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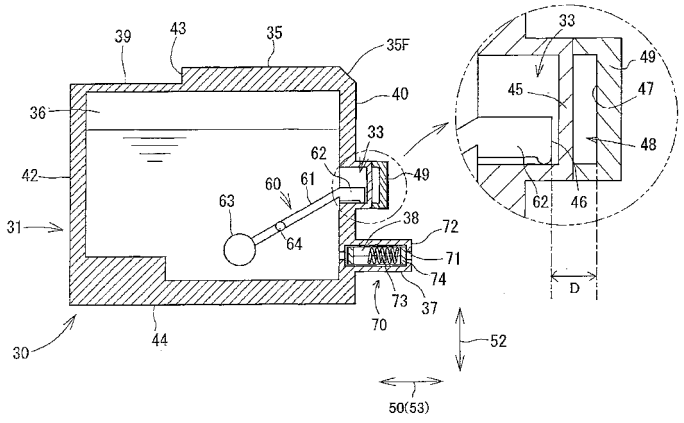
(54) Ink cartridge and recording apparatus

(57) An ink supplying apparatus is provided with a cartridge installation portion into which an ink cartridge is detachably loadable in an installation direction. The ink cartridge includes: a cartridge body having a front wall which is a leading side in the installation direction and defining therein an ink chamber in which ink is accommodated, the cartridge body having a height in a first direction perpendicular to the installation direction; an ink outlet port provided on the front wall for supplying the ink in the ink chamber to an outside; and a detection region provided at a position rearward of the ink outlet port in the installation direction and at a position different from the ink outlet port in the first direction, the detection region being defined by a first surface generally extending in the first direction and a second surface generally extending in the first direction and aligned with the first surface in the installation direction, The cartridge installation portion includes: a guide portion slidably movably guiding the cartridge body in the installation direction when the ink cartridge is loaded into the cartridge installation portion; an ink needle insertable into the ink outlet port when the cartridge body is silidingly guided along the guide portion; an optical sensor provided to be in coincident with the detection region in the installation direction upon insertion of the ink needle into the ink outlet port, the detection region capable of altering an optical characteristic of light emitted from the optical sensor in the installation direction during loading of the ink cartridge into the cartridge installation portion, the optical sensor outputting optical information based on the optical characteristic of the light altered at the detection region; and a control unit configured to determine information on the ink cartridge in accordance with the optical information outputted from the optical sensor.

FIG. 3



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Description

[0001] The present invention relates to an ink cartridge and a recording apparatus provided with a cartridge installation portion on which the ink cartridge is detachably loadable,

[0002] In a known image recording device, an ink cartridge is located outside of a carriage provided with a recording head, and this ink cartridge and the recording head are connected to each other via a tube. This ink cartridge is installed into a cartridge installation portion in a horizontal direction through an opening formed in the cartridge installation portion, the opening being positioned, for example, on a front surface of the image recording device. This cartridge installation portion accommodates the ink cartridge to be attachable thereto and detachable therefrom. When the ink cartridge is installed in the cartridge installation portion, an ink channel extending from the ink cartridge to the recording head is formed, Through this ink channel, ink is supplied to the recording head from the ink cartridge.

[0003] The ink cartridge is provided with a detection area for allowing detection of an amount of ink left within the ink cartridge and a type of the ink cartridge. A cartridge installation portion for accommodating this ink cartridge is provided with a sensor for detecting the detection area of the ink cartridge while the ink cartridge is being installed and when the ink cartridge has been installed in the cartridge installation portion.

[0004] During a process in which the ink cartridge is installed in the cartridge installation portion, acceleration acts on the ink cartridge in an installation direction of the ink cartridge. The acceleration depends on operations of users. If a user inserts the ink cartridge too quickly into the cartridge installation portion, there may arise a problem that the sensor cannot accurately detect the detection area of the ink cartridge. As the detection area has a smaller dimension in the installation direction, the sensor tends to have more difficulty in detecting the detection area, since the detection is performed depending on the speed of the user's insertion of the ink cartridge.

[0005] The present invention has been made in light of the above-described circumferences, and it is an object of the present invention to provide a recording apparatus capable of controlling an installation speed of an ink cartridge into an cartridge installation portion, and also capable of detecting a detection section of the ink cartridge with accuracy.

[0006] In order to attain the above and further objects, there is provided an ink cartridge installable in a cartridge installation portion of a recording apparatus in an installation direction. The ink cartridge includes a body, a first signal blocking portion, a second signal blocking portion and an ink supply portion. The body includes a front surface, a rear surface positioned to face the front surface and an ink chamber that accommodates ink therein. The first signal blocking portion is positioned at or adjacent to the front surface and extends in a height direction perpendicular to the installation direction, wherein the first signal blocking portion is configured to prevent a signal from the cartridge installation portion from passing through the first signal blocking portion, the first signal blocking portion having an upper end and a lower end opposite to the upper end in the height direction. The second signal blocking portion projects further forward than the first signal blocking portion in the installation direction, wherein the second signal blocking portion is configured to prevent the signal from passing therethrough when the second signal blocking portion receives the signal, The ink supply portion is provided at or adjacent to a lower end of the front surface in the height direction and configured to supply the ink to outside from the ink chamber, wherein the ink supply portion has an end projecting further forward than the first signal blocking portion and the second signal blocking portion in the installation direction. The upper end of the first signal blocking portion is positioned further forward than the lower end of the first signal blocking portion in the installation direction during installation of the ink cartridge into the cartridge installation portion.

[0007] Preferably, the body includes an upper surface extending from the front surface to the rear surface and a bottom surface opposite to the upper surface, and the upper surface is provided with an engaging portion that is engaged with a locking member for preventing the body installed in the cartridge installation portion from moving toward the rear surface.

[0008] Preferably, the ink cartridge further includes a signal transmissible portion configured to pass the signal therethrough and positioned between the first signal blocking portion and the second signal blocking portion in the installation direction.

[0009] Preferably, the upper end of the first signal blocking portion is further forward than the lower end of the first signal blocking portion when an ink needle in the cartridge installation portion contacts the ink supply portion.

[0010] Preferably, the first signal blocking portion is positioned at a generally intermediate position of the front surface in the height direction.

[0011] Preferably, the first signal blocking portion is positioned within the body and be configured to prevent the signal from the cartridge installation portion from passing through the first signal blocking portion based on an amount of the ink in the ink chamber.

[0012] Preferably, the ink cartridge further includes an arm member positioned within the ink chamber and configured to change its posture between a light-transmission state and a low light-transmission state based on the amount of the ink in the ink chamber, wherein the arm member has an indicator positioned in the ink chamber and functioning as the first signal blocking portion.

[0013] Preferably, the body has a height in the height direction and a thickness in a width direction perpendicular to the installation direction and the height direction, the height being greater than the width of the body. The

height direction is a vertical direction, and the ink supply portion is positioned below the first signal blocking portion and the second signal blocking portions with respect to the height direction.

[0014] Preferably, the end of the ink supply section is formed with an ink outlet port, and the ink supply portion further includes an ink supply valve body movably provided in the ink supply portion and a biasing member that biases the ink supply valve body in a direction to close the ink outlet port, an ink needle being inserted into the ink outlet port against a biasing force of the biasing member.

[0015] Preferably, the first signal blocking portion and the second signal blocking portion have protruding lengths smaller than a protruding length of the ink supply section in the installation direction.

[0016] According to another aspect of the present invention, there is provided a recording apparatus including a cartridge installation portion configured to allow the ink cartridge to be inserted thereinto in the installation direction. The cartridge installation portion includes a guide portion, an ink needle, an optical sensor and a control unit. The guide portion guides the body in the installation direction during the installation of the ink cartridge in the cartridge installation portion. The ink needle is insertable into the ink supply portion when the body is installed in the cartridge installation portion. The optical sensor is positioned to be in coincidence with a detection region in the installation direction upon insertion of the ink needle into the ink supply portion, the detection region being capable of altering an optical characteristic of light outputted from the optical sensor during the installation of the ink cartridge into the cartridge installation portion, the optical sensor emitting a signal based on the optical characteristic of the light altered at the detection region. The control unit is configured to determine information on the ink cartridge in accordance with the signal outputted from the optical sensor.

[0017] Preferably, the detection region is defined by a first surface generally extending in the height direction and a second surface generally extending in the height direction and aligned with the first surface in the installation direction, the first surface having a first end and a second end further from the end of the ink supply portion than the first end to the end of the ink supply portion in the height direction, and the second surface having a third end and a fourth end farther from the end of the ink supply portion than the third end to the end of the ink supply portion in the height direction. A gap is provided between the guide portion and the cartridge body in the height direction so that the ink cartridge maintains its forward-tiling posture during installation operation as a result of contact of the ink needle with the ink supply portion, whereupon the first surface is slanted relative to the height direction such that the second end is located forward of the first end in the installation direction, and the second surface is slanted relative to the height direction such that the fourth end is located forward of the third end in the installation direction.

[0018] Preferably, the second signal blocking portion includes a detection portion generally extending in the height direction and having a rear surface in the installation direction functioning as the second surface.

[0019] Preferably, the first signal blocking portion includes an end wall positioned rearward of the second signal blocking portion in the installation direction and generally extending in the height direction, the end wall having a rear surface in the installation direction functioning as the first surface.

[0020] Preferably, the first signal blocking portion includes an end wall positioned rearward of the second signal blocking portion in the installation direction and generally extending in the height direction, the end wall having a front surface in the installation direction functioning as the first surface.

[0021] Preferably, when the indicator serves as the first signal blocking portion, the indicator is positioned rearward of the second signal blocking portion in the installation direction and has a front surface in the installation direction functioning as the first surface.

[0022] According to still another aspect of the present invention, there is provided an ink supplying apparatus provided with a cartridge installation portion into which an ink cartridge is detachably installable in an installation direction. The ink cartridge includes: a cartridge body having a front wall which is a leading side in the installation direction and defining therein an ink chamber in which ink is accommodated, the cartridge body having a height in a first direction perpendicular to the installation direction; an ink outlet port provided on the front wall for supplying the ink in the ink chamber to an outside; and a detection region provided at a position rearward of the ink outlet port in the installation direction and at a position different from the ink outlet port in the first direction, the detection region being defined by a first surface generally extending in the first direction and a second surface generally extending in the first direction and aligned with the first surface in the installation direction. The cartridge installation portion includes; a guide portion slidably movably guiding the cartridge body in the installation direction when the ink cartridge is installed in the cartridge installation portion; an ink needle insertable into the ink outlet port when the cartridge body is silidingly guided along the guide portion; an optical sensor provided to be in coincidence with the detection region in the installation direction upon insertion of the ink needle into the ink outlet port, the detection region capable of altering an optical characteristic of light emitted from the optical sensor in the installation direction during installation of the ink cartridge into the cartridge installation portion, the optical sensor outputting optical information based on the optical characteristic of the light altered at the detection region; and a control unit configured to determine information on the ink cartridge in accordance with the optical information outputted from the optical sensor.

[0023] According to further aspect of the present in-

vention, there is provided an ink cartridge detachably loadable on a cartridge installation portion in an installation direction, the cartridge installation portion having one surface on which an ink needle and an optical sensor are provided. The ink cartridge includes: a cartridge body having a front wall which is a leading side in the installation direction and a rear wall which is a trailing side in the installation direction, the front wall and the rear wall extending in a first direction perpendicular to the installation direction, and the cartridge body defining therein an ink chamber in which an ink is accommodated; an ink supply section positioned at a lower portion of the front wall for supplying the ink in the ink chamber to an outside, the ink supply section having a tip end positioned frontward in the installation direction, the tip end being in abutment with the ink needle at a first position during loading of the ink cartridge into the cartridge installation portion; and a detection region disposed on the front wall at a position above the ink supply section in the first direction and rearward of the tip end of the ink supply section in the installation direction, the detection region extending in the first direction and the installation direction and in alignment with the optical sensor in the installation direction while the cartridge body is pivotally moved about the first position in a frontward-tilting posture during loading of the ink cartridge into the cartridge installation portion.

[0024] In the drawings:

Fig. 1 is a schematic view showing an internal construction of a printer incorporating an ink cartridge according to an embodiment of the present invention;

Fig. 2 is a perspective view of the ink cartridge according to the embodiment;

Fig. 3 is a vertical cross-sectional view of the ink cartridge according to the embodiment;

Fig. 4 is a vertical cross-sectional view of a cartridge installation portion in the printer of Fig. 1;

Fig. 5 is a block diagram of a control unit in the printer of Fig. 1, the control unit being connected to an optical sensor;

Fig. 6 is a vertical cross-sectional view of the ink cartridge according to the embodiment and the cartridge installation portion and showing an initial installation state of the ink cartridge into the cartridge installation portion;

Fig. 7 is a vertical cross-sectional view of the ink cartridge according to the embodiment and the cartridge installation portion and showing a loading state of the ink cartridge into the cartridge installation portion after the state of Fig. 6;

Fig. 8 is a partially enlarged view of an area encircled as VIII in Fig. 7 showing an essential portion of the ink cartridge according to the embodiment;

Fig. 9 is a vertical cross-sectional view of the ink cartridge according to the embodiment and the cartridge installation portion and showing an installed state of the ink cartridge into the cartridge installation portion;

Fig. 10A is a timing chart illustrating an output signal of the optical sensor when the ink cartridge according to the embodiment is being inserted in the cartridge installation portion while being pivotally moved upward;

Fig. 10B is a timing chart illustrating an output signal of the optical sensor when the ink cartridge according to the embodiment is being loaded into the cartridge installation portion without being pivotally moved upward;

Fig. 11 is a partially enlarged view of an ink cartridge according to a first modification to the embodiment;

Fig. 12 is a partially enlarged view of an ink cartridge according to a second modification to the embodiment; and

Fig. 13 is a partially enlarged view of an ink cartridge according to a third modification to the embodiment.

[0025] First, an ink cartridge 30 according to an embodiment of the present invention will be described with reference to Figs. 1 to 10 wherein like parts and components are designated by the same reference numerals to avoid duplicating description.

[0026] A general configuration of a printer 10 in which the ink cartridge 30 is accommodated will first be described with reference to Fig. 1. The terms "upward", "downward", "upper", "lower", "above", "below", "beneath", "right", "left", "front", "rear" and the like will be used throughout the description assuming that the printer 10 is disposed in an orientation in which it is intended to be used.

[0027] The printer 10 is configured to form an image by ejecting ink droplets onto a sheet in accordance with an ink jet recording system. The printer 10 is adapted for accommodating four kinds of ink cartridges 30 therein, As shown in Fig. 1, the printer 10 includes an ink supplying unit 100, a recording head 21 and four ink tubes 20 connecting therebetween. For simplicity, only one ink cartridge 30 and the corresponding ink tube 20 are depicted in Fig. 1.

[0028] The ink supplying unit 100 includes a cartridge installation portion 110 on which the four kinds of ink cartridges 30 are loadable, Each ink cartridge 30 stores an ink of one of four colors: cyan, magenta, yellow and black to be used in the printer 10. The cartridge installation portion 110 has one side (front side) formed with an opening 112 exposed to an atmosphere. The ink cartridge 30 can be inserted into the cartridge installation portions 110, and removed therefrom through the opening 112. The opening 112 is normally covered by a cover member (not shown) provided at a frame of the printer 10. The cover is opened for installing the ink cartridge 30.

[0029] When the ink cartridge 30 is fully loaded on the cartridge installation portion 110, the ink cartridge 30 is connected to the recording head 21 via the ink tube 20 of the corresponding color. The recording head 21 includes a plurality of nozzles 29 and four sub tanks 28

each corresponding to one of the four colors. The each sub tank 28 temporarily stores one of the four colors of ink supplied from the ink cartridge 30 of the same color through the corresponding ink tube 20. The recording head 21 selectively ejects the ink supplied from the respective ink cartridges 30, using the nozzle 29, in a form of fine ink droplet.

[0030] The printer 10 also includes a sheet supply tray 15, a sheet supply roller 23, a sheet passage 24, a pair of transfer rollers 25, a platen 26, a pair of discharge rollers 22, and a discharge tray 16 arranged in this order in a sheet feeding direction. As shown in Fig. 1, the sheet supplied from the sheet supply tray 15 to the sheet passage 24 by the sheet supply roller 23 is conveyed to the platen 26 by the pair of transfer rollers 25. Then, the ink is selectively ejected from the recording head 21 onto the sheet conveyed on the platen 26 to form an inked image on the sheet, The sheet is then discharged onto the discharge tray 16 by the pair of discharge rollers 22.

[0031] A detailed configuration of the ink cartridge 30 according to the embodiment will be described next with reference to Figs. 2 and 3.

[0032] The ink cartridge 30 is inserted into or removed from the cartridge installation portion 110 with respect to installation/removal directions 50 in an upstanding state shown in Fig. 2. More precisely, the ink cartridge 30 is inserted into the cartridge installation portion 110 in an installation direction 56, while being removed from the cartridge installation portion 110 in a removal direction 55 in the upstanding state (see Figs. 6 and 9).

[0033] The ink cartridge 30 includes a cartridge body 31 defining an outer contour of the ink cartridge 30. The ink cartridge 30 defines therein an ink chamber 36 in which the ink is accommodated, The ink chamber 36 may be a space defined inside the cartridge body 31, or can be defined by a member separate from the cartridge body 31 but inside the cartridge body 31.

[0034] The cartridge body 31 has a generally flat rectangular shape having small width (in a direction indicated by an arrow 51 which will be referred to as widthwise direction or horizontal direction), height (in a direction indicated by an arrow 52 which will be referred to as vertical direction) and depth (in a direction indicated by an arrow 53 which will be referred to as depthwise direction perpendicular to the height and widthwise directions) those greater than the width. The installation/removal directions 50 of the ink cartridge 30 relative to the cartridge installation portion 110 correspond to the depthwise direction 53.

[0035] The cartridge body 31 has a front wall 40, a rear wall 42, a top wall 39, a bottom wall 41 and a pair of side walls 83, 84. The front wall 40 and the rear wall 42 are a leading end wall and a trailing end wall, respectively, when installing the ink cartridge 30 into the cartridge installation portion 110, and are spaced away from each other in the depthwise direction 53. The pair of side walls 83, 84 extends in the depthwise direction 53 and is connected to the front wall 40 and the rear wall 42. The top wall 39 extends in the depthwise direction 53 for connecting upper ends of the front wall 40, rear wall 42, and the pair of side walls 83, 84. The bottom wall 41 extends in the depthwise direction 53 for connecting lower ends of the front wall 40, rear wall 42, and the pair of side walls 83, 84.

[0036] The front wall 40 is provided with a detection section 33 at a generally intermediate position in the vertical direction 52. The detection section 33 has a box shape with an opening that allows ink in the ink chamber 36 to fluid communicate with the detection section 33. The detection section 33 has an end wall 45 positioned frontward in the installation direction 56. The end wall 45 possesses translucent properties, The detection section 33 also has a pair of side walls facing each other in the widthwise direction 51 and made from a translucent material, such as a resin. The pair of side walls allows light emitted from an optical sensor 114 (Fig. 4) to pass therethrough. The optical sensor 114 is provided at the cartridge installation portion 110.

[0037] As shown in Fig. 3, the detection section 33 provides therein a hollow space. A sensor arm 60 is pivotably movably disposed within the ink chamber 36. The sensor arm 60 has a rod-like shaped arm body 61 and a shaft 64. The sensor arm 60 is pivotably movably supported to the shaft 64. The shaft 64 extends in the widthwise direction 51 and is supported to the pair of side walls 83, 84. The shaft 64 may not be supported to the pair of side walls 83, 84. The arm body 61 has one end provided with an indicator 62 movably positioned in the hollow space, and the other end provided with a float 63. With this structure, the sensor arm 60 is adapted to change its pivoting posture in accordance with an amount of the ink in the ink chamber 36 between a lower position as shown in Fig. 3 in which the indicator 62 approaches a lower wall of the detection section 33 and an upper position (not shown) in which the indicator 62 approaches an upper wall of the detecting portion 33. In other words, the indicator 62 is positioned at or adjacent to the front wall 40.

[0038] The indicator 62 has a front surface 46 which is positioned forward in the installation direction 56 when the sensor arm 60 is in the lower position. The front surface 46 extends in the widthwise direction 51 and the vertical direction 52 (i,e., in a direction perpendicular to the depthwise direction 53 or the installation direction 56). The indicator 62 has a light blocking characteristic or a light attenuating characteristic such that the optical sensor 114 can output a signal indicative of LOW level of light when the light emitted from the optical sensor 114 is irradiated onto the indicator 62.

[0039] In the installation state of the ink cartridge 30 into the cartridge installation portion 110, the detection section 33 is changeable between a light-transmission state and a low light-transmission state. In the light-transmission state, not less than a predetermined amount of infrared light can be transmitted through the detection section 33, and in the low light-transmssive state, less

than the predetermined amount of infrared light is transmitted therethrough (the light is shut off, attenuated by a prism or reflected by a mirror to alter a path of the light). More specifically, the transmission state and the low light-transmission state are provided when the indicator 62 is at its upper position and lower position, respectively. In accordance with the light transmission status of the detection section 33, an amount of ink in the ink chamber 36 can be detected.

[0040] As shown in Fig. 3, an ink supply portion 37 is provided at the front wall 40 at a position below the detection section 33 in the vertical direction 52. The ink supply portion 37 has a cylindrical shape and protrudes from the front wall 40 frontward in the installation direction 56. The ink supplying section 37 has a protruding length greater than that of the detection section 33. The ink supply portion 37 has a tip end portion 72 on which an ink outlet port 71 is formed. An ink passage 38 extending in the installation/removal directions 50 is formed in the ink supply portion 37 so as to allow fluid communication between the ink chamber 36 and outside via the ink outlet port 71. The ink supply portion 37 may be provided adjacent to a lower end of the front wall 40.

[0041] The ink outlet port 71 can be opened and closed with a provision of an ink supply valve 70 within the ink supply portion 37. The ink supply valve 70 includes a coil spring 73 and a valve body 74. The coil spring 73 biases the valve body 74 toward the ink outlet port 71, thereby enabling the valve body 74 to close the ink outlet port 71. The cartridge installation portion 110 is provided with an ink needle 122 (Fig. 4). Upon installing the ink cartridge 30 into the cartridge installation portion 110, the ink needle 122 pushes the valve body 74 in the removal direction 55 against the biasing force of the coil spring 73 and opens the ink outlet port 71. As a result, the ink stored within the ink chamber 36 flows into the ink needle 122 through the ink passage 38.

[0042] Incidentally, instead of the ink supply valve 70, a film covering the ink outlet port 71 is available. In the latter case, upon installation of the ink cartridge 30 in the cartridge installation portion 110, the ink needle 122 breaks the film to open the ink outlet port 71.

[0043] As shown in Fig. 3, the front wall 40 of the cartridge body 31 is further provided with a detection portion 49 at a position adjacent to and frontward of the detection section 33 in the installation direction 56. The detection portion 49 blocks or attenuates the infrared light traveling in the widthwise direction 51. The detection portion 49 has a width similar to that of the detection section 33. This width of the detection portion 49 is set such that the detection portion 49 can be interposed between a light-emitting element and a light-receiving element of the optical sensor 114 at the time of installation of the ink cartridge 30 into the cartridge installation portion 110. The detection portion 49 is positioned rearward of the tip end portion 72 of the ink supply portion 37 with respect to the installation direction 56. With respect to the vertical direction 52, the detection section 33 and the detection portion 49 are both formed above the ink supply portion 37 (i,e., at a position different from the ink outlet port 71).

[0044] Therefore, as shown in Fig. 3, there is formed a space (or an interval) between the detection portion 49 and the detection section 33 in the installation/removal directions 50. The infrared light traveling in the widthwise direction 51 can pass the space without being blocked nor attenuated to a level below the predetermined amount. The detection portion 49 has a rear surface 47 positioned rearward in the installation direction 56 and frontward of the end wall 45 in the installation direction 56. The rear surface 47 extends in the widthwise direction 51 and the vertical direction 52 (i,e., in a direction perpendicular to the depthwise direction 53). The rear surface 47 may be a plate member extending in the widthwise direction 51 and the depthwise direction 53.

[0045] Between the detection portion 49 and the detection section 33 in the installation direction 56, the rear surface 47 of the detection portion 49 and the front surface 46 of the indicator 62 define a region that allows light to be transmitted therethrough. This region bounded by the rear surface 47 and the front surface 46 will be referred to as a detection region 48 within which light is transmitted so that the optical sensor 114 can output a HIGH level signal.

[0046] The detection region 48 has a dimension D (D1 or D2) with respect to the installation/removal directions 50 (see Figs. 3, 10A and 10B). The dimension D can be made variant, depending on dimensions of the detection portion 49 in the installation/removal directions 50. This variation of the dimension D is used for discriminating types of the ink cartridges 30, for example, colors of ink, components of ink and initial amounts of ink charged in the ink cartridge 30.

[0047] As shown in Fig. 2, a guide portion 35 protrudes upward from the top wall 39 and extends in the depthwise direction 53. A rib or projecting arrangement is available as the guide portion 35. Further, the guide portion 35 has a width smaller than that of the cartridge body 31.

[0048] The guide portion 35 has an end face that is positioned rearward in the installation direction 56 which serves as an engaging portion 43. The engaging portion 43 is located at a position in the vicinity of the center of the top wall 39 in the depthwise direction 53. The engaging portion 43 is a vertical flat surface that extends in the widthwise direction 51 and in the vertical direction 52. The engaging portion 43 may be a plate member extending in the widthwise direction 51 and the in the installation/removal directions 50. When the ink cartridge 30 is installed in the cartridge installation portion 110, the engaging portion 43 is engaged with a lock lever 145 provided on the cartridge installation portion 110.

[0049] The guide portion 35 has another end face that is positioned frontward in the installation direction 56 which serves as a guide surface 35F. The guide surface 35F slopes diagonally downward and forward in the installation direction 56.

[0050] Another guide portion 44 protrudes downward

from the bottom wall 41 and extends in the depthwise direction 53, as shown in Figs. 2 and 3. A plate or projecting segment is available as the guide portion 44. Further, the guide portion 44 has a width smaller than that of the cartridge body 31. The guide portions 35 and 44 are adapted to be guided along guide grooves 108, 109 (Fig. 4) respectively provided on an inner perimeter of the cartridge installation portion 110 when the ink cartridge 30 is installed in or removed from the cartridge installation portion 110.

[0051] The cartridge installation portion 110 will be described next in detail with reference to Fig. 4.

[0052] The cartridge installation portion 110 includes a casing 101 that is a box shaped member formed with the opening 112 at a front side of the printer 10. As shown in Fig. 4, the casing 101 includes a top wall 101T, a bottom wall 101B opposite to the top wall 101T in the vertical direction 52, a front wall 101F opposite to the opening 112 in the depthwise direction 53 and a pair of side walls (now shown) extending in the installation/removal directions 50 and connecting the top wall 101T to the bottom wall 101B. Inner surfaces of the top wall 101T, bottom wall 101B, the front wall 101F and the side walls define an inner space for accommodating the ink cartridge 30 therein.

[0053] The inner surface of the top wall 101T is formed with four guide grooves 108 and the inner surface of the bottom wall 101B is formed with four guide grooves 109. Each pair of the guide grooves 108, 109 is adapted to receive the ink cartridge 30 of the corresponding color. The guide grooves 108, 109 extend in the depthwise direction 53 to receive the guide portions 35, 44 of the ink cartridge 30 respectively. Specifically, when the ink cartridge 30 is installed in or removed from the casing 101, the guide portion 35 is inserted into the corresponding guide groove 108, while the guide portion 44 is inserted into the corresponding guide groove 109. In this way, movement of the ink cartridge 30 in the installation/removal directions 50 can be guided by the guide grooves 108, 109.

[0054] The inner surface of the front wall 101F is provided with four connecting sections 103 at positions adjacent to the inner surface of the bottom wall 101B. Each connecting section 103 is positioned on the inner surface of the front wall 101F such that the connecting section 103 is aligned with the ink supply portion 37 of the ink cartridge 30 of the corresponding color when the ink cartridge 30 is accommodated within the casing 101.

[0055] Each connecting section 103 includes the ink needle 122 and a holding portions 121. The ink needle 122 is a resin needle of a tubular shape. Each ink needle 122 penetrates through the front wall 101F and is connected to the ink tube 20 of the corresponding color so that the ink can be supplied to the recording head 21 through the ink tube 20.

[0056] The holding portion 121 is formed in a cylindrical shape extending in the depthwise direction 53. The ink needle 122 coaxially extends through the holding portion 121. The holding portion 121 is adapted to accommodate therewithin the cylindrical-shaped ink supply portion 37 when the ink cartridge 30 is inserted into the cartridge installation portion 110 (See Figs. 6, 7 and 9). As shown in Fig. 6, upon installing the ink cartridge 30 into the cartridge installation portion 110, the ink supply portion 37 is hermetically inserted, by a predetermined depth, into an inner peripheral surface of the holding portion 121, As a result of insertion of the ink supply portion 37 into the holding portion 121, the ink needle 122 is inserted into the ink outlet port 71 of the ink supply portion 37. Thus, the ink accommodated in the ink chamber 36 can be flowed out of the ink chamber 36 and into the ink needle 122 (See Fig. 9),

[0057] Four light sensors 114 are disposed on the inner surface of the front wall 101F, each in correspondence with four kinds of ink cartridges 30 installable in the casing 101. Each optical sensor 114 is positioned above the corresponding connecting section 103, as shown in Fig. 4, and has a horseshoe-shaped exterior. These optical sensors 114 are arrayed in line in the widthwise direction 51.

[0058] The optical sensor 114 includes a light-emitting element, for example, light-emitting diode(LED) and a light-receiving element, for example, a phototransistor or a photoreceptor). The light-emitting element and the light-receiving element are disposed in opposition to each other in the widthwise direction 51 with a prescribed space interposed therebetween (not shown). The light-emitting element and the light-receiving element are respectively surrounded by casings which constitute the horseshoe-shaped exterior of the optical sensor 114. The light-emitting element emits light in one direction from the casing, while the light-receiving element receives the emitted light from light-emitting element. The detection section 33 and the detection portion 49 of the ink cartridge 30 are adapted to be entered into the space between the light-emitting element and the light-receiving element so that the optical sensor 114 can detect light transmitting state of the installed ink cartridge 30 at the detection position. The optical sensor 114 makes a determination based on whether or not the light emitted from the light-emitting element is received by the light-receiving element, A position where the optical sensor 114 can perform detection is called as "detection position," which is indicated by a circle in the optical sensor 114 in Figs. 4, 6, 7, 8, 11, 12 and 13. The detection position (the circle) is in coincidence with the light-emitting element or the light-receiving element in these drawings.

[0059] The casing 101 is also provided with four lock levers 145 (as a locking member). Each lock lever 145 serves to hold the ink cartridges 30 of the corresponding color installed on the cartridge installation portion 110 at an installed position. Each lock lever 145 is provided at an upper end of the opening 112, as shown in Fig. 4.

[0060] The lock lever 145 is of an arm shape and has a center portion through which a shaft 147 extends, The shaft 147 is supported to the casing 101. Thus, the lock

lever 145 is pivotally movable about an axis of the shaft 147 at the upper portion of the opening 112.

[0061] The lock lever 145 has a first side as an operation section 149 and a second side as an engagement section 146. The operation section 149 extends outward from the opening 112 for manually pivotally moving the lock lever 145.

[0062] The engagement section 146 extends into the casing 101. The engagement section 146 is adapted to be engaged with the engaging portion 43 of the ink cartridge 30. When engaged with the engaging portion 43, the engagement section 146 serves to retain the ink cartridge 30 in the installed position.

[0063] Although not shown, the lock lever 145 is provided with a coil spring to pivotally move the engaging section 146 in a clockwise direction in Fig. 6. If the operation section 149 is pushed downward when the engagement section 146 is in engagement with the engaging portion 43, the engagement section 146 is pivotally moved upward to be disengaged from the engaging portion 43.

[0064] Next, a control unit 90 of the printer 10 will be described with reference to Fig. 5.

[0065] The control unit 90 is a microcomputer for controlling overall operations of the printer 10. The control unit 90 includes a CPU 91, a ROM 92, a RAM 93, an EEPROM 94 and an ASIC 95, as shown in Fig. 5.

[0066] The ROM 92 stores various programs that the CPU 91 uses to control operations of the printer 10 and to execute processes described later. The RAM 93 temporarily stores data and signals used by the CPU 91 for the execution of the programs. The RAM 93 also serves as a work area for processing data. The EEPROM 94 stores settings and flags that should be saved even after power supply to the printer 10 is terminated. For example, the EEPROM 94 stores data (a look-up table) that indicates correlationship between output signals of the optical sensor 114 and types of the ink cartridges 30.

[0067] The ASIC 95 is connected to the optical sensor 114. Further, although not shown, the followings are also connected to the ASIC 95: a drive circuit for driving the sheet feed roller 23 and the pair of conveyor rollers 25 and the like; an input unit for inputting various instructions on the printer 10; and a display unit for displaying information on the printer 10.

[0068] The optical sensor 114 outputs analog electric signals (voltage signals or current signals) in accordance with intensities of light received at the light-receiving element. The control unit 90 monitors these electric signals outputted from the optical sensor 114 at prescribed timings. The control unit 90 determines that the electric signals are HIGH level when the electrical signals indicate levels (voltage values or current values) greater than or equal to a prescribed threshold value, while determining as LOW level when indicated levels of the electrical signals are smaller than the prescribed threshold value. In the present embodiment, the control unit 90 determines the output signals from the optical sensor 114 as LOW level when the light of the optical sensor 114 is blocked or attenuated at the detection position, and as HIGH level when the light is neither blocked nor attenuated.

[0069] Installing operation of the ink cartridge 30 into the cartridge installation portion 110 will be described next with reference to Figs. 6 through 10.

[0070] As shown in Fig. 6, the ink cartridge 30 is aligned with the opening 112 after opening the cover member (not shown) that normally covers the opening 112 such that the front wall 40 is at a leading side in the installation direction 56. The movement of the cover is detected by a sensor (not shown) which outputs signals in accordance with status of the cover. The control unit 90 detects whether the cover is open based on the output signals of this sensor. Upon detecting that the cover is opened, the control unit 90 controls the optical sensor 114 to emit infrared light. In other words, opening the cover serves as a trigger to activate the optical sensor 114. In response to the signals outputted from the optical sensor 114, the control unit 90 performs computations based on an operation clock of the CPU 91.

[0071] For installing the ink cartridge 30, a user holds by his fingers a portion of the cartridge body 31, the portion being close to the rear wall 42. The finger-held portion of the cartridge body 31 is not definite. However, according to an envisioned or assumed installation manner, the insertion of the ink cartridge 30 into the cartridge installation portion 110 is accompanied by user's looking down the opening 112 of the cartridge installation portion 110 provided that the printer 10 is often installed on a user's desk. Therefore, the user may often nip with his fingers a portion located in a region spanning between the vertical center portion and the upper end portion of the cartridge body 31. The cartridge body 31 of the ink cartridge 30 may have a printed marking that specifies nipping regions for user's access to the ink cartridge 30. Alternatively, an anti-slipping member may be provided to the cartridge body 31, or an anti-slipping shape may be partly formed at an outer surface of the cartridge body 31 for facilitating nipping of the cartridge body 31 by user's fingers.

[0072] In the initial stage of insertion of the ink cartridge 30 into the cartridge installation portion 110, the engagement section 146 of the lock lever 145 is brought into contact with the guide surface 35F of the guide portion 35. When the ink cartridge 30 is further inserted into the cartridge installation portion 110, the engagement section 146 rides over the guide portion 35. Thus, the lock lever 145 is pivotally moved in the counterclockwise direction as shown in Figs. 6 and 7.

[0073] Concurrently, the ink needle 122 is inserted into the ink outlet port 71 of the ink supply portion 37, and the inner end of ink needle 122 is brought into abutment with the valve body 74 of the ink supply valve 70 that is biased toward the ink outlet port 71 by the coil spring 73. Then, the ink cartridge 30 is further inserted into the cartridge installation portion 110 against the biasing force of the coil spring 73. In other words, the user pushes the rear

wall 42 of the ink cartridge 30 in the installation direction 56. In this way, the installing speed is moderated by the biasing force of the coil spring 73.

[0074] As above described, the ink outlet port 71 is provided at the front wall 40 at a position adjacent to the bottom wall 41 of the cartridge body 31. The user is assumed to nip with his fingers the cartridge body 31 at the portion adjacent to the rear wall 42 and between the vertical center portion and the upper end portion of the cartridge body 31. In other words, the ink outlet port 71 is located at a position below the portion at which the user nips the cartridge body 31. Therefore, when the ink needle 122 is brought into contact with the ink supply valve 70, the ink cartridge 30 is urged to be pivotally moved in the clockwise direction in Fig. 6.

[0075] More specifically, the ink cartridge 30 is biased to be pivotally moved upward at its rear side, about a position where the ink needle 122 and the ink supply valve 70 are in contact with each other (to be referred to as "contact position"), up to an extent maximum in the clockwise direction but within a range of a clearance between the ink cartridge 30 and the cartridge installation portion 110. In other words, the contact position functions as a fulcrum about which the cartridge body 31 is pivotally moved. This range of the clearance is determined based on gaps formed between the guide groove 108 and the guide portion 35, and between the guide groove 109 and the guide portion 44. While the ink needle 122 is being inserted into the ink supply portion 37, the ink needle 122 is constantly applied with a reaction force from the ink supply valve 70 and a silding frictional force with the ink outlet port 71. Therefore, as long as the user pushes the ink cartridge 30 into the cartridge installation portion 110 to completely insert the ink cartridge 30, the cartridge body 31 of the ink cartridge 30 is kept in a state where the ink cartridge 30 is inclined (tilted) with its front-side down and rear-side up as much as possible within the range of the clearance.

[0076] As shown in Fig. 7, when the ink cartridge 30 is further inserted into the cartridge installation portion 110 in the installation direction 56, the detection portion 49 passes the detection position of the optical sensor 114 at a timing T1. At the timing T1, since the detection portion 49 blocks or attenuates the light, the optical sensor 114 outputs a LOW level signal (see Figs. 10A and 10B). After the detection portion 49 has moved past the optical sensor 114, the optical sensor 114 detects the detection region 48 (the space between the detection portion 49 and the indicator 62) at a timing T2. At the timing T2, the output signal of the optical sensor 114 changes to the HIGH level from the LOW level, as shown in Figs, 10A and 10B, since nothing blocks or attenuates the light within the detection region 48. At the timing T2, even in a case that the light may be blocked or attenuated to some extent, the resultant amount of light is not less than the predetermined amount and therefore the optical sensor 114 still outputs the HIGH level signal. The control unit 90 constantly monitors the status of the output signals from the optical sensor 114. Upon detecting that the output signal of the optical sensor 114 has changed from the LOW level to the HIGH level at the timing T2, the control unit 90 stores a flag indicating that the detection portion 49 was detected. Meanwhile, as shown in Fig. 7, the ink needle 122 has been inserted further within the ink supply portion 37 and opens the ink supply valve 70. The ink is thus allowed to be supplied from the ink chamber 36 to the ink tube 20 via the ink needle 122.

[0077] When the ink cartridge 30 is further inserted in the installation direction 56, the ink cartridge 30 is completely accommodated within the casing 101 (in the installed position), as shown in Fig. 9. At this time, at a timing T3, the detection section 33 reaches the detection position of the optical sensor 114.

[0078] If more than a prescribed amount of ink is left within the ink chamber 36 when the ink cartridge 30 is in the installed position, the optical sensor 114 detects the indicator 62 of the sensor arm 60 at the timing T3. In other words, since the light is blocked or attenuated by the indicator 62, the output signal of the optical sensor 114 now indicates the LOW level at the timing T3 and thereafter.

[0079] If the amount of ink left in the ink chamber 36 is smaller than the prescribed amount when the ink cartridge 30 is in the installed position, the indicator 62 is located in its upper position within the detection section 33. Therefore, the optical sensor 114 does not detect the indicator 62 and continues to output the HIGH level signal after the timing T3 (as indicated by a thick dotted line in Figs. 10A and 10B).

[0080] As shown in Figs. 10A and 10B, the output signal of the optical sensor 114 first changes from HIGH level to LOW level (at the timing T1) and then changes again to HIGH level when the detection portion 49 passes the detection position of the optical sensor 114 (at the timing T2). Subsequently, when the indicator 62 reaches the detection position after passage of the detection region 48, the output signal changes to LOW level from HIGH level at the timing T3.

[0081] The control unit 90 can determine the types of the mounted ink cartridges 30 based on the output signals from the optical sensor 114 indicative of the detection of the detection portion 49. For example, each detection portion 49 may have a dimension in the installation/removal directions 50 determinative of types of the ink cartridge 30. That is, the dimensions may be determined in accordance with the types of the ink cartridges 30. Due to the differences in the dimensions of the detection elements 49, the optical sensor 114 outputs LOW level signals for different periods of time. The control unit 90 can therefore determine the types of the ink cartridges 30 based on the differences in the output signals of the optical sensor 114. Alternatively, differentiation of the dimensions of the detection elements 49 may be made according to the colors of the ink stored in the ink cartridges 30 and amounts of ink within the ink chamber 36.

[0082] In the installed position, the engaging portion

43 becomes aligned with the engagement section 146 as a result of movement of the ink cartridge 30 in the installation direction 56. The lock lever 145 is pivotally moved in the clockwise direction in Fig. 9 by the biasing force of the coil spring (not shown) so that the engagement section 146 is brought into engagement with the engaging portion 43. Therefore, the installed position can be maintained. The installation of the ink cartridge 30 into the cartridge installation portion 110 thus is completed.

[0083] The lock lever 145 can provide a lockable pivot position as shown in Fig. 9 where the engagement section 146 is engageable with the engaging portion 43, and an unlocked pivot position as shown in Fig. 6 where the engagement section 146 is not engaged with the engaging portion 43.

[0084] During the process of insertion of the ink cartridge 30, the ink cartridge 30 has been maintained in the state where the ink cartridge 30 is pivotally moved as much as possible in the clockwise direction about the fulcrum (the contact position) within the range of the clearance. In the meantime, the detection portion 49 and the indicator 62 sequentially reach the detection position of the optical sensor 114. Because of the pivotal movement of the cartridge body 31, the detection portion 49 and the detection section 33 are also made to be pivotally moved in the clockwise direction. Therefore, as shown in Fig. 8, the rear surface 47 of the detection portion 49 and the front surface 46 of the indicator 62, which define the detection region 48, are slanted relative to the installation/removal directions 50 (the horizontal direction) by an angle θ. The rear surface 47 and the front surface 46 are inclined such that the upper end portions thereof are positioned forward in the installation direction 56 relative to the lower end portions thereof.

[0085] Assume that a dimension D1 is a dimension between the front surface 46 and the rear surface 47 with respect to the installation/removal directions 50 when the front surface 46 and the rear surface 47 are parallel to the vertical direction 52 (see Fig. 10B). Also, as shown in Figs. 8 and 10A, a dimension D2 is a dimension between the front surface 46 and the rear surface 47 with respect to the installation/removal directions 50 when the front surface 46 and the rear surface 47 are inclined by the angle θ relative to the installation/removal directions 50. In the state where the cartridge body 31 is pivotally moved by the angle θ relative to the installation/removal directions 50 as in the present embodiment, the dimension D2 is larger than the D1 dimension ($D2=D1/\sin\theta$) at the detection position of the optical sensor 114. This means that, a time period between the timing T2 and the timing T3 can be made longer in case of the dimension D2 (Fig. 10A) than in case of the dimension D1 (Fig, 10B). In other words, the optical sensor 114 is allowed to have longer time until the detection of the passage of the front surface 46 (change from HIGH level signal to LOW level signal) since the detection of the passage of the rear surface 47 (change from LOW level signal to HIGH level signal) in the present embodiment due to the inclined posture (forward-tilting, front-down and rear-up posture) of the cartridge body 31.

[0086] With the above-described configuration, when the ink cartridge 30 is being loaded on the cartridge installation portion 110, the ink needle 122 is inserted into the ink outlet point 71 before the detection region 48 reaches the detection position of the optical sensor 114. Upon insertion of the ink needle 122 into the ink supply inlet 71, the ink cartridge 30 is applied with a resistant force that is generated at the contact position where the ink needle 122 and the ink supply valve 70 is in abutment with each other (the reaction force from the ink supply valve 70 and the silding frictional force with the ink outlet port 71). The resistant force acts in the removal direction 55, thereby serving to slow down the speed at which the user inserts the ink cartridge 30 into the cartridge installation portion 110 (i.e., the speed at which the detection region 48 approaches the detection position of the optical sensor 114).

[0087] Further, since the detection region 48 is provided at a position different from the ink outlet port 71 in the vertical direction 52, due to the generation of the resistant force generated at the contact position, the detection region 48 is pivotally moved about the contact position (fulcrum) during the user's installation operation of the ink cartridge 30 into the cartridge installation portion 110.

[0088] As a result, the dimension D2 (the dimension between the rear surface 47 and the front surface 46 with respect to the installation/removal directions 50 when the ink cartridge 30 is inclined with its front-side up and rear-side down) can become greater than the dimension D1 (the dimension between the rear surface 47 and the front surface 46 with respect to the installation/removal directions 50 when the ink cartridge 30 is NOT in the forward-tilting posture), as shown in Figs, 10A and 10B. With this structure, even though the dimension D1 is designed to be as small as possible in consideration of rise time and fall time of the output signals of the optical sensor 114 and the operation clock of the control unit 90, the detection region 48 can be accurately detected.

[0089] In the present embodiment, the detection region 48 serves as a region within which an optical characteristic of the light emitted from the optical sensor 114 can be altered (HIGH or LOW) in the installation direction 56. Such a region may be defined by members being aligned in the installation direction 56, the members having optical characteristics different from each other. Alternatively, members constituting the region may have optical characteristic identical to each other, but the optical sensor 114 may detect changes in intensities of light depending on availability of ink or a light-blocking member within the members.

[0090] Various modifications are conceivable.

[0091] A first modification to the present embodiment is shown in Fig. 11 wherein like parts and components are designated by the same reference numerals as those of the embodiment to avoid duplicating description,

[0092] In the first embodiment, the sensor arm 60 is

dispensed with. Since the sensor arm 60 is not provided, the light emitted from the light-emitting element is blocked or attenuated when there is ink within the detection section 33, while the light is transmitted when no ink is left within the detection section 33. As shown in Fig. 11, the detection section 33 has an inner surface 77 (a rear surface of the end wall 45) that extends in the widthwise direction 51 and the vertical direction 52. In the first modification, instead of the front surface 46 of the indicator 62, the inner surface 77 serves to define a detection region 148 along with the rear surface 47 of the detection portion 49. The inner surface 77 should be made of a light-transmissive material as in the forgoing embodiment so that the optical sensor 114 does not detect the passage of the end wall 45, and also the ink stored in the ink chamber 36 of the ink cartridge 30 should have a light-blocking characteristic (or at least attenuates the light to a level at which the optical sensor 114 can output the LOW level signal), such as black pigment ink. Therefore, the threshold value at which the control unit 90 determines whether the output signal of the optical sensor 114 is HIGH level or LOW level needs to be set appropriately in order to detect the light transmission status of the ink at the detection position.

[0093] Assume that a dimension D3 is a dimension between the rear surface 47 and the inner surface 77 with respect to the installation/removal directions 50 when the rear surface 47 and the inner surface 77 are parallel to the vertical direction 52. A dimension D4 (shown in Fig. 11) is a dimension between the rear surface 47 and the inner surface 77 with respect to the installation/removal directions 50 when the rear surface 47 and the inner surface 77 are slanted by the angle θ relative to the installation/removal directions 50 due to the pivotal movement of the cartridge body 31 of the ink cartridge 30. In the first modification, the dimension D4 is greater than the dimension D3 ($D4 = D3/\sin\theta$) at the detection position of the optical sensor 114. This configuration can also achieve the technical effects identical to those of the present embodiment.

[0094] A second modification to the present embodiment is shown in Fig. 12 wherein like parts and components are also designated by the same reference numerals as those of the embodiment to avoid duplicating description,

[0095] In the second modification, the optical sensor 114 may be so configured as to output the LOW level signal when an end wall 245 of the detection section 33 comes to the detection position of the optical sensor 114. More specifically, as shown in Fig. 12, the end wall 245 has a front surface 78 that opposes the rear surface 47 of the detection portion 49. This front surface 78 extends in the widthwise direction 51 and the vertical direction 52. A detection region 248 in the second modification is defined by the rear surface 47 and the front surface 78. The end wall 245 is made from a light-shielding material (or at least attenuates the light to a level at which the optical sensor 114 can output the LOW level signal), unlike the above-described embodiment. Further, the threshold value needs to be set such that the control unit 90 can detect passage of the front surface 78 (the signal outputted from the optical sensor 114 changes from HIGH level to LOW level when the front surface 78 reaches the detection position).

[0096] A dimension D5 is assumed to be a dimension between the rear surface 47 and front surface 78 with respect to the installation/removal directions 50 when the rear surface 47 and the front surface 78 are parallel to the vertical direction 52. A dimension D6 (shown in Fig. 12) is a dimension between the rear surface 47 and the front surface 78 with respect to the installation/removal directions 50 when the rear surface 47 and the front surface 78 are slanted by the angle θ relative to the installation/removal directions 50 due to the pivotal movement of the cartridge body 31 of the ink cartridge 30. In the second modification as well, the dimension D6 is greater than the dimension D5 ($D6 = D5/\sin\theta$) at the detection position of the optical sensor 114. Therefore, this configuration can also achieve the technical effects identical to those of the present embodiment.

[0097] A third modification to the present embodiment is shown in Fig. 13 wherein like parts and components are also designated by the same reference numerals as those of the embodiment to avoid duplicating description.

[0098] Surfaces that define the detection region 48 may not necessarily extend in the widthwise direction 51 and the vertical direction 52, as in the forging embodiment and modifications. As shown in Fig. 13, in the third modification, a rear surface 347 of the detection element 49 is sloped relative to the vertical direction 52 such that an upper portion of the rear surface 347 is positioned forward of its rear portion in the installation direction 56. A detection region 348 in the third modification is defined by the rear surface 347 and the front surface 78. The rear surface 347 and the front surface 78 are made of a material that does not transmit light (or at least attenuates the light) so that the optical sensor 114 can output LOW level signals when the light is irradiated onto the rear surface 347 and the front surface 78 respectively.

[0099] Here, a point P is defined as an intersection between the slanted rear surface 347 and a horizontal line passing through a center of the detection position. A dimension D7 is a horizontal distance between the front surface 78 and the point P but the front surface 78 is oriented in a direction parallel to the vertical direction 52. A dimension D8 is a horizontal distance between the front surface 78 and the point P when the front surface 78 is sloped by the angle θ relative to the installation/removal directions 50,

[0100] With this configuration as well, the dimension D8 can be made greater than the dimension D7 at the detection position of the optical sensor 114 due to the pivotal movement of the cartridge body 31 of the ink cartridge 30. Therefore, this configuration can also achieve the technical effects identical to those of the present embodiment. Conversely, instead of the rear surface 347,

the front surface 78 of the end wall 245 may be slanted relative to the vertical direction 52 such that the upper portion of the front surface 78 is located forward of its rear portion with respect to the installation direction 56.

Claims

1. An ink cartridge (30) installable in a cartridge installation portion (110) of a recording apparatus (100) in an installation direction, the ink cartridge comprising:

   a body (31) including a front surface (40), a rear surface (42) positioned to face the front surface (40) and an ink chamber (36) that accommodates ink therein;
   a first signal blocking portion (62, 45, 245) positioned at or adjacent to the front surface (40) and extending in a height direction perpendicular to the installation direction (56), wherein the first signal blocking portion (62, 45, 245) is configured to prevent a signal from the cartridge installation portion (110) from passing through the first signal blocking portion (62, 45, 245), the first signal blocking portion (62, 45, 245) having an upper end and a lower end opposite to the upper end in the height direction;
   a second signal blocking portion (49) projecting further forward than the first signal blocking portion (62, 45, 245) in the installation direction (56), wherein the second signal blocking portion (49) is configured to prevent the signal from passing therethrough when the second signal blocking portion (49) receives the signal; and
   an ink supply portion (37) provided at or adjacent to a lower end of the front surface (40) in the height direction and configured to supply the ink to outside from the ink chamber (36), wherein the ink supply portion (37) has an end (72) projecting further forward than the first signal blocking portion (62, 45, 245) and the second signal blocking portion (49) in the installation direction (56),
   wherein the upper end of the first signal blocking portion (62, 45, 245) is positioned further forward than the lower end of the first signal blocking portion (62, 45, 245) in the installation direction during installation of the ink cartridge (30) into the cartridge installation portion (110).

2. The ink cartridge according to claim 1, wherein the body (31) includes an upper surface (39) extending from the front surface (40) to the rear surface (42) and a bottom surface (41) opposite to the upper surface (39), and wherein the upper surface (39) is provided with an engaging portion (43) that is engaged with a locking member (145) for preventing the body (31) installed in the cartridge installation portion (110) from moving toward the rear surface (42).

3. The ink cartridge according to claim 1 or 2, further includes a signal transmissible portion configured to pass the signal therethrough and positioned between the first signal blocking portion (62, 45, 245) and the second signal blocking portion (49) in the installation direction (56).

4. The ink cartridge according to any of claims 1 to 3, wherein the upper end of the first signal blocking portion (62, 45, 245) is further forward than the lower end of the first signal blocking portion (62, 45, 245) when an ink needle (122) in the cartridge installation portion (110) contacts the ink supply portion (37).

5. The ink cartridge according to claim 4, wherein the first signal blocking portion (62, 45, 245) is positioned at a generally intermediate position of the front surface (40) in the height direction.

6. The ink cartridge according to any of claims 1 to 5, wherein the first signal blocking portion (62) is positioned within the body (31) and is configured to prevent the signal from the cartridge installation portion (110) from passing through the first signal blocking portion (62) based on an amount of the ink in the ink chamber (36).

7. The ink cartridge according to claim 6, further comprising an arm member (60) positioned within the ink chamber (36) and configured to change its posture between a light-transmission state and a low light-transmission state based on the amount of the ink in the ink chamber (36), wherein the arm member (60) has an indicator (62) positioned in the ink chamber (36) and functioning as the first signal blocking portion.

8. The ink cartridge according to any of claims 1 to 7, wherein the body (31) has a height in the height direction (52) and a thickness in a width direction (51) perpendicular to the installation direction (56) and the height direction (52), the height being greater than the width of the body (31),
   wherein the height direction (52) is a vertical direction, and
   wherein the ink supply portion (37) is positioned below the first signal blocking portion (62, 45, 245) and the second signal blocking portion (49) with respect to the height direction (52).

9. The ink cartridge according to any of claims 1 to 8, wherein the end (72) of the ink supply section (37) is formed with an ink outlet port (71), and the ink supply portion (37) further comprises an ink supply valve body (74) movably provided in the ink supply

portion (37) and a biasing member (73) that biases the ink supply valve body (74) in a direction to close the ink outlet port (71), an ink needle (122) being inserted into the ink outlet port (71) against a biasing force of the biasing member (73).

10. The ink cartridge according to claim 9, wherein the first signal blocking portion (62, 45, 245) and the second signal blocking portion (49) have protruding lengths smaller than a protruding length of the ink supply section (37) in the installation direction.

11. A recording apparatus (10) comprising:

a cartridge installation portion (110) configured to allow the ink cartridge (30) according to any one of claims 1 to 10 to be inserted thereinto in the installation direction;
the cartridge installation portion (110) comprising:

a guide portion (108, 109) guiding the body (31) in the installation direction (56) during the installation of the ink cartridge (30) in the cartridge installation portion (110);
an ink needle (122) insertable into the ink supply portion (37) when the body (31) is installed in the cartridge installation portion (110);
an optical sensor (114) positioned to be in coincidence with a detection region (48, 148, 248, 348) in the installation direction (56) upon insertion of the ink needle (122) into the ink supply portion (37), the detection region (48, 148, 248, 348) capable of altering an optical characteristic of light outputted from the optical sensor (114) during the installation of the ink cartridge (30) into the cartridge installation portion (110), the optical sensor (114) emitting a signal based on the optical characteristic of the light altered at the detection region (48, 148, 248, 348); and
a control unit (90) configured to determine information on the ink cartridge (30) in accordance with the signal outputted from the optical sensor (114).

12. The recording apparatus according to claim 11, wherein the detection region (48, 148, 248, 348) is defined by a first surface (46, 77, 78) generally extending in the height direction (52) and a second surface (47, 347) generally extending in the height direction and aligned with the first surface (46, 77, 78) in the installation direction, the first surface (46, 77, 78) having a first end and a second end further from the end (72) of the ink supply portion (37) than the first end to the end (72) of the ink supply portion (37) in the height direction (52), and the second surface (47, 347) having a third end and a fourth end farther from the end (72) of the ink supply portion (37) than the third end to the end (72) of the ink supply portion (37) in the height direction (52); and
wherein a gap is provided between the guide portion (108, 109) and the cartridge body (31) in the height direction (52) so that the ink cartridge (30) maintains its forward-tiling posture during installation operation as a result of contact of the ink needle (122) with the ink supply portion (37), whereupon the first surface (46, 77, 78) is slanted relative to the height direction (52) such that the second end is located forward of the first end in the installation direction (56), and the second surface (47, 347) is slanted relative to the height direction (52) such that the fourth end is located forward of the third end in the installation direction (56).

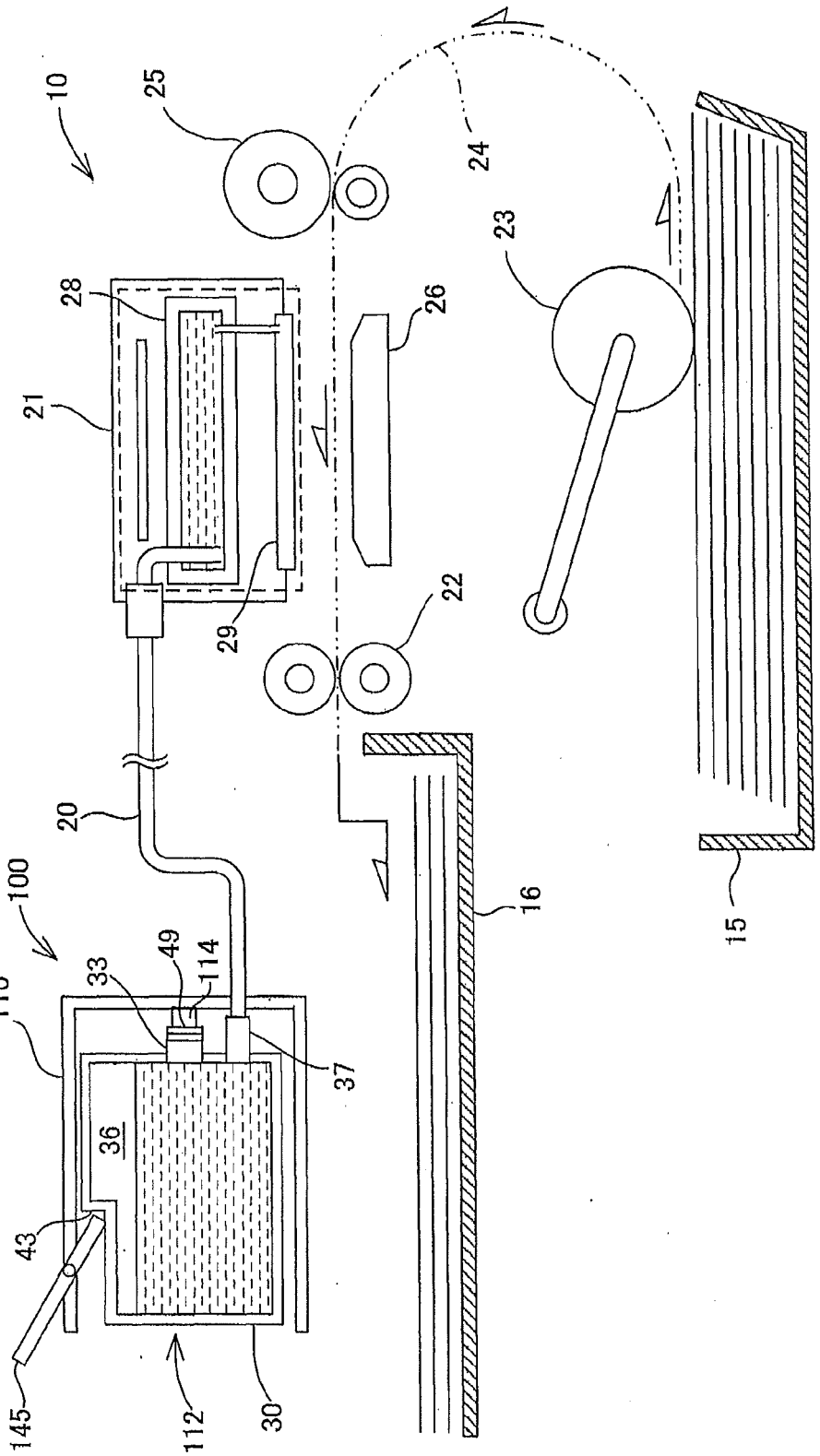
13. The recording apparatus as claimed in claim 11 or 12, wherein the second signal blocking portion (49) includes a detection portion (49) generally extending in the height direction (52) and having a rear surface (47, 347) in the installation direction (56) functioning as the second surface.

14. The recording apparatus according to claim 13, wherein the first signal blocking portion (45) includes an end wall (45) positioned rearward of the second signal blocking portion (49) in the installation direction (56) and generally extending in the height direction (52), the end wall (45) having a rear surface (77) in the installation direction (56) functioning as the first surface.

15. The recording apparatus according to claim 13, wherein the first signal blocking portion (245) includes an end wall (245) positioned rearward of the second signal blocking portion (49) in the installation direction (56) and generally extending in the height direction (52), the end wall (245) having a front surface (78) in the installation direction (56) functioning as the first surface.

16. The recording apparatus according to claim 13, wherein, when the indicator (62) serves as the first signal blocking portion (62), the indicator (62) is positioned rearward of the second signal blocking portion (49) in the installation direction (56) and has a front surface (46) in the installation direction functioning as the first surface.

FIG. 1


10
25
24
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26
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16
15
110
33
49
114
37
36
43
145
112
30

FIG. 2

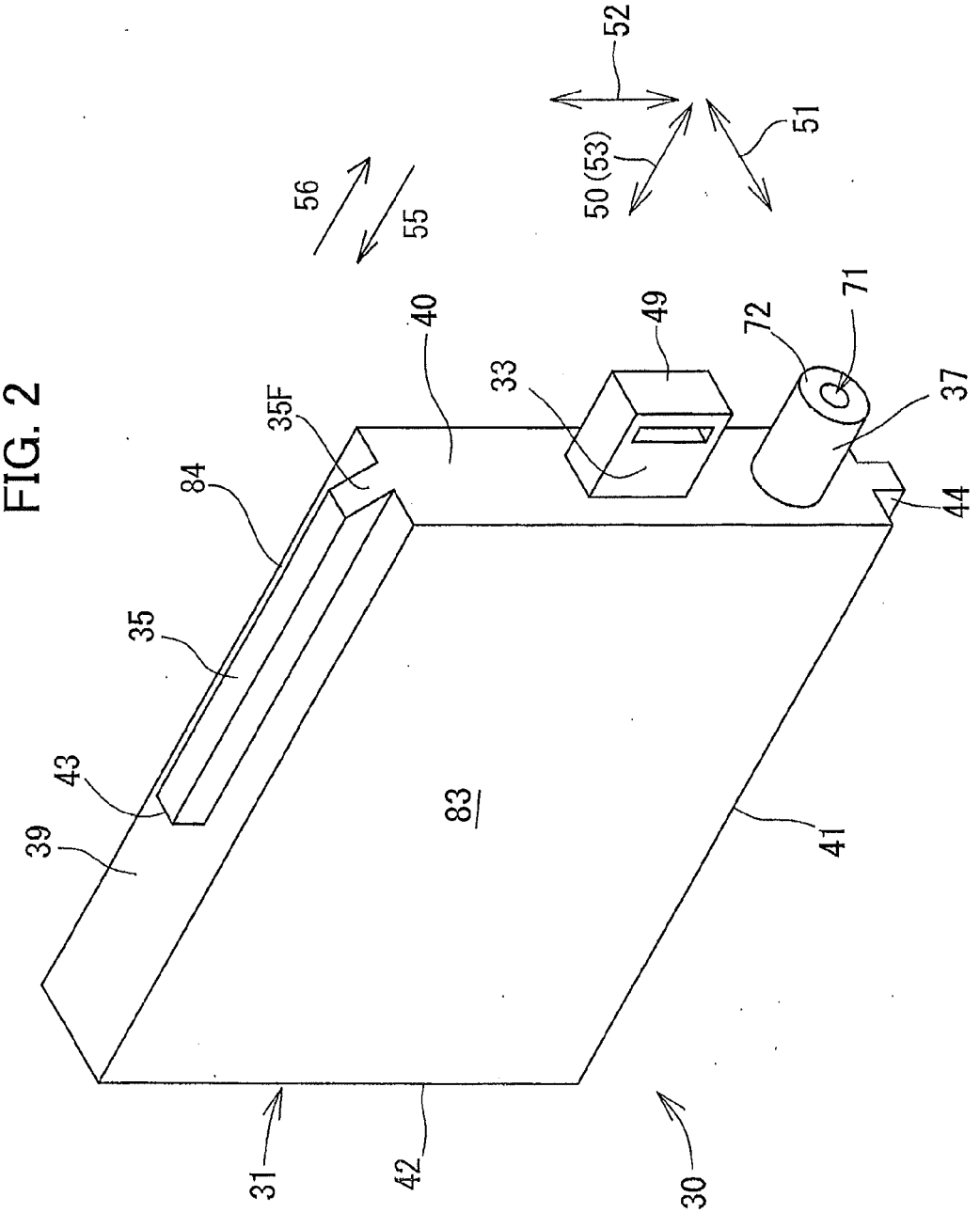

FIG. 3

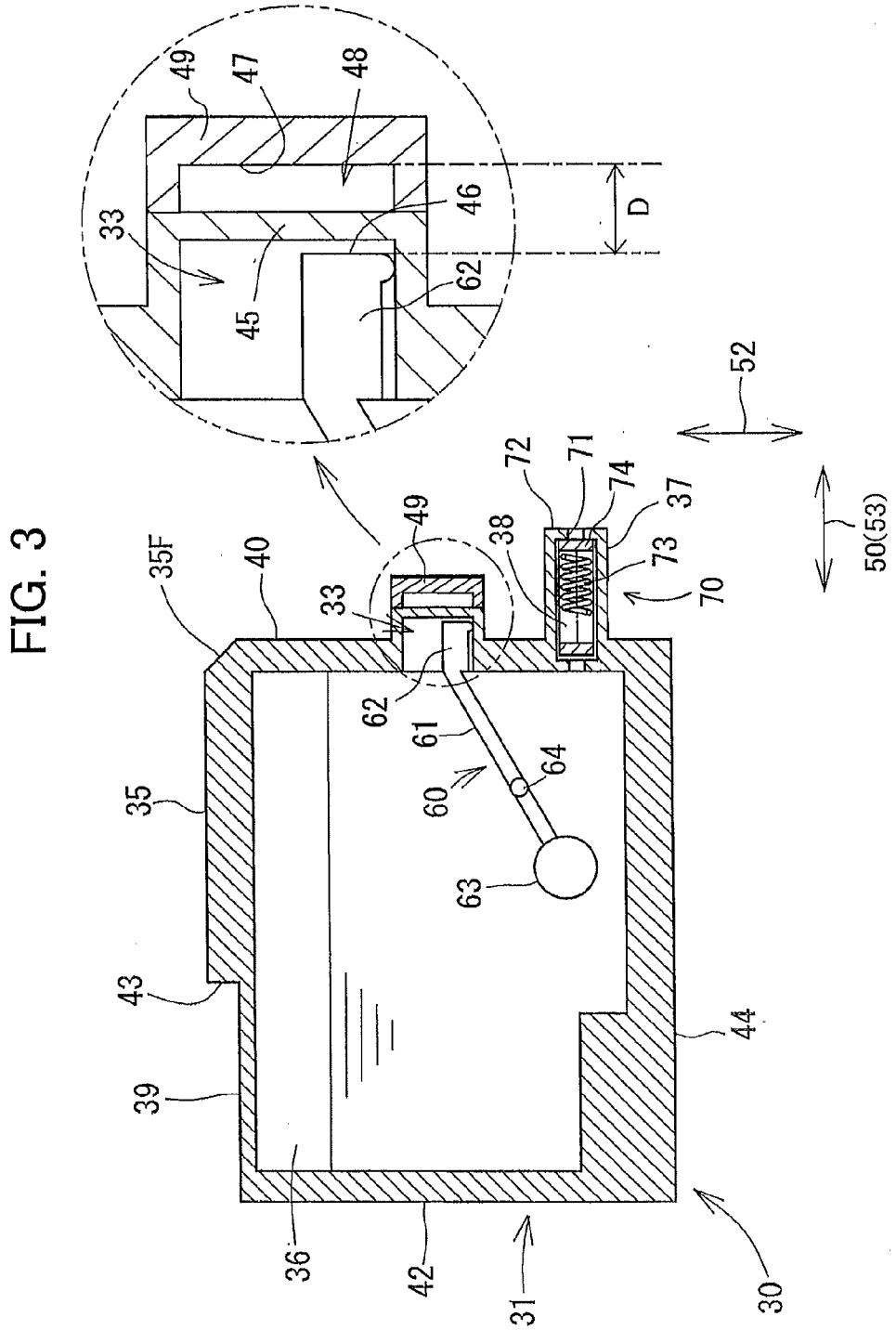
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FIG. 4

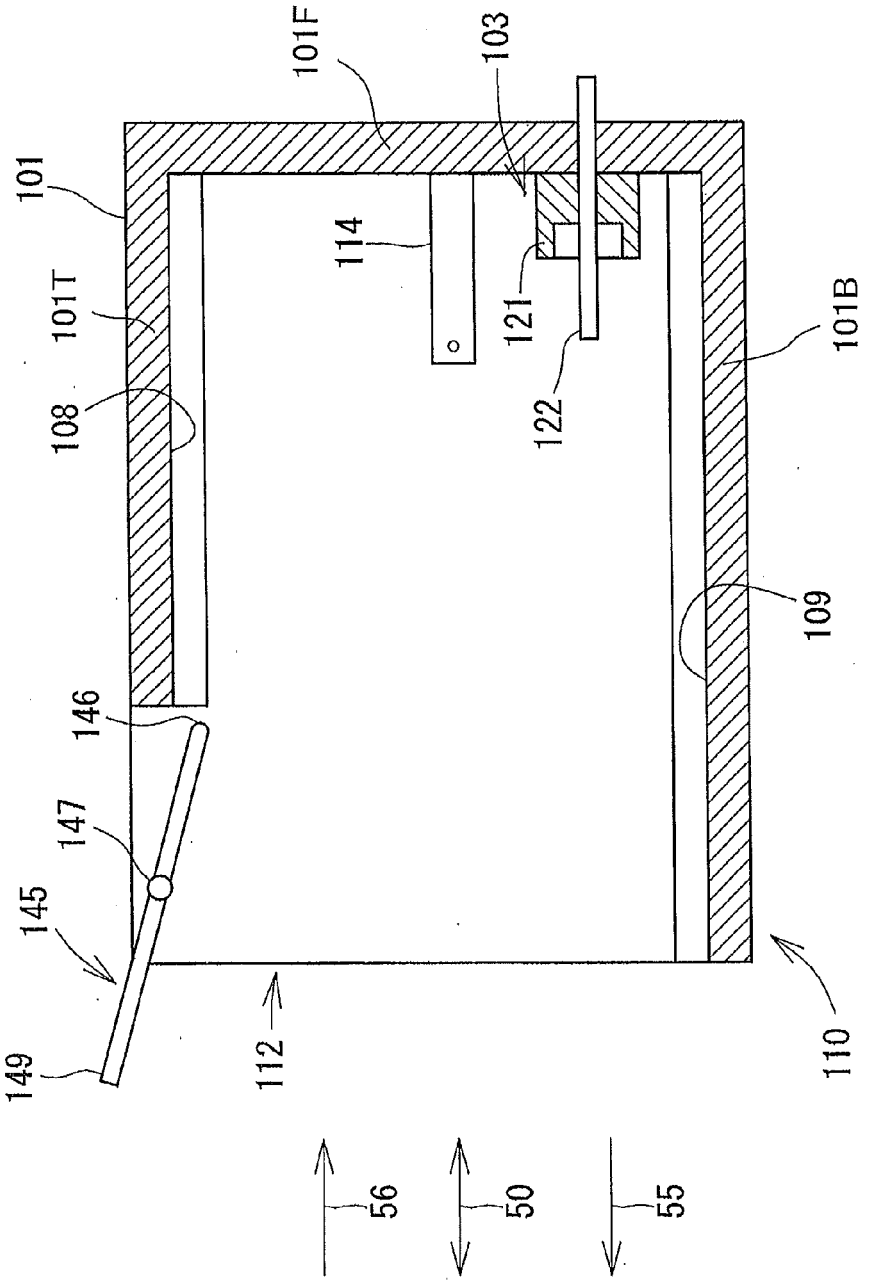
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FIG. 5

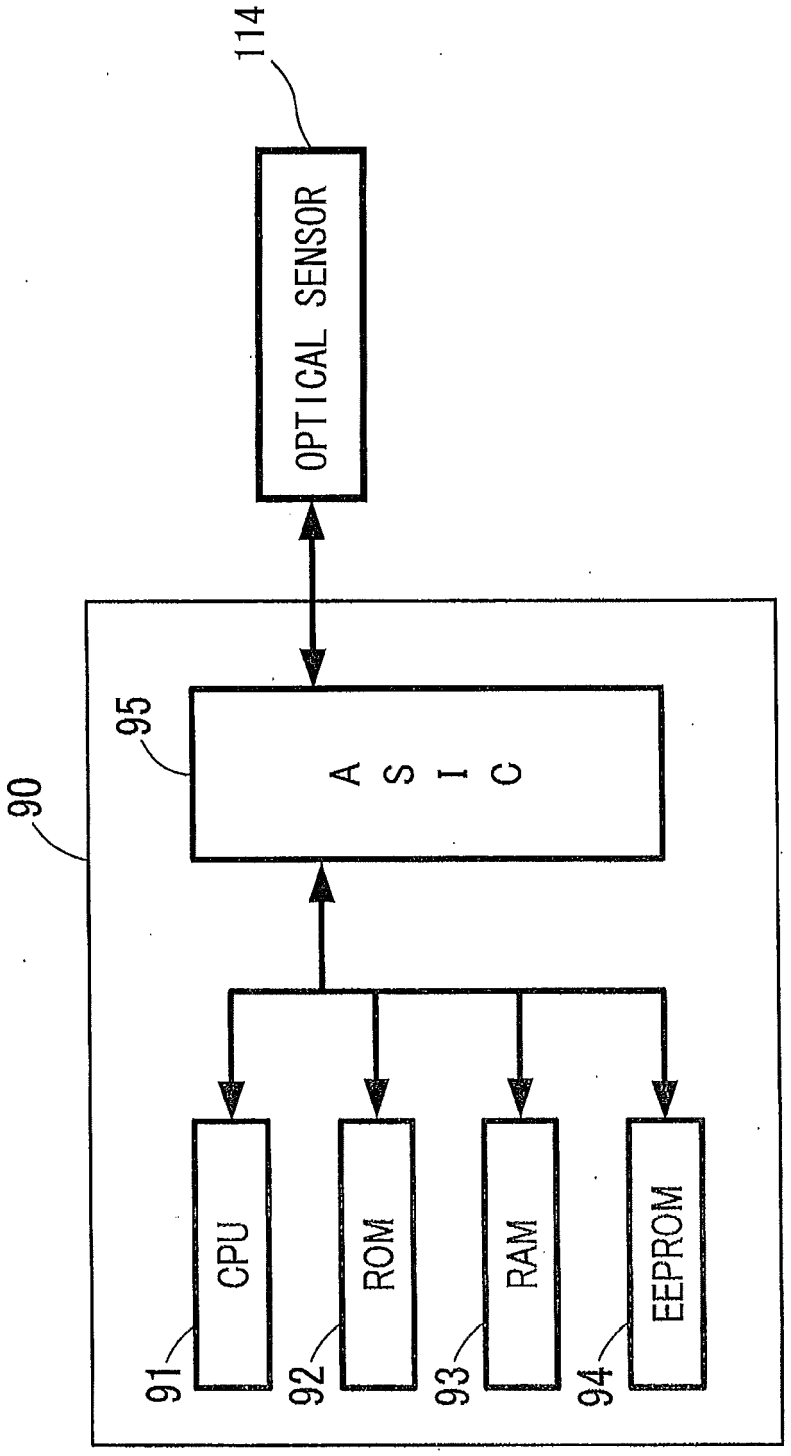

FIG. 6

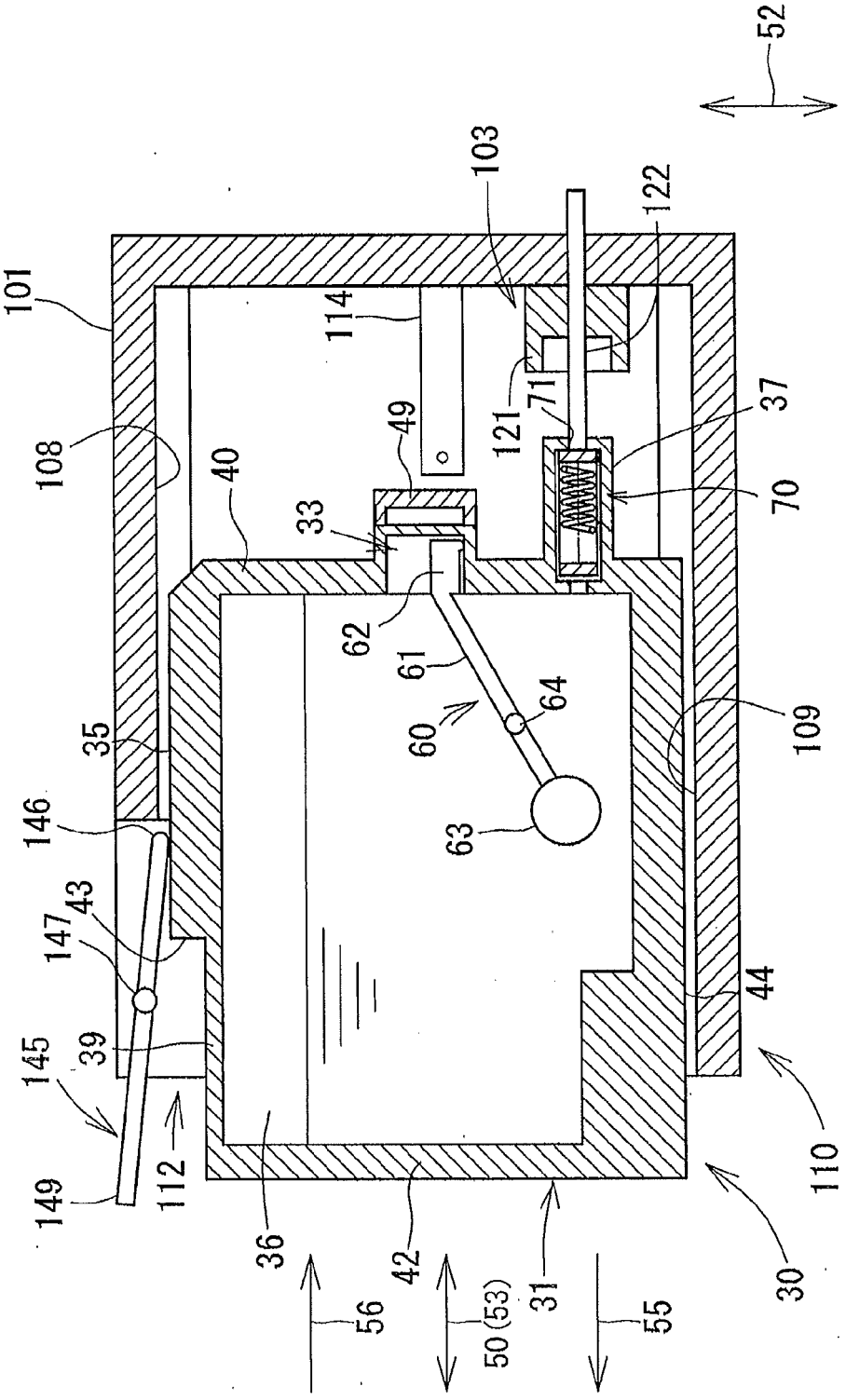
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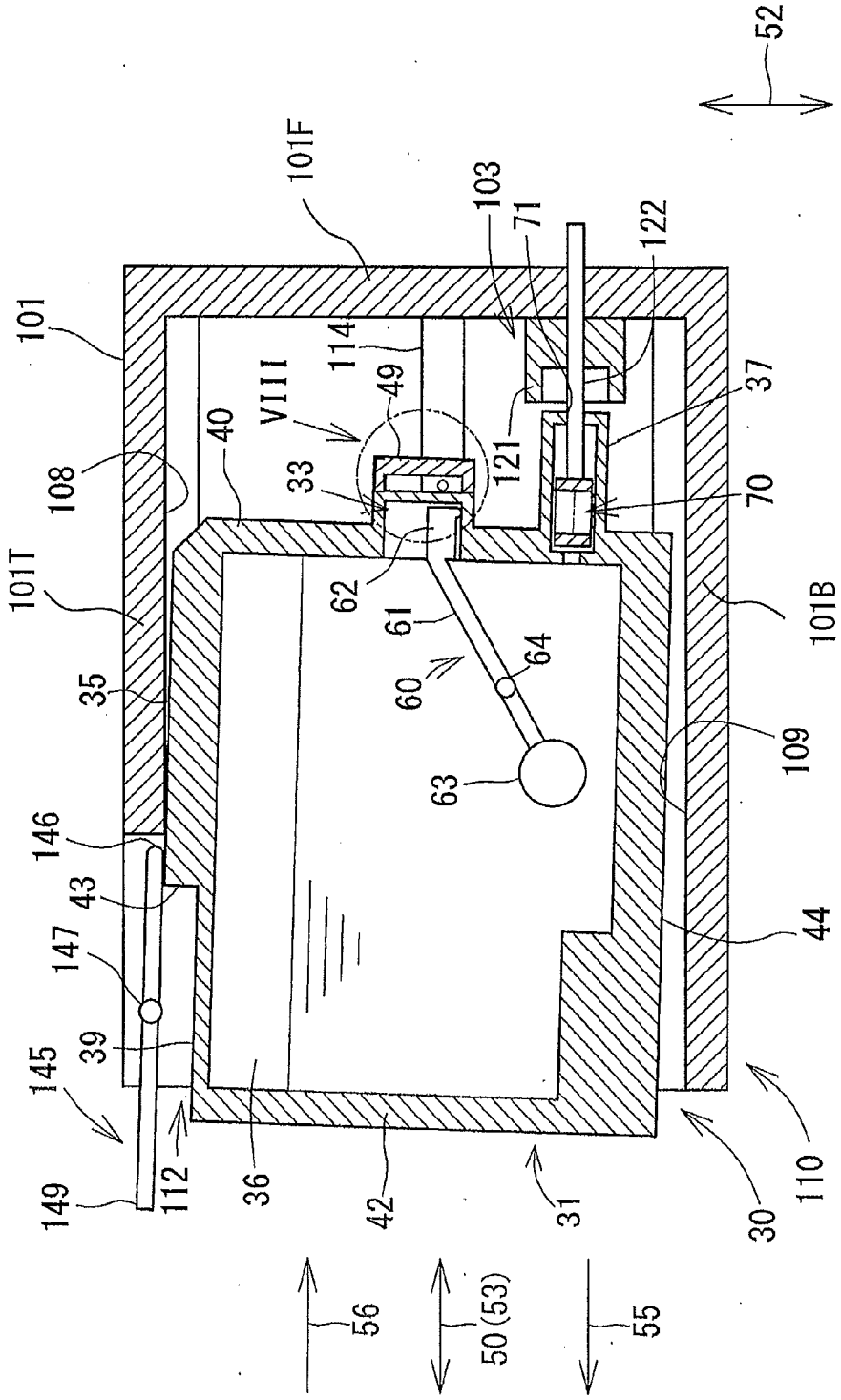
FIG. 7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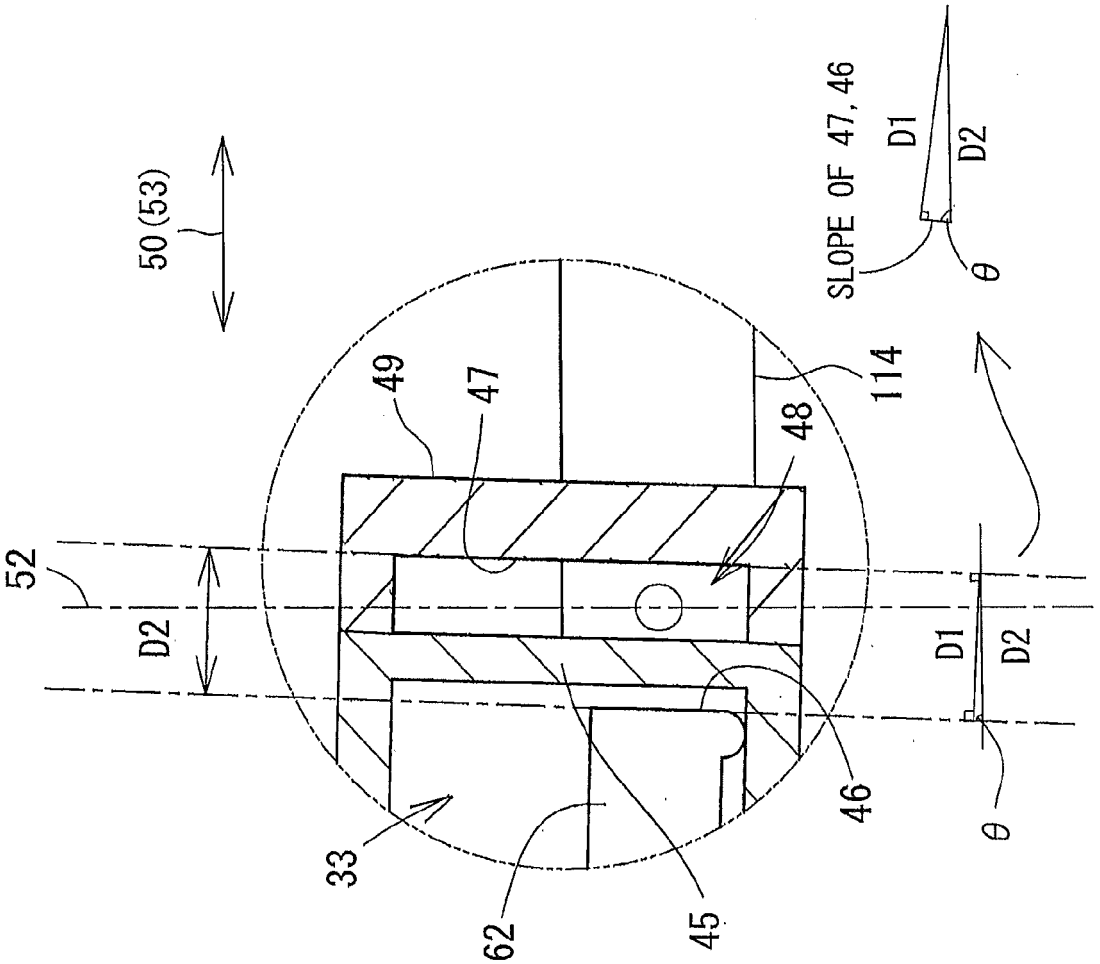

FIG. 8

FIG. 9

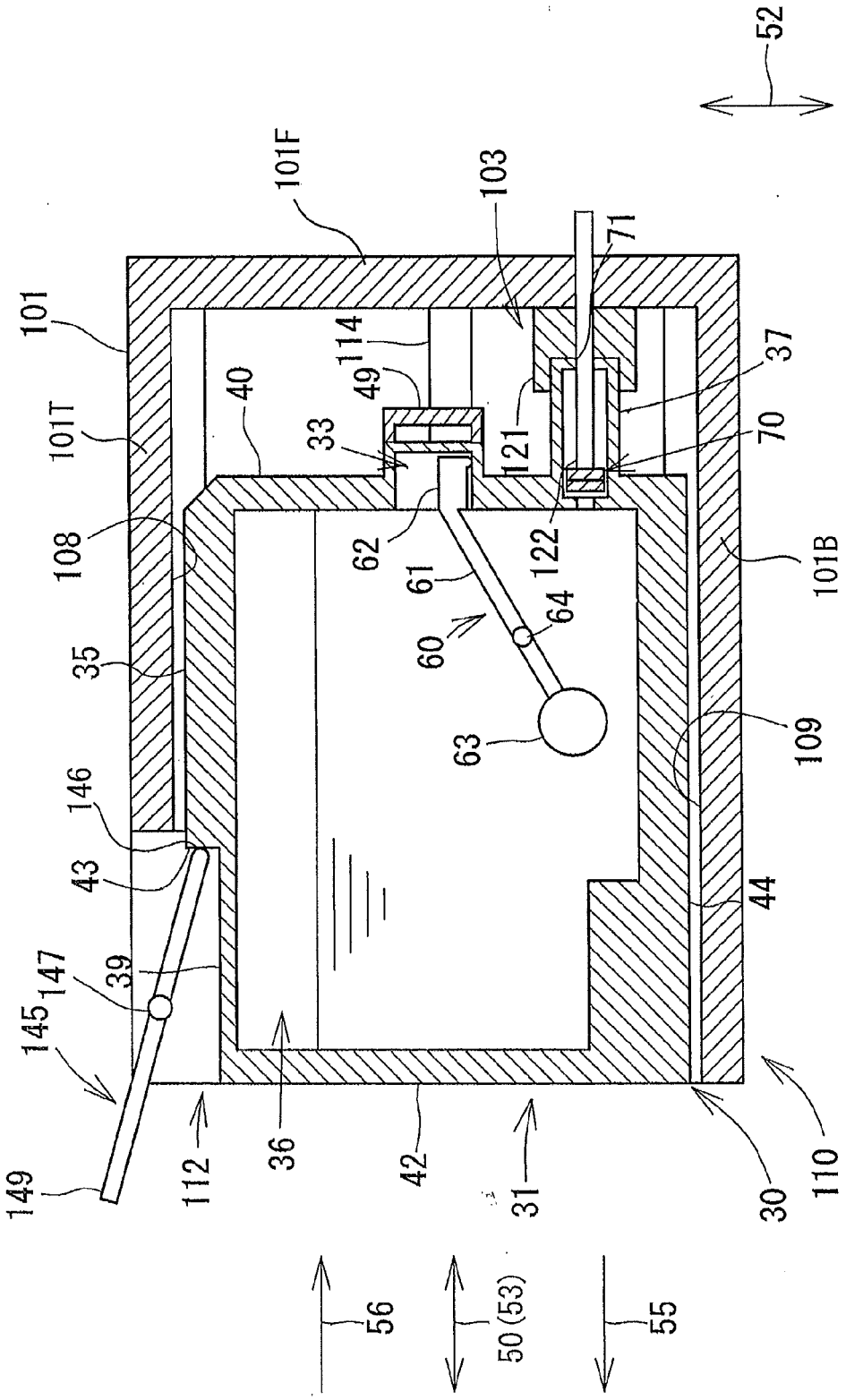
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FIG. 10A

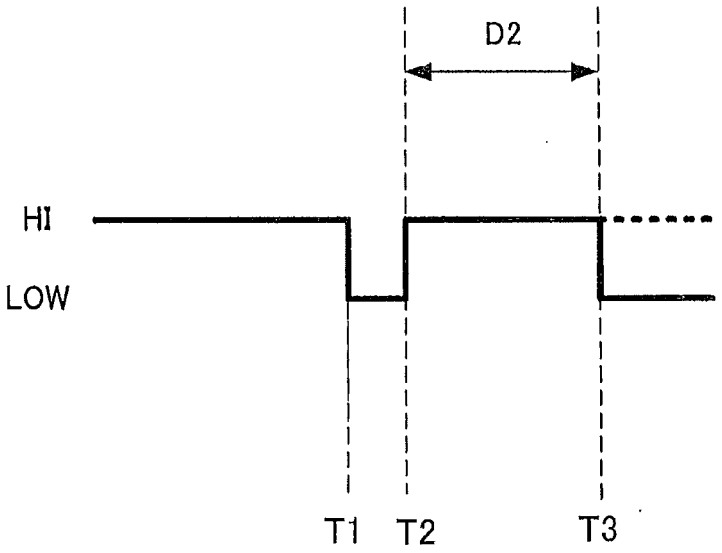
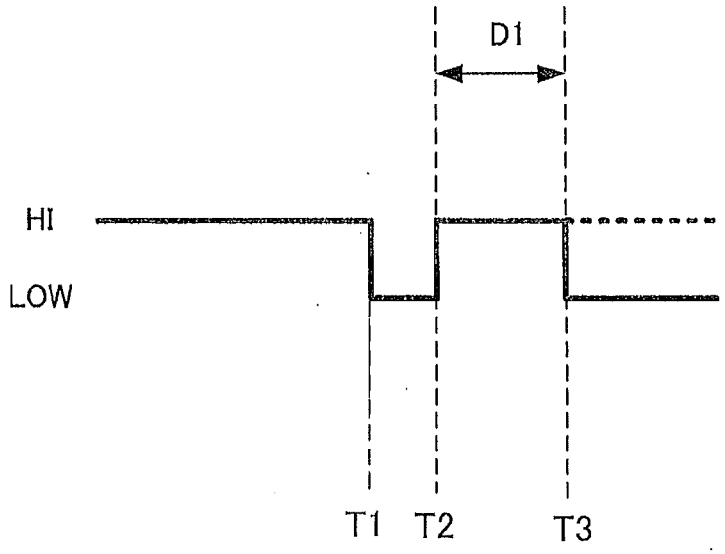


FIG. 10B



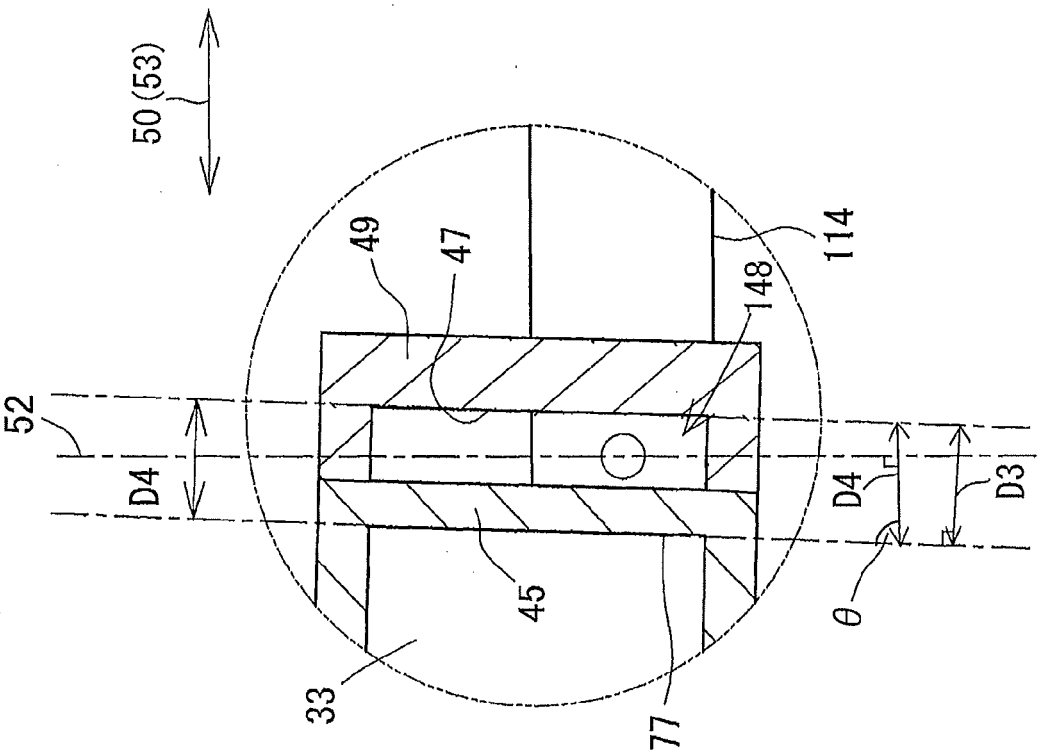


FIG. 11

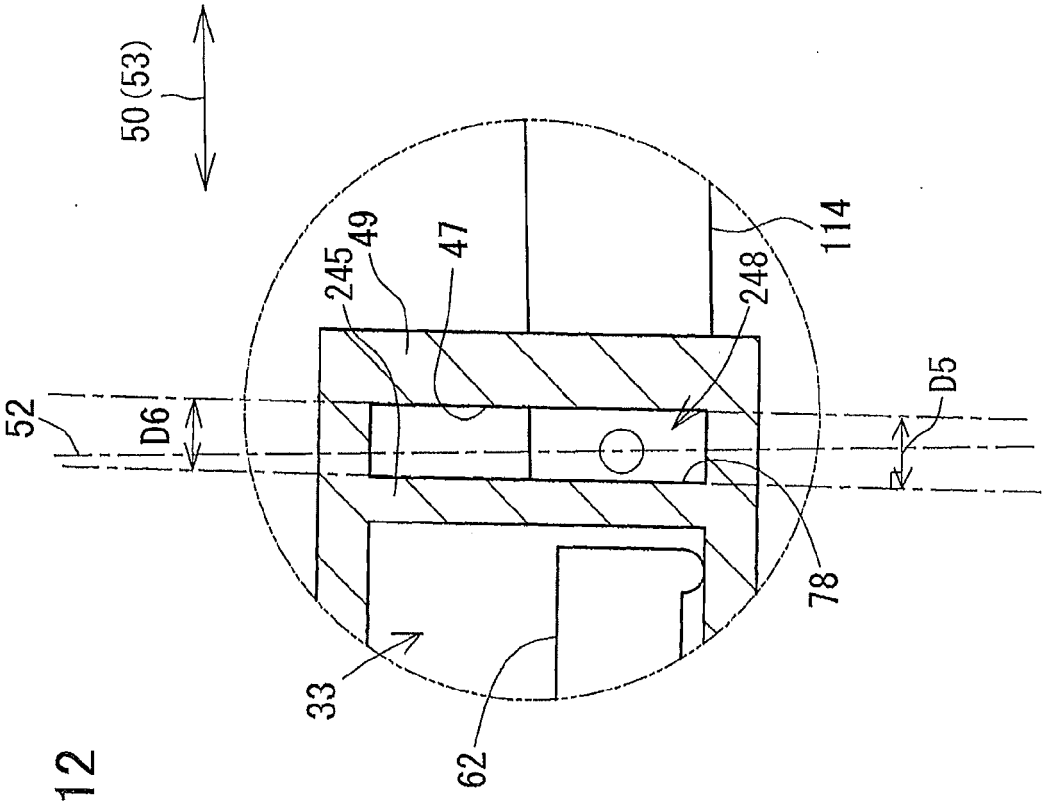


FIG. 12

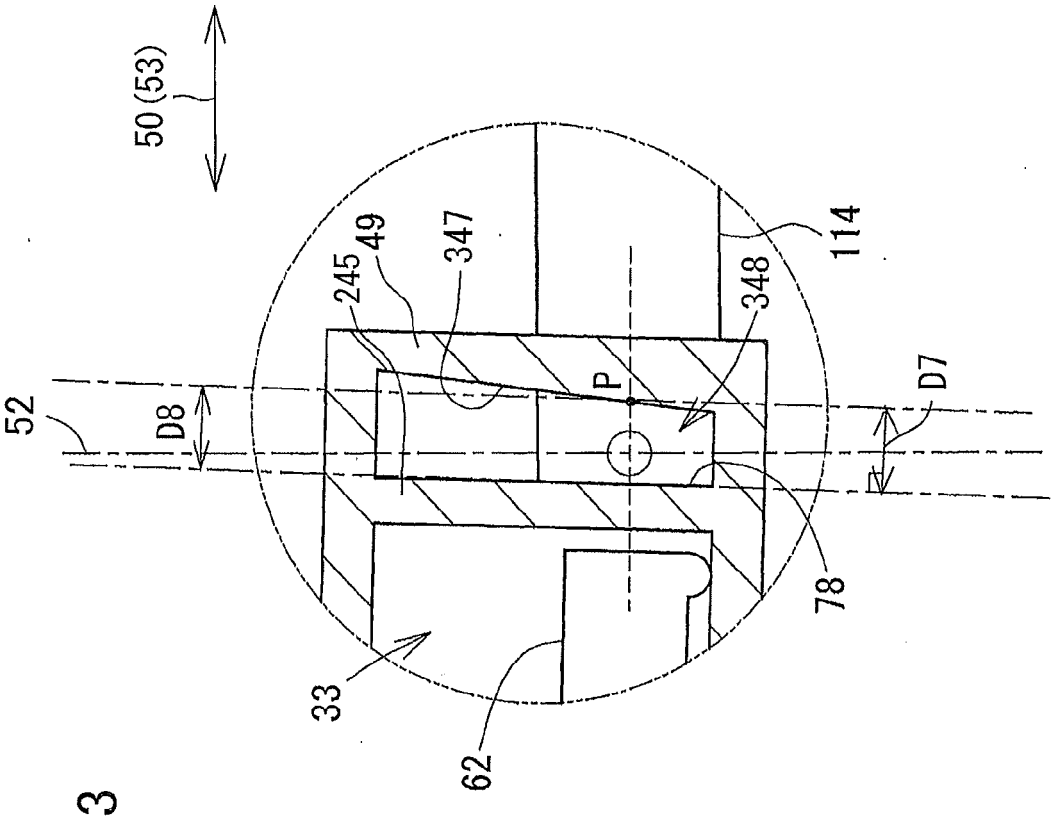


FIG. 13

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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