEN LIGHT RECEIVER 344C CHANGED FROM ON TO OFF
S71
START TIMER
S72
J ← STATE OF LIGHT RECEIVER 342C
I ← STATE OF LIGHT RECEIVER 342C
S73
J=I?
NO
YES
S77
NORMAL
S74
TIME UP?
YES
S78
ABNORMAL
NO
S75
J ← I
END
S76
I ← STATE OF LIGHT RECEIVER 342C

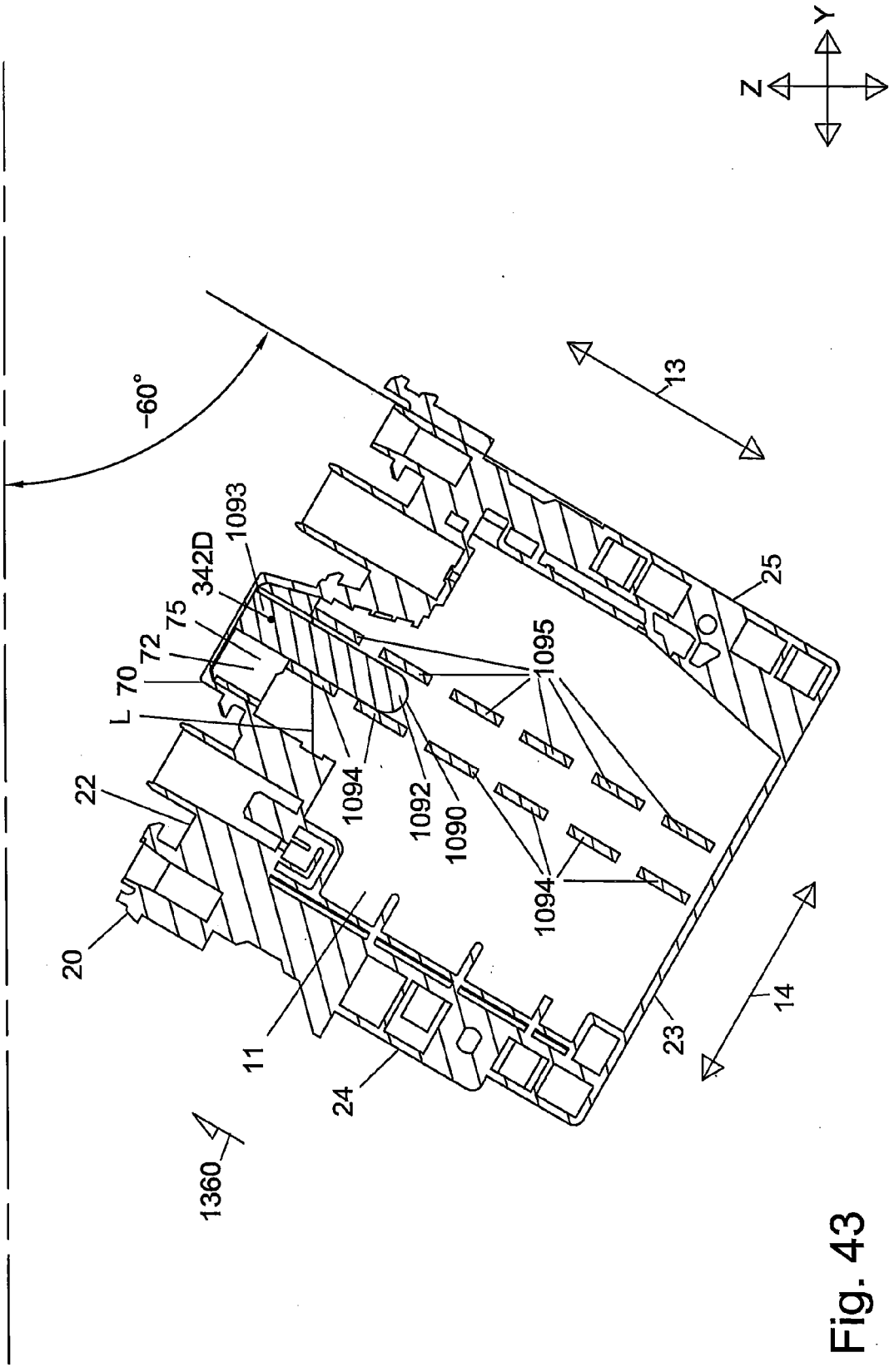

Y
Z
-60°
13
1093
342D
75
72
70
L
1095
25
22
1094
1092
1090
1094
20
11
24
23
14
1360

Fig. 43

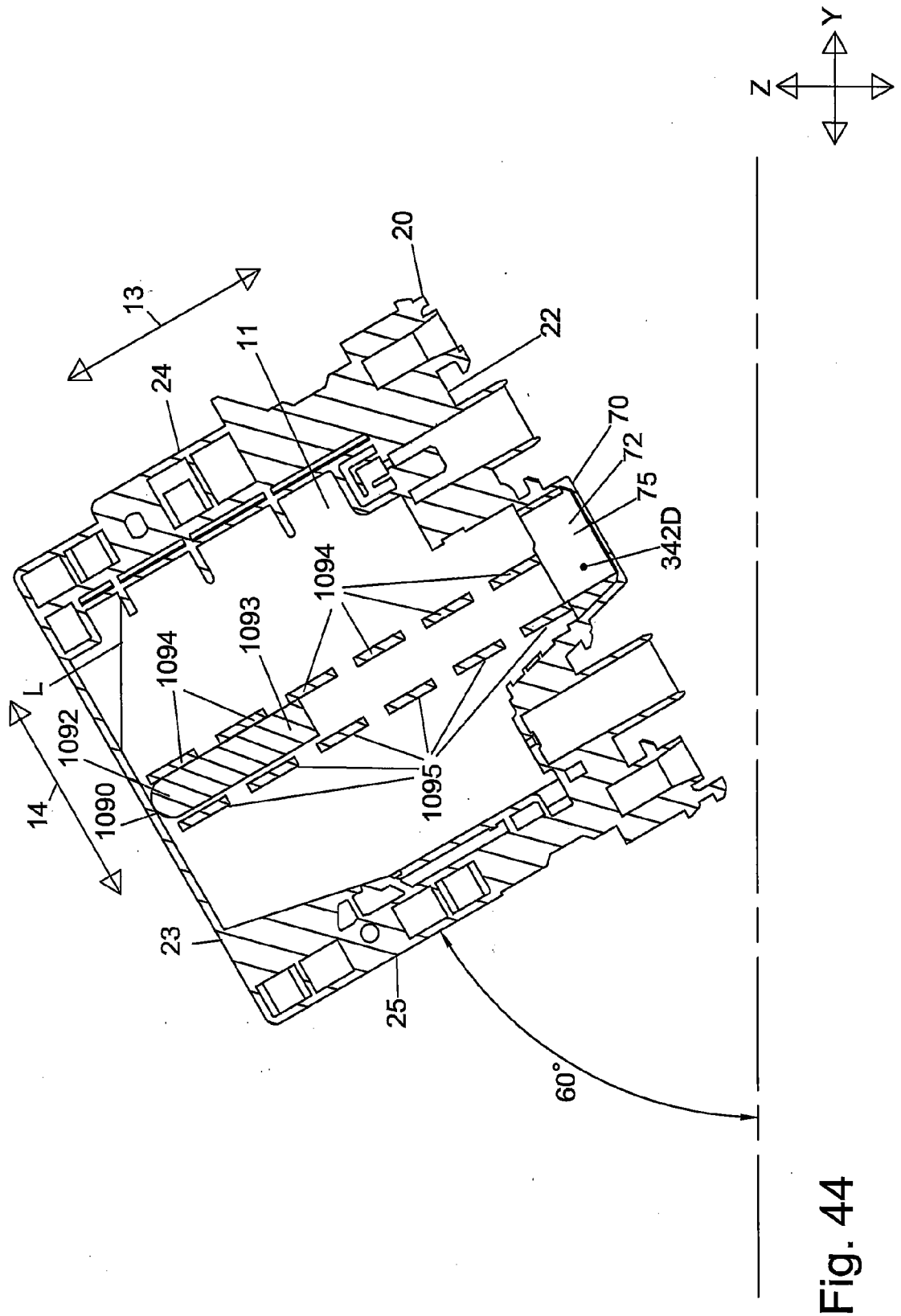

Y
Z
20
13
22
11
24
70
72
75
342D
1094
1093
1094
L
1092
1090
14
1095
23
25
60°

Fig. 44

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EUROPEAN SEARCH REPORT

Application Number
EP 09 17 0461

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	JP 2005 125738 A (BROTHER IND LTD) 19 May 2005 (2005-05-19) * paragraph [0025] * * paragraph [0043] - paragraph [0046] * -----	1-2,7, 11,13-14 3,5-6, 8-10,12	INV. B41J2/175
X,P	US 2009/219310 A1 (KONDO HIROFUMI [JP]) 3 September 2009 (2009-09-03) * the whole document * -----	1,13	
A	EP 1 839 872 A1 (BROTHER IND LTD [JP]) 3 October 2007 (2007-10-03) * the whole document * -----	1-13	

TECHNICAL FIELDS SEARCHED (IPC)

B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 November 2009	Gavaza, Bogdan

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20-11-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2005125738 A	19-05-2005	NONE	
US 2009219310 A1	03-09-2009	JP 2009208297 A	17-09-2009
EP 1839872 A1	03-10-2007	CN 101015993 A	15-08-2007
		JP 2007268948 A	18-10-2007

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Patent documents cited in the description

- JP 2005125738 A **[0004]**