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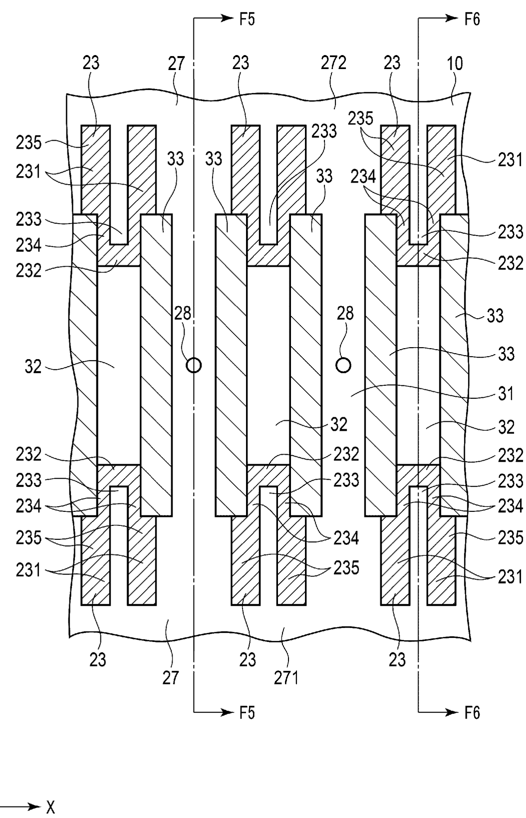
(54) **LIQUID EJECTION HEAD**

(57) A liquid ejection head according to an embodiment includes a plurality of sidewalls and a cover member. The plurality of sidewalls form a plurality of grooves that alternately configure a plurality of pressure chambers and a plurality of air chambers. The cover member includes an inner wall section formed between a pair of the sidewalls configuring both sides of each of the air chambers and an outer wall section disposed further on an outer side than end portions of the pair of sidewalls. The cover member includes a void section in at least a part thereof and closes an opening end portion of the air chamber.

FIG. 4



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Description

FIELD

[0001] Embodiments described herein relate generally to a liquid ejection head.

BACKGROUND

[0002] In recent years, high productivity is requested for an inkjet head. An increase in speed and an increase in a liquid droplet amount are problems in the inkjet head. For example, a share-mode shared-wall inkjet head generally adopts so-called three-cycle driving for sharing the same driving element in two pressure chambers and simultaneously driving one third of a plurality of arrayed chambers as pressure chambers. An independent driving head is also developed that uses both sides of a pressure chamber to be driven as dummy pressure chambers and drives one pressure chamber with independent two driving elements. For example, a structure is also developed in which a large number of grooves are formed in a piezoelectric body, entrances of the grooves are closed by photosensitive resin walls or the like at every other grooves, and the grooves not closed in the entrances are used as pressure chambers and the closed grooves are used as air chambers to perform independent driving.

[0003] In the inkjet head explained above, if walls for sealing the air chambers are formed using photosensitive resin, peeling is sometimes caused between the photosensitive resin and the driving elements, which are bonding surfaces, by contraction reaction of the photosensitive resin. If the formation of the walls of the air chambers is insufficient, ink intrudes into the air chambers, natural vibration periods of the pressure chambers adjacent to each other deviate and pressure chamber natural vibration frequency fluctuation in a plane increases, causing deterioration in ejection performance. If the air chambers are filled with the ink, a (crosstalk) phenomenon in which vibration is transmitted to the adjacent pressure chambers occurs. As a result, deterioration and omission of ink arrival accuracy occur, causing deterioration in ejection performance.

[0004] Related art is described in, for example, JP-A-2015-189031.

DISCLOSURE OF INVENTION

[0005] To this end, there is provided a liquid ejection head comprising a plurality of sidewalls forming a plurality of grooves that alternately configure a plurality of pressure chambers and a plurality of air chambers; and a cover member including an inner wall section formed between a pair of the sidewalls configuring both sides of each of the air chambers and an outer wall section disposed further on an outer side than end portions of the pair of sidewalls, the cover member including a void section in at least a part thereof and closing an opening end portion of the air chamber. Preferred embodiments are set out in dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG. 1 is a perspective view illustrating an inkjet head according to an embodiment;
FIG. 2 is an exploded perspective view illustrating a configuration of a part of the inkjet head;
FIG. 3 is a perspective view in which a main part of the inkjet head illustrated in FIG. 2 is partially enlarged;
FIG. 4 is a sectional view illustrating a configuration of the inkjet head in an enlarged form;
FIG. 5 is a sectional view of the inkjet head illustrated in FIG. 4 taken along an F5-F5 line;
FIG. 6 is a sectional view of the inkjet head illustrated in FIG. 4 taken along an F6-F6 line;
FIG. 7 is a partially enlarged sectional view in which a part of a cross section of the inkjet head illustrated in FIG. 2 taken along an F7-F7 line is enlarged;
FIG. 8 is a partially enlarged sectional view for explaining a driving operation of the inkjet head;
FIG. 9 is a schematic diagram illustrating an inkjet printer according to the embodiment; and
FIG. 10 is a sectional view illustrating a configuration of a part of an inkjet head according to another embodiment in an enlarged form.

DETAILED DESCRIPTION

[0007] An object of embodiments is to provide a liquid ejection head that can ensure a satisfactory ejection characteristic.

[0008] A liquid ejection head according to an embodiment includes a plurality of sidewalls and a cover member. The plurality of sidewalls form a plurality of grooves that alternately configure a plurality of pressure chambers and a plurality of air chambers. The cover member includes an inner wall section formed between a pair of the sidewalls configuring both sides of each of the air chambers and an outer wall section disposed further on an outer side than end portions of the pair of sidewalls. The cover member includes a void section in at least a part thereof and closes an opening end portion of the air chamber.

[0009] A configuration of an inkjet head 10, which is a liquid ejection head, according to a first embodiment is explained below with reference to FIGS. 1 to 8. FIG. 1 is a perspective view illustrating an inkjet head according to the first embodiment. FIG. 2 is an exploded perspective view of a part of the inkjet head. FIG. 3 is a perspective view illustrating a configuration of a part of the inkjet head in an enlarged form. FIGS. 4 to 7 are sectional views illustrating configurations of parts of the inkjet head in an enlarged form. FIG. 8 is an explanatory diagram of a driving state. X, Y, and Z in the figures respectively indicate a first direction, a second direction, and a third direction orthogonal to one another. Note that, in this embodiment, directions are explained based on a posture in which a parallel arrangement direction of nozzles 28 and pressure chambers 31 of the inkjet head 10 extends along an X axis, an extending direction of the pressure chambers 31 is along a Y axis, and an ejecting direction of liquid is along a Z axis. However, the directions are not limited to these directions.

[0010] As illustrated in FIGS. 1 to 7, the inkjet head 10 is a share-mode shared-wall inkjet head of a so-called side shooter type. The inkjet head 10 is a device for ejecting ink and is mounted, for example, on the inside of an inkjet printer. For example, the inkjet head 10 is an inkjet head of an independent driving type in which the pressure chambers 31 and air chambers 32 are alternately disposed. The air chambers 32 are air chambers to which ink is not supplied and do not include the nozzles 28.

[0011] The inkjet head 10 includes an actuator base 11, a nozzle plate 12, and a frame 13. The actuator base 11 is an example of a base material. An ink chamber 27 to which ink, which is an example of liquid, is supplied is formed on the inside of the inkjet head 10.

[0012] Further, the inkjet head 10 includes components such as a circuit board 17 that controls the inkjet head 10 and a manifold 18 that forms a part of a path between the inkjet head 10 and an ink tank.

[0013] As illustrated in FIG. 2, the actuator base 11 includes a substrate 21 and a pair of actuators 22.

[0014] The substrate 21 is formed in a rectangular plate shape by ceramics such as alumina. The substrate 21 includes a flat mounting surface. The pair of actuators 22 is bonded to the mounting surface of the substrate 21. A plurality of supply holes 25 and a plurality of discharge holes 26 are formed in the substrate 21.

[0015] As illustrated in FIGS. 2, 5, and 6, pattern wires 211 are formed on the substrate 21 of the actuator base 11. The pattern wires 211 are formed by, for example, a nickel thin film. The pattern wires 211 include a common pattern and an individual pattern and are configured in a predetermined pattern shape connected to electrode layers 34 formed in the actuators 22. For example, the pattern wires 211 are formed in positions avoiding the supply holes 25 and the discharge holes 26.

[0016] The supply holes 25 are provided side by side in the longitudinal direction of the actuators 22 between the pair of actuators 22 in the center of the substrate 21. The supply holes 25 communicate with an ink supply section of the manifold 18. The supply holes 25 are connected to the ink tank via the ink supply section. The supply holes 25 supply the ink in the ink tank to the ink chamber 27.

[0017] The discharge holes 26 are provided side by side in two rows across the supply holes 25 and the pair of actuators 22. The discharge holes 26 communicate with an ink discharge section of the manifold 18. The discharge holes 26 are connected to the ink tank via the ink discharge section. The discharge holes 26 discharge the ink in the ink chamber 27 to the ink tank.

[0018] The pair of actuators 22 is bonded to the mounting surface of the substrate 21. The pair of actuators 22 is provided on the substrate 21 side by side in two rows across the supply holes 25. Each of the actuators 22 is formed by plate-like two piezoelectric bodies formed by, for example, lead zirconate titanate (PZT). The two piezoelectric bodies are pasted together such that polarization directions thereof are directions opposite to each other with respect to the thickness direction thereof. The actuators 22 are bonded to the mounting surface of the substrate 21 by, for example, an epoxy adhesive having a thermosetting property. As illustrated in FIG. 2, the actuators 22 are disposed side by side in parallel in the ink chamber 27 to correspond to the nozzles 28 disposed side by side in two rows. The actuators 22 divide the ink chamber 27 into a first common chamber 271 in which the supply holes 25 are opened and two second common chambers 272 in which the discharge holes 26 are opened.

[0019] The width in the latitudinal direction of the actuator 22 gradually increases from the top side toward the substrate side. A sectional shape in a direction (the latitudinal direction) orthogonal to the longitudinal direction of the actuator 22 is formed in a trapezoidal shape. A side surface section 221 of the actuator 22 includes inclined surfaces inclined with respect to the second direction and the third direction. The top of the actuator 22 is bonded to the nozzle plate 12. The actuator 22 includes a plurality of pressure chambers 31 and a plurality of air chambers 32. The actuator 22 includes a plurality of sidewalls 33 functioning as driving elements and includes, among the plurality of sidewalls 33, grooves configuring the pressure chambers 31 and the air chambers 32. In other words, the sidewalls 33 function as columnar driving elements formed among the grooves forming the pressure chambers 31 and the air chambers 32.

[0020] FIG. 4 is a sectional view in which one of the actuators 22 of the inkjet head 10 illustrated in FIG. 2 is partially enlarged. FIG. 5 is a sectional view of the groove configuring the pressure chamber 31 of the inkjet head 10 illustrated in FIG. 4 taken along F5-F5. FIG. 6 is a sectional view of the groove configuring the air chamber 32 of the inkjet head 10 illustrated in FIG. 4 taken along F6-F6.

[0021] As illustrated in FIGS. 2, 5, and 6, the bottom surface section of the groove and the principal plane of the substrate 21 are connected by the inclined sidewall sections 221. The pressure chambers 31 and the air chambers 32 are alternately disposed. The pressure chambers 31 and the air chambers 32 respectively extend in a direction crossing the longitudinal direction of the actuator 22. The plurality of the pressure chambers 31 and the plurality of air chambers 32 are disposed in parallel in the first direction (the X axis in the figures), which is the longitudinal direction of the actuator 22. In this embodiment, for example, the width dimension in the

X direction of the grooves is fixed in the depth direction extending in the Z direction. A cross section orthogonal to the Y direction, which is an extending direction of the grooves, is formed in a rectangular shape.

[0022] Note that a shape of the pressure chambers 31 and a shape of the air chambers 32 may be different. The sidewalls 33 are formed between the pressure chambers 31 and the air chambers 32 and deformed according to a driving signal to change the volume of the pressure chambers 31.

[0023] The electrode layers 34 are respectively provided on the inner wall surfaces of the pressure chambers 31 and the air chambers 32 and the side surface section 221 of the actuator base 11. The electrode layers 34 are formed by a conductive film such as a nickel thin film. The electrode layers 34 lead from the inner surface sections of the grooves onto the substrate 21 through the side surface section 221 and are connected to the pattern wires 211. For example, the electrode layers 34 are formed on at least one of the side surface sections and the bottom surface sections of the sidewalls 33.

[0024] The plurality of pressure chambers 31 communicate with the plurality of nozzles 28 of the nozzle plate 12 bonded to the tops of the pressure chambers 31. Both ends in the second direction of each of the pressure chambers 31 communicate with the ink chamber 27. That is, one end portion is opened to the first common chamber 271 of the ink chamber 27 and the other end portion is opened to the second common chambers 272 of the ink chamber 27. Therefore, ink flows in from one end portion of the pressure chamber 31 and flows out from the other end portion. The ink may flows in from both the end portions of the pressure chamber 31.

[0025] As illustrated in FIGS. 3 and 6, one side in the third direction (the Z direction) of the air chamber 32 is closed by the nozzle plate 12 bonded to the top of the air chamber 32. For example, both the ends in the second direction of the plurality of air chambers 32 are closed by the cover members 23. That is, the cover members 23 are respectively disposed between the first common chamber 271 of the ink chamber 27 and the air chamber 32 and between the air chamber 32 and the second common chambers 272. Both ends of the air chamber 32 is separated from the ink chamber 27. Therefore, the air chamber 32 configures an air chamber into which ink does not flow.

[0026] For example, the cover members 23 are respectively provided at both the ends in the Y direction (the second direction), which is an extending direction of the air chambers 32. The cover members 23 connect end portions of the sidewalls 33 and separate the common chambers 271 and 272 and the air chamber 32. The cover members 23 include void sections 233 at least in a part of the cover members 23 and close an opening end portion of the air chamber 32.

[0027] Each of the cover members 23 includes a pair of extending walls 231 extending in the extending direction of the air chamber 32 and a connecting wall 232 that connects the pair of extending walls 231 and includes the void section 233 formed between the pair of extending walls 231. For example, the void section 233 smaller than the width between the pair of sidewalls 33 is formed between the pair of extending walls 231. That is, the pair of extending walls 231 is separated in the first direction (the X direction), which is a deforming direction of the pair of extending walls 231. For example, the cover member 23 is formed in a reverse C shape or a U shape opened toward the outer side in the extending direction of the air chamber 32 in a plan view as illustrated in FIG. 4.

[0028] The pair of extending walls 231 is wall members extending in the extending direction and the depth direction of the subject air chamber 32. The pair of extending walls 231 integrally includes inner wall sections 234 formed on the inner surfaces of a pair of sidewalls configuring both the sides in an arranging direction of the air chambers 32 and outer wall sections 235 disposed further on the outer side than end portions of the pair of sidewalls. For example, the pair of extending walls 231 is formed in a range from a counter surface of the nozzle plate 12 to the bottoms of the grooves over the entire length of the depth of the grooves in the Z direction (depth direction). The void section 233 is formed between the pair of extending walls 231. As an example, a width dimension in the X direction of the void section 233 is fixed over the entire length in the extending direction. The inner wall sections 234 have smaller thickness dimension in the arranging direction and are configured thinner than the outer wall sections 235 in the arranging direction.

[0029] The void section 233 is a slit-like space having a width dimension smaller than the width dimension of the air chamber 32 in the width direction. The void section 233 is formed between the end portions of the sidewalls 33 on both the sides in the extending direction (for example, the void section 233 may partially extend into the air chamber 32 between the sidewalls 33). The void section 233 is formed over end portions of the pair of extending walls 231 from a position beside the end portions of the sidewalls 33 in a direction away from the air chamber 32 and the connecting wall 232 (for example, the void section 233 may partially extend outside the air chamber 32 between the sidewalls 33) . In this embodiment, the void section 233 opened toward the outer side is formed to the connecting wall 232 provided further on the inner side than the end portions of the sidewalls 33.

[0030] The connecting wall 232 is a wall-like member that closes the air chamber 32 in a position further on the inner side in the extending direction of the air chamber 32 than the end portions of the sidewalls 33. The connecting wall 232 is a wall member extending along a surface orthogonal to the longitudinal direction of the air chamber 32. The connecting wall 232 connects the end portions on the inner side of the pair of extending walls 231 in the arranging direction and is formed from the counter surface of the nozzle plate 12 to the bottoms of the grooves in the Z direction to cover the end portion of the air chamber 32.

[0031] The cover member 23 is made of a material having hardness lower than the hardness of a piezoelectric material. For example, the cover member 23 is made of a resin material softer than the sidewalls 33. As an example, the cover member 23 is made of a photosensitive resin material. For example, after photosensitive resin is applied to both end portions of the air chamber 32, the cover member 23 is formed by exposing the photosensitive resin to light and hardening the photosensitive resin in the shape of the cover member 23. Peeling of the cover member 23 by contraction stress at the time of the hardening can be prevented because the void section 233 is interposed between the pair of extending walls 231 separated from each other in the X direction, which is a vibrating direction of the sidewalls 33.

[0032] The nozzle plate 12 is formed by, for example, a rectangular film made of polyimide. The nozzle plate 12 faces the mounting surface of the actuator base 11. In the nozzle plate 12, a plurality of nozzles 28 piercing through the nozzle plate 12 in the thickness direction thereof are formed.

[0033] The plurality of nozzles 28 are provided as many as the pressure chambers 31 and are disposed to respectively face the pressure chambers 31. The plurality of nozzles 28 are disposed in the first direction (the X direction) and arrayed in two rows to correspond to the pair of actuators 22. Each of the nozzles 28 is formed in a tubular shape, the axis of which extends in the third direction. For example, even if the diameter of the nozzles 28 is fixed, the nozzles 28 may have a shape reduced in diameter toward the center or the distal end portion thereof. The nozzles 28 are disposed to face halfway portions in the extending direction of the pressure chambers 31 formed in the pair of actuators 22 and respectively communicate with the pressure chambers 31. The nozzles 28 are disposed one by one in positions corresponding to the positions between both the end portions of the pressure chambers 31, for example, the longitudinal direction centers of the pressure chambers 31.

[0034] The frame 13 is formed in a rectangular frame shape by, for example, a nickel alloy. The frame 13 is interposed between the mounting surface of the actuator base 11 and the nozzle plate 12. The frame 13 is bonded to the mounting surface of the actuator base 11 and the nozzle plate 12. That is, the nozzle plate 12 is attached to the actuator base 11 via the frame 13.

[0035] The manifold 18 is bonded to a side of the actuator base 11 opposite to the nozzle plate 12. An ink supply section, which is a flow path communicating with the supply holes 25, and an ink discharge section, which is a flow path communicating with the discharge holes 26, are formed on the inside of the manifold 18.

[0036] The circuit board 17 illustrated in FIG. 1 is a film carrier package (FCP). The circuit board 17 includes a film 51 on which a plurality of wires are formed, the film 51 being made of flexible resin, and a driving IC 52 connected to the plurality of wires of the film 51. The driving IC 52 is electrically connected to the electrode layers 34 via the wires of the film 51 and the pattern wires 211.

[0037] On the inside of the inkjet head 10 configured as explained above, the ink chamber 27 surrounded by the actuator base 11, the nozzle plate 12, and the frame 13 is formed. That is, the ink chamber 27 is formed between the actuator base 11 and the nozzle plate 12. For example, the ink chamber 27 is partitioned into three sections in the second direction (the Y direction) by the two actuators 22 and includes the two second common chambers 272, which are common chambers in which the discharge holes 26 are opened, and the first common chamber 271, which is a common chamber in which the supply holes 25 are opened. The first common chamber 271 and the second common chambers 272 communicate with the plurality of pressure chambers 31.

[0038] FIG. 7 is an enlarged sectional view of a portion where the inkjet head 10 illustrated in FIG. 2 is taken along F7-F7 in the longitudinal direction. FIG. 8 is a partially enlarged sectional view illustrating an example of a state in which the sidewalls 33 illustrated in FIG. 7 is subjected to share mode deformation.

[0039] In the inkjet head 10 configured as explained above, ink circulates between the ink tank and the ink chamber 27 through the supply holes 25, the pressure chambers 31, and the discharge holes 26. The driving IC 52 applies a driving voltage to the electrode layers 34 of the pressure chambers 31 via the wires of the film 51 according to, for example, a signal input from a control unit of the inkjet printer to thereby cause a potential difference between the electrode layers 34 of the pressure chambers 31 and the electrode layers 34 of the air chambers 32 to selectively subject the sidewalls 33 to share mode deformation. The driving IC 52 deforms the sidewalls 33 formed between the pressure chambers 31 and the air chambers 32 according to a driving signal to change the volume of the pressure chambers 31.

[0040] As indicated by a solid line in FIG. 8, the sidewalls 33 undergo the share mode deformation, whereby the volume of the pressure chambers 31 in which the electrode layers 34 are provided increases and the pressure in the pressure chambers 31 decreases. Consequently, the ink in the ink chamber 27 flows into the pressure chambers 31.

[0041] In a state in which the volume of the pressure chambers 31 increases, the driving IC 52 applies a driving voltage having the opposite potential to the electrode layers 34 of the pressure chambers 31. Consequently, as indicated by an alternate long and two short dashes line in FIG. 8, the sidewalls 33 undergo the share mode deformation, the volume of the pressure chambers 31 in which the electrode layers 34 are provided decreases, and the pressure in the pressure chambers 31 increases. Consequently, the ink in the pressure chambers 31 is pressurized and ejected from the nozzles 28.

[0042] A method of manufacturing the inkjet head 10 is explained. First, a piezoelectric member, on which a plurality of grooves are formed, is stuck to the plate-like substrate 21 by an adhesive or the like, machining is applied to the piezoelectric member using a dicing saw, a slicer, or the like to mold the actuator base 11 having a predetermined external shape. Note that, for example, a block-like base member having thickness equivalent to a plurality of actuator bases 11 may be formed and then divided to manufacture the plurality of actuator bases 11 having a predetermined shape.

[0043] Subsequently, the electrode layers 34 and the pattern wires 211 are formed on the inner surfaces of the grooves configuring the pressure chambers 31 and the air chambers 32 and the surface of the substrate 21. Consequently, the electrode layers 34 and the pattern wires 211 are respectively formed in predetermined parts on the surface of the actuator base 11.

[0044] Subsequently, both the ends of the air chambers 32 are closed by forming the cover members 23 at the end portions of the air chambers 32. For example, photosensitive resin is filled in the grooves configuring the air chambers 32 and target parts are hardened by exposure to form the cover members 23. Alternatively, after the photosensitive resin is hardened, parts to be the void sections 233 are removed to form the slit-like void sections 233 and photosensitive resin layers are molded in a reverse C shape, whereby the cover members 23 are formed.

[0045] The actuator base 11 is assembled to the manifold 18 and the frame 13 is stuck to one surface of the substrate 21 of the actuator base 11 by an adhesive sheet of thermoplastic resin.

[0046] Then, the assembled frame 13, the tops of the sidewalls 33 of the actuators 22, and the surfaces of the cover members 23 on the nozzle plate 12 side are polished to be the same surface. The nozzle plate 12 is bonded and attached to the polished surfaces of the tops of the sidewalls 33, the frame 13, and the cover members 23. At this time, the nozzles 28 are positioned to face the pressure chambers 31. Further, the driving IC 52 and the circuit board 17 are connected to, via a flexible printed board, the pattern wires 211 formed on the principal plane of the substrate 21 as illustrated in FIG. 1, whereby the inkjet head 10 is completed.

[0047] An example of an inkjet printer 100 including the inkjet head 10 is explained below with reference to FIG. 9. The inkjet printer 100 includes a housing 111, a medium supply unit 112, an image forming unit 113, a medium discharge unit 114, a conveying device 115, and a control unit 116.

[0048] The inkjet printer 100 is a liquid ejecting device that performs image formation processing on paper P by, for example, ejecting liquid such as ink while conveying the paper P as a recording medium, which is an ejection target object, along a predetermined conveying path A leading from the medium supply unit 112 to the medium discharge unit 114 through the image forming unit 113.

[0049] The housing 111 configures an outer frame of the inkjet printer 100. A discharge port for discharging the paper P to the outside is provided in a predetermined part of the housing 111.

[0050] The medium supply unit 112 includes a plurality of paper feeding cassettes and is configured to be capable of stacking and storing pluralities of pieces of the paper P of various sizes.

[0051] The medium discharge unit 114 includes a paper discharge tray configured to be capable of holding the paper P discharged from the discharge port.

[0052] The image forming unit 113 includes a supporting section 117 that supports the paper P and a plurality of head units 130 disposed to face one another above the supporting section 117.

[0053] The supporting section 117 includes a conveying belt 118 provided in a loop shape in a predetermined region where image formation is performed, a support plate 119 that supports the conveying belt 118 from the rear side thereof, and a plurality of belt rollers 120 provided on the rear side of the conveying belt 118.

[0054] The supporting section 117 supports the paper P on a holding surface, which is the upper surface of the conveying belt 118, and feeds the conveying belt 118 at predetermined timing according to rotation of the belt rollers 120 to thereby convey the paper P to a downstream side.

[0055] The head units 130 include a plurality of inkjet heads 10 (for four colors), ink tanks 132 functioning as liquid tanks respectively mounted on the inkjet heads 10, connection flow paths 133 that connect the inkjet heads 10 and the ink tanks 132, and circulation pumps 134, which are circulating units. The head units 130 are circulation-type head units that always circulate liquid in the ink tanks 132 and the pressure chambers 31, the air chambers 32, and the ink chambers 27 fabricated on the inside of the inkjet head 10.

[0056] In this embodiment, the head units 130 include the inkjet heads 10 for four colors of cyan, magenta, yellow, and black and the ink tanks 132 that respectively store inks of these colors. The ink tanks 132 are connected to the inkjet heads 10 by the connection flow paths 133. The connection flow paths 133 includes supply flow paths connected to supply ports of the inkjet heads 10 and collection flow paths connected to discharge ports of the inkjet heads 10.

[0057] Not-illustrated negative pressure control devices such as pumps are coupled to the ink tanks 132. The negative pressure control devices control the insides of the ink tanks 132 to a negative pressure according to water head values of the inkjet head 10 and the ink tanks 132 to form a meniscus having a predetermined shape with the inks supplied to the nozzles 28 of the inkjet head 10.

[0058] The circulation pumps 134 are, for example, liquid feeding pumps configured by piezoelectric pumps. The circulation pumps 134 are provided in the supply flow paths. The circulation pumps 134 are connected to a driving circuit of the control unit 116 by wires and are configured to be controllable by a CPU (Central Processing Unit). The circulation pumps 134 circulate liquid in a circulation flow path including the inkjet head 10 and the ink tanks 132.

[0059] The conveying device 115 conveys the paper P along the conveying path A leading from the medium supply unit 112 to the medium discharge unit 114 through the image forming unit 113. The conveying device 115 includes a plurality of guide plate pairs 121 and a plurality of conveying rollers 122 disposed along the conveying path A.

[0060] The plurality of guide plate pairs 121 respectively include pair of plate members disposed to face each other across the conveyed paper P and guide the paper P along the conveying path A.

[0061] The conveying rollers 122 are driven by the control of the control unit 116 to rotate to send the paper P to the downstream side along the conveying path A. Note that sensors that detect conveyance states of the paper P are disposed in places of the conveying path A.

[0062] The control unit 116 includes a control circuit such as a CPU, which is a controller, a ROM (Read Only Memory) that stores various programs and the like, a R_AM (Random Access Memory) that temporarily stores various variable data, image data, and the like, and an interface unit that receives data from the outside and outputs data to the outside.

[0063] In the inkjet printer 100 configured as explained above, for example, if a printing instruction by operation of an operation input unit by a user is detected in the interface unit, the control unit 116 drives the conveying device 115 to convey the paper P and outputs a printing signal to the head units 130 at predetermined timing to drive the inkjet head 10. As an ejecting operation, the inkjet head 10 sends a driving signal to the driving IC 52 according to an image signal corresponding to image data, applies a driving voltage to the electrode layers 34 of the pressure chambers 31 via the wires to selectively drive the sidewalls 33 of the actuators 22 and eject the inks, which are droplets, from the nozzles 28, and forms an image on the paper P held on the conveying bels 118. As a liquid ejecting operation, the control unit 116 drives the circulation pumps 134 to circulate liquid in the circulation flow path that passes through the ink tanks 132 and the inkjet head 10. The circulation pumps 134 are driven by a circulating operation, whereby the inks in the ink tanks 132 are supplied from the supply holes 25 to the first common chamber 271 of the ink chamber 27 through the ink supply section of the manifold 18. The inks are supplied to the plurality of pressure chambers 31 of the pair of actuators 22. The inks flow into the second common chambers 272 of the ink chamber 27 through the pressure chambers 31. The inks are discharged from the discharge holes 26 to the ink tanks 132 through the ink discharge section of the manifold 18.

[0064] According to the embodiment explained above, since the air chambers 32 are closed by the cover members 23 including the void sections 233, it is possible to reduce contraction stress at the time of the photosensitive resin hardening if the cover members 23 are formed. Therefore, it is possible to prevent the bonding surfaces of the cover members 23 from peeling from the sidewalls 33, prevent a material from being broken, and prevent inks from intruding into the air chambers 32. By preventing the inks from intruding into the air chambers 32, it is possible to prevent so-called crosstalk that affects the pressure of the inks in the pressure chambers 31 adjacent to each other. It is easy to maintain ejection performance. If the sidewalls 33 are displaced in the X direction, since the extending walls 231 are elastically deformed to be displaced in the X direction, the cover members 23 can absorb displacement vibration of the sidewalls 33 and prevent vibration from being transmitted from one sidewall 33 to the other sidewall 33. That is, it is possible to prevent vibration of one sidewall 33 from being transmitted to the other sidewall 33 and it is possible to prevent the so-called cross talk. It is easy to maintain the ejection performance.

[0065] Note that embodiments are not limited to the embodiment explained above per se. The constituent elements can be modified and embodied without departing from the gist of the embodiments in an implementation stage.

[0066] For example, the shape opened toward the extending direction outer side of the air chambers 32 and bending in the reverse C shape is illustrated as the shape of the cover members 23. However, not only this, but, for example, the cover members 23 may include bending sections bending in, for example, a U shape or may be a shape opened toward the extending direction inner side of the air chambers 32.

[0067] In the embodiment explained above, an example in which the connecting wall 232 is disposed further on the inner side than the end portions of the sidewalls 33 is explained. However, not only this, but, for example, as another embodiment, as in a cover member 230 illustrated in FIG. 10, the connecting wall 232 may be disposed further on the outer side than the end portions of the sidewalls 33.

[0068] For example, the cover member 230 includes the pair of extending walls 231 and the connecting wall 232. The connecting wall 232 is disposed at the end portion on the outer side in the extending direction in the extending walls 231. The connecting wall 232 is located further on the outer side in an extending direction of the air chamber 32 than the end portions of the sidewalls 33. As an example, the cover member 230 is formed in a reverse C shape opened toward the inner side in the extending direction in a plan view. The pair of extending walls 231 includes the inner wall sections 234 formed on the inner surfaces of the sidewalls 33 and the outer wall sections 235. The void section 233 is formed between the pair of extending walls 231. For example, the connecting wall 232 may be a flat wall member or may be a bent wall. As an example, a width dimension in the X direction of the void section 233 is fixed over the entire length in the extending direction. The inner wall sections 234 have a width dimension in an arranging direction thereof smaller than the thickness dimension of the outer wall sections 235 and is configured thinner than the outer wall sections 235.

[0069] The pair of extending walls 231 is wall members extending in the extending direction of the subject air chamber 32. The pair of extending walls 231 includes the inner wall sections 234 formed on the inner surfaces of the pair of sidewalls configuring both the sides in the arranging direction of the air chambers 32 and the outer wall sections 235 disposed further on the outer side than end portions of the pair of sidewalls. The void section 233 is formed between the pair of extending walls 231. As an example, the void section 233 has fixed width in the extending direction. The inner wall sections 234 have a thickness dimension, which is a dimension in the arranging direction, smaller than the thickness dimension of the outer wall sections 235 and are configured thinner than the outer wall sections 235.

[0070] The void section 233 is a slit-like space having a width dimension smaller than the width dimension of the air chamber 32 in the width direction. The void section 233 is formed between the end portions of the sidewall 33 on both the sides in the extending direction. In this embodiment, the void section 233 opened toward the inner side is formed from a position beside the end portions of the sidewalls 33 to the connecting wall 232 provided further on the outer side than the end portions of the sidewalls 33. In this embodiment, the void section 233 communicates with the air chamber 32. The void section 233 may function as the air chamber 32 as well.

[0071] The connecting wall 232 is a wall-like member that closes the air chamber 32 in a position further on the outer side in the extending direction of the air chamber 32 than the end portions of the sidewalls 33. The connecting wall 232 is a wall member orthogonal to or crossing the extension of the air chamber 32. The connecting wall 232 connects the pair of extending walls 231 in the arranging direction and is formed from the counter surface of the nozzle plate 12 to the bottoms of the grooves in the Z direction to cover the end portion of the air chamber 32.

[0072] The cover member 230 is made of a material having hardness lower than the hardness of a piezoelectric material. For example, the cover member 230 is made of a resin material softer than the sidewalls 33. As an example, the cover member 230 is made of a photosensitive resin material. For example, after photosensitive resin is applied to both the end portions of the air chamber 32, the cover member 230 is formed by exposing the photosensitive resin to light and hardening the photosensitive resin in the shape of the cover member 230. Peeling of the cover member 230 by contraction stress at the time of the hardening can be prevented because the void section 233 is interposed between the pair of extending walls 231 separated from each other in the X direction, which is a vibrating direction of the sidewalls 33.

[0073] In this embodiment as well, since the cover member 230 includes the void section 233, it is possible to reduce contraction stress of the photosensitive resin if the cover member 230 is formed and prevent peeling of the cover member 230 by the contraction stress. Therefore, it is possible to ensure satisfactory ejection performance. If the sidewalls 33 are displaced in the X direction, since the extending walls 231 are elastically deformed to be displaced in the X direction, the cover member 230 can absorb displacement vibration of the sidewalls 33 and prevents vibration from being transmitted from one sidewall 33 to the other sidewall 33. That is, it is possible to prevent vibration of one sidewall 33 from being transmitted to the other sidewall 33 and it is possible to prevent so-called cross talk. It is easy to maintain the ejection performance.

[0074] Note that the connecting wall 232 may be provided in a halfway portion in the extending direction of the pair of extending walls 231 and may have a shape including the void sections 233 respectively on the inner side and the outer side in the extending direction.

[0075] In the embodiment explained above, an example in which the actuators 22 including the plurality of grooves are disposed in the principal plane portion of the substrate 21 is explained. However, not only this, but, for example, actuators may be provided on the end face of the substrate 21. The number of nozzle rows is not limited to the number in the embodiment. One row or three or more rows of nozzles may be provided.

[0076] In the embodiment explained above, the actuator base 11 including the stacked piezoelectric body including the piezoelectric members on the substrate 21 is illustrated. However, not only this, but the actuator base 11 may be formed by, for example, only the piezoelectric members without using a substrate. One piezoelectric member may be used rather than the two piezoelectric members. The supply side and the discharge side may be opposite or the supply side and the discharge side may be configured to be switchable.

[0077] In the embodiment explained above, as an example, the circulation-type inkjet head is illustrated in which one side of the pressure chamber 31 is the supply side and the other side is the discharge side and the ink in the first common chamber flows in from one side of the pressure chamber 31 and flows out from the other side. However, not only this, but, for example, the inkjet head may be a non-circulation type. For example, a configuration may be adopted in which common chambers on both the sides of the pressure chamber 31 are the supply side and the ink flows in from both the sides. That is, a configuration may be adopted in which the ink flows in from both the sides of the pressure chamber 31 and flows out from the nozzles 28 disposed in the center of the pressure chamber 31. Shapes of the cover members 23 respectively formed at both the ends may be different from each other. The supply holes 25 provided in the substrate 21 are not limited to a shape of a plurality of circular holes provided between the pair of actuators 22 illustrated in FIG. 2. For example, the supply holes 25 may be one long hole provided between the pair of actuators 22.

[0078] For example, the liquid to be ejected is not limited to the ink for printing. The liquid may be, for example, liquid including conductive particles for forming a wiring pattern of a printed wiring board.

[0079] In the embodiment explained above, an example in which the inkjet head is used for the liquid ejection device such as the inkjet printer is explained. However, not only this, but the inkjet head can also be used for, for example, a 3D printer, an industrial manufacturing machine, and a medical use. The inkjet head enables a reduction in size and weight and a reduction in cost.

[0080] According to at least one embodiment explained above, it is possible to provide a liquid ejection head and a method of manufacturing the liquid ejection head that can ensure a stable ejection characteristic.

[0081] Besides, the several embodiments are explained above. However, these embodiments are presented as examples and are not intended to limit the scope of the invention. These new embodiments can be implemented in other various forms. Various omissions, substitutions, and changes can be made without departing from the gist of the invention. These embodiments and modifications thereof are included in the scope of the invention and included in the inventions described in the claims and the scope of the inventions.

Claims

1. A liquid ejection head comprising:

a plurality of sidewalls (33) forming a plurality of grooves that alternately configure a plurality of pressure chambers (31) and a plurality of air chambers (32); and
a cover member (23, 230) including an inner wall section formed between a pair of the sidewalls configuring both sides of each of the air chambers and an outer wall section disposed further on an outer side than end portions of the pair of sidewalls, the cover member including a void section (233) in at least a part thereof and closing an opening end portion of the air chamber.

2. The head according to claim 1, wherein the void section is formed between the end portions of the pair of sidewalls configuring both the sides.

3. The head according to claim 1 or 2, wherein the void section is a slit-like space having a width dimension smaller than the width dimension of the air chamber.

4. The head according to any one of claim 1 to 3, wherein

the pressure chambers communicate with nozzles that ejects droplets, and
the cover member includes a pair of extending walls integrally including the inner wall section formed on an inner side surface of the air chamber between the pair of sidewalls and the outer wall section extending to an extending direction outer side of the air chamber from the inner wall section and a connecting wall connecting the pair of extending walls, and the void section smaller than width between the pair of sidewalls is formed between the pair of extending walls.

5. The head according to claim 4, further comprising a nozzle plate, wherein
the pair of extending walls is formed in a range from a counter surface of the nozzle plate to the bottoms of the grooves over the entire length of the depth of the grooves in a depth direction.

6. The head according to any one of claims 1 to 5, wherein the inner wall sections have smaller thickness dimension in an arranging direction of the air chambers and are configured thinner than the outer wall sections in the arranging direction.

7. The head according to any one of claims 1 to 6, wherein

the sidewalls are made of a piezoelectric material,
the cover member is made of a photosensitive resin material having hardness lower than hardness of the piezoelectric material, and
the void section is opened toward an outer side in an extending direction of the air chamber.

8. The head according to claim 7, wherein
the cover member is formed in a reverse C shape or a U shape, seen along an ejecting direction of liquid, opened toward the outer side in the extending direction of the air chamber.

9. The head according to any one of claims 1 to 6, wherein

the sidewalls are made of a piezoelectric material,
the cover member is made of a photosensitive resin material having hardness lower than hardness of the piezoelectric material, and
the void section is opened toward an inner side in an extending direction of the air chamber.

10. The head according to claim 9, wherein
the cover member is formed in a reverse C shape or a U shape, seen along an ejecting direction of liquid, opened toward the inner side in the extending direction of the air chamber.

11. The head according to claim 9 or 10, wherein the void section communicates with the air chamber.

12. The head according to any one of claims 1 to 11, wherein the void section partially extends into the air chamber between the sidewalls and partially extends outside the air chamber between the sidewalls in an extending direction of the air chamber.

13. The head according to any one of claims 1 to 12, wherein the connecting wall is provided in a halfway portion in the extending direction of the cover member, and have a shape including the void sections respectively on the inner side and the outer side in the extending direction.

FIG. 1

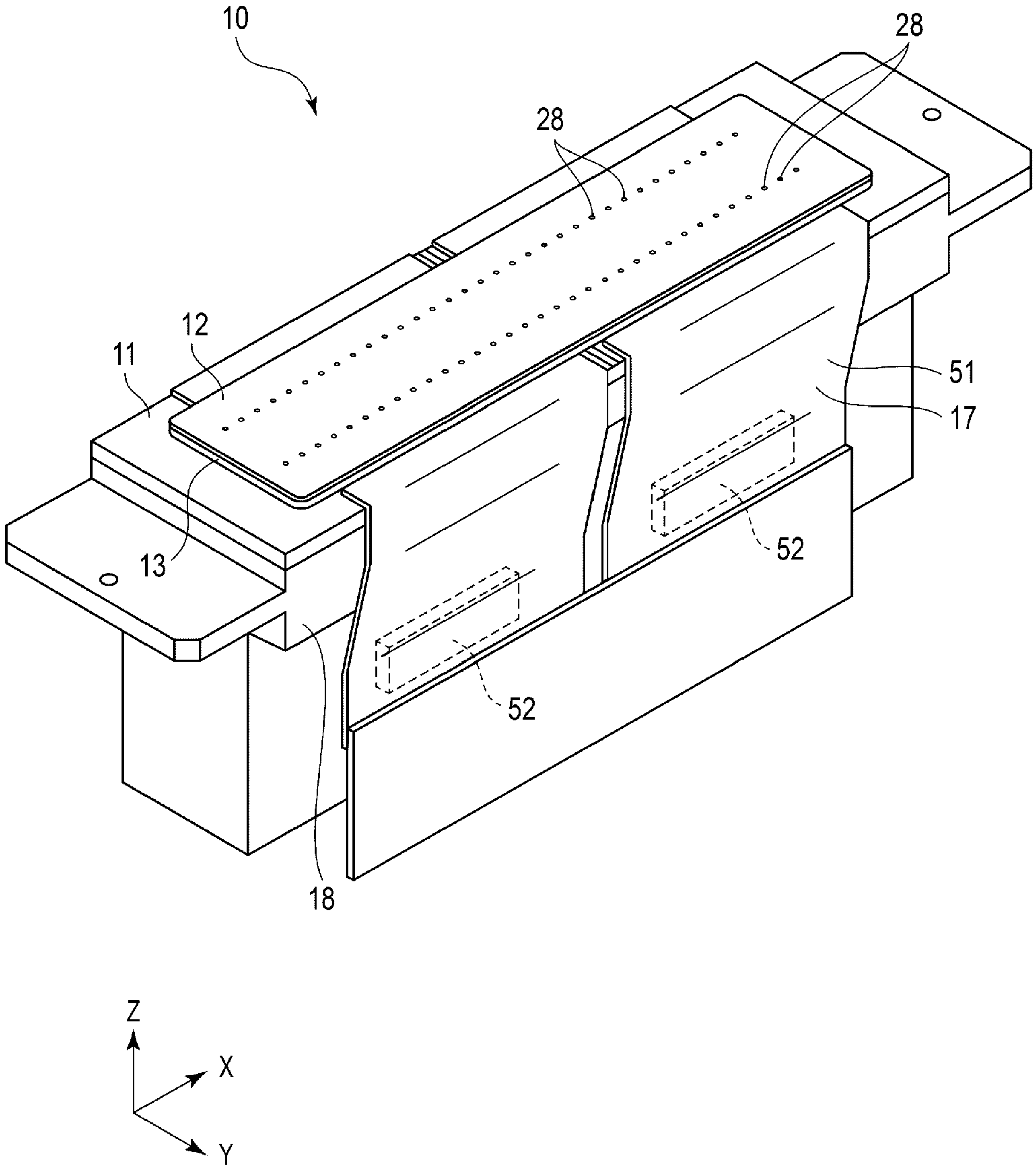

FIG. 2

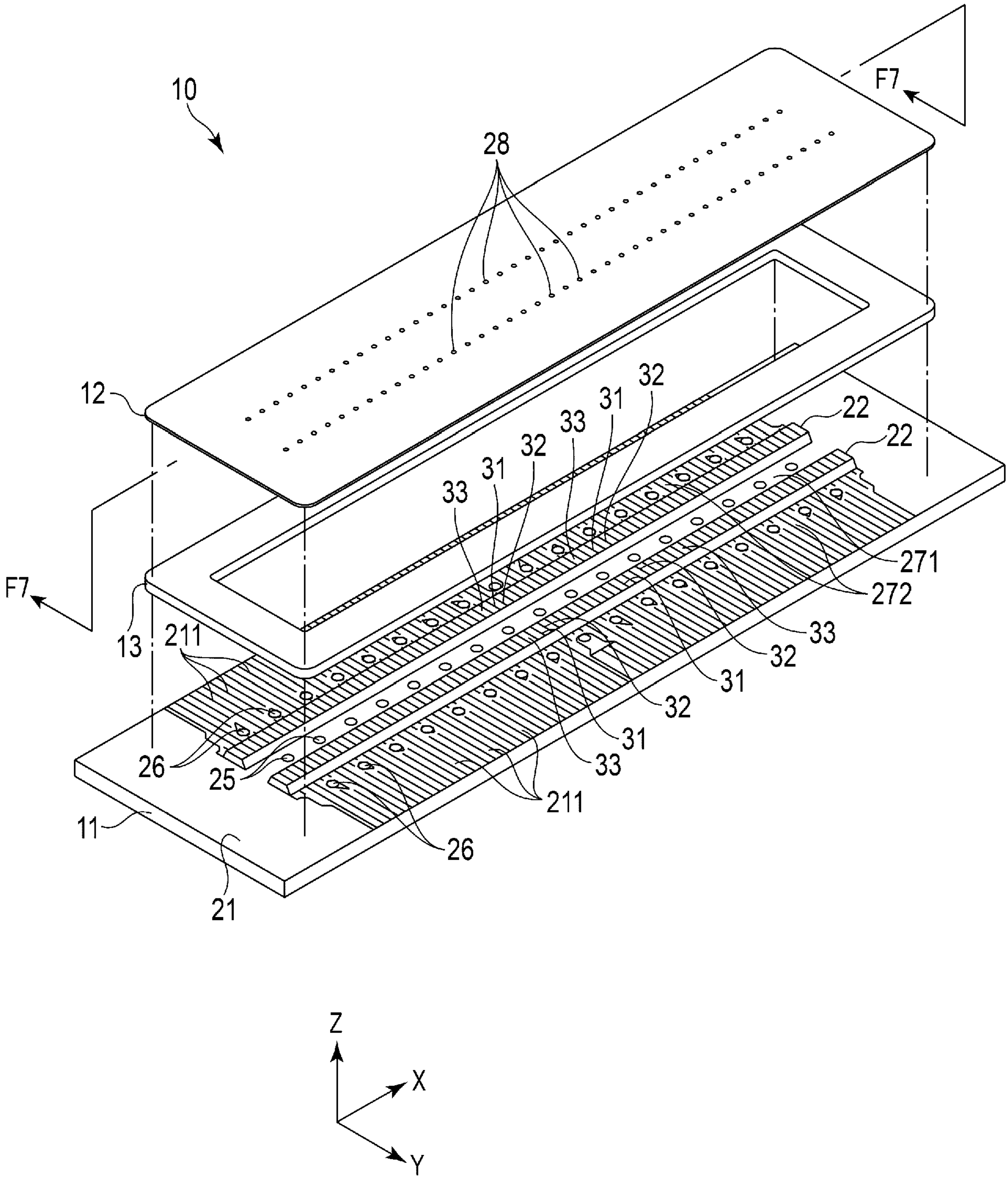
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FIG. 3

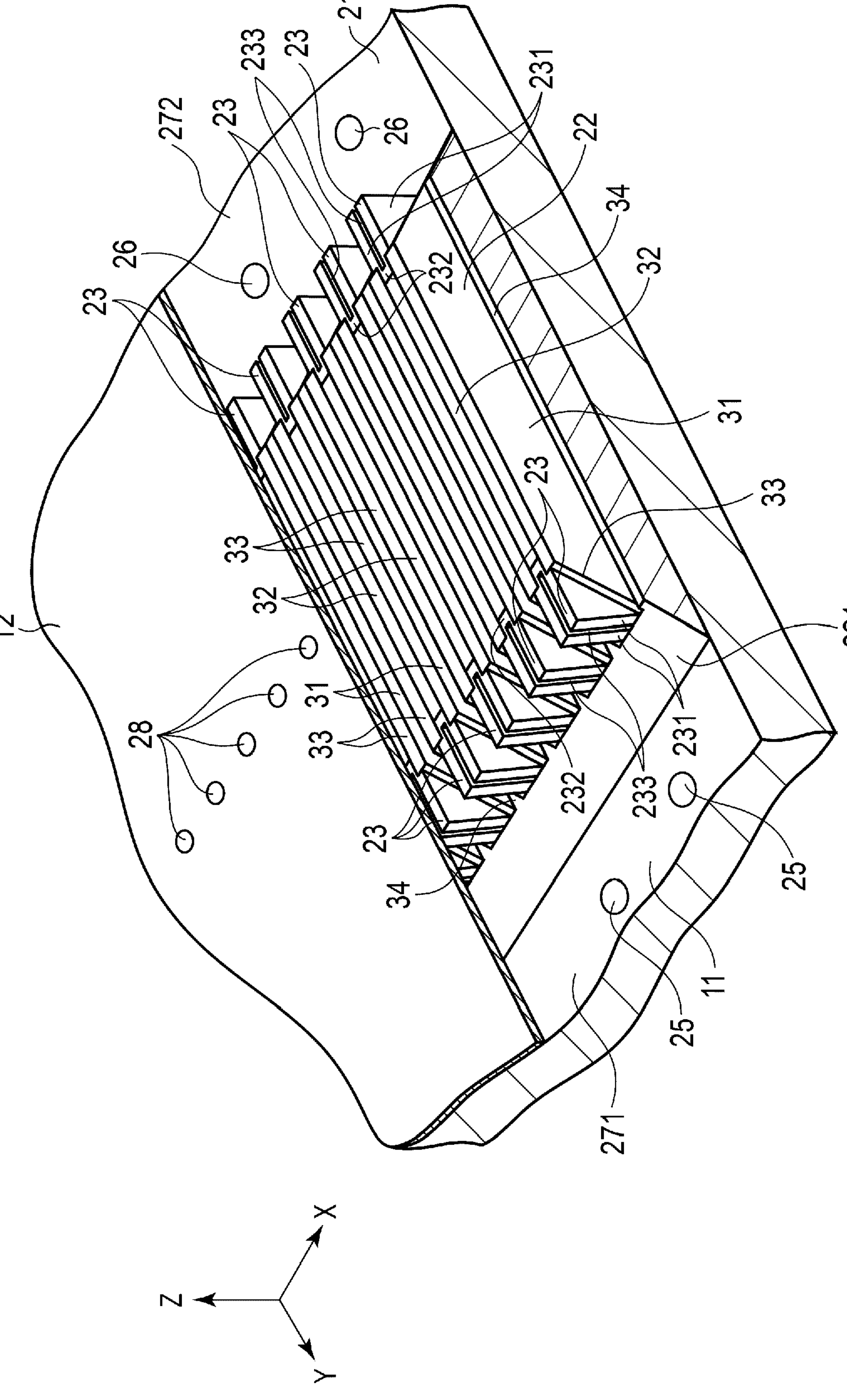
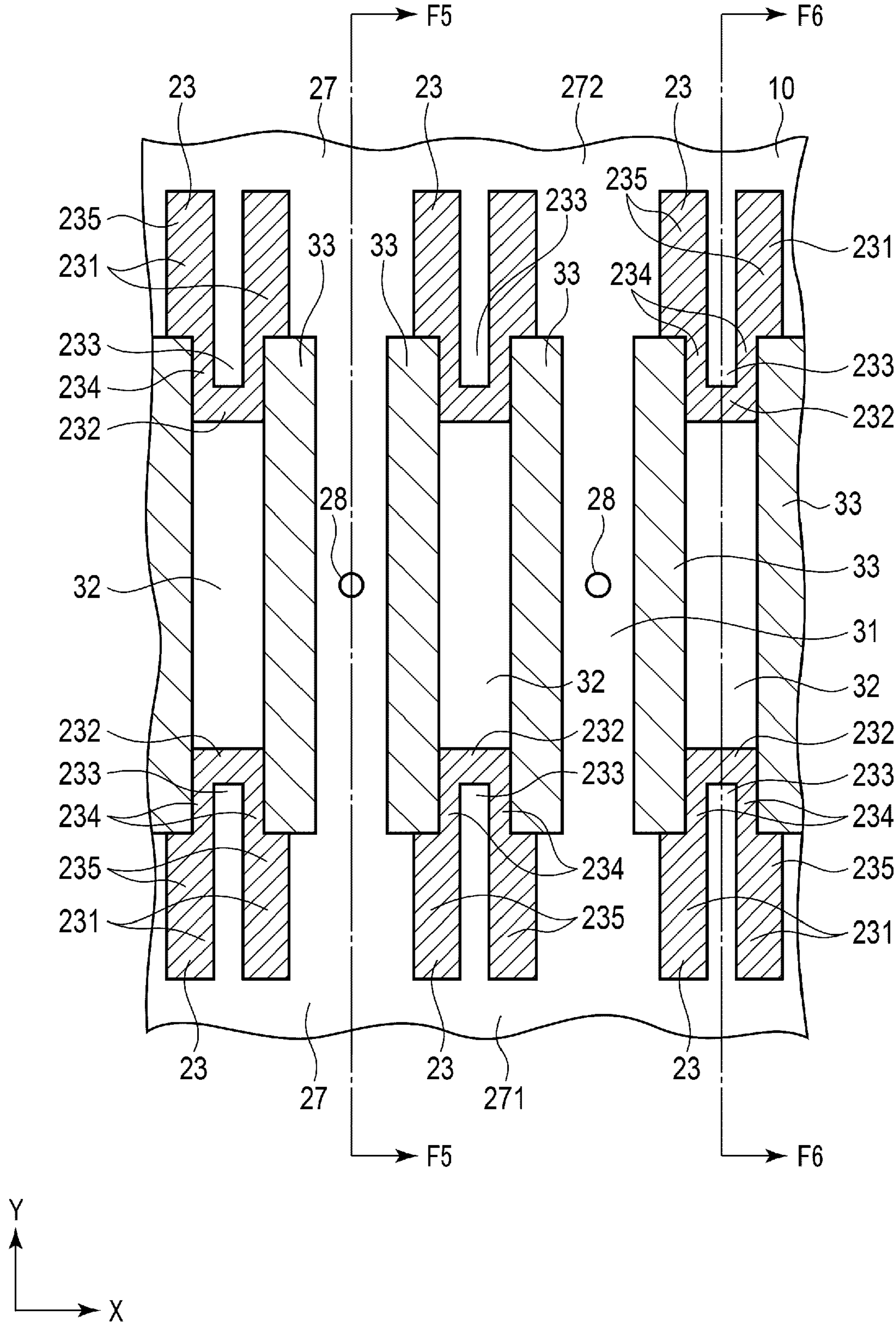


FIG. 4



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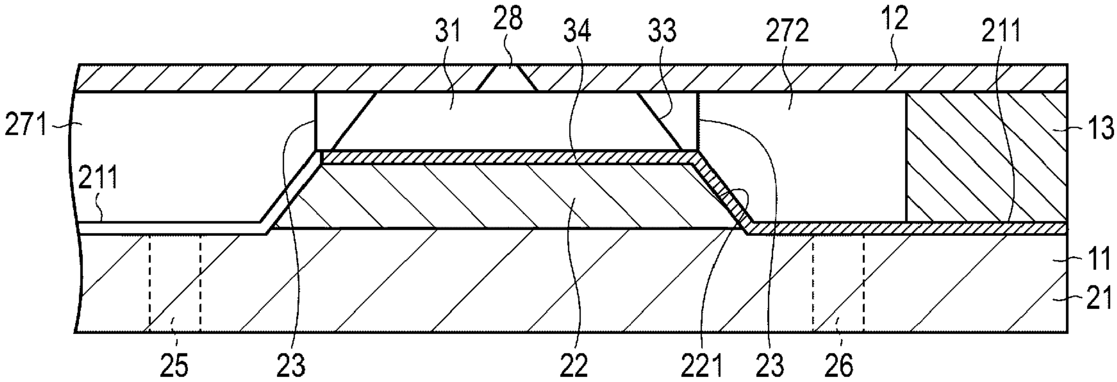
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FIG. 6

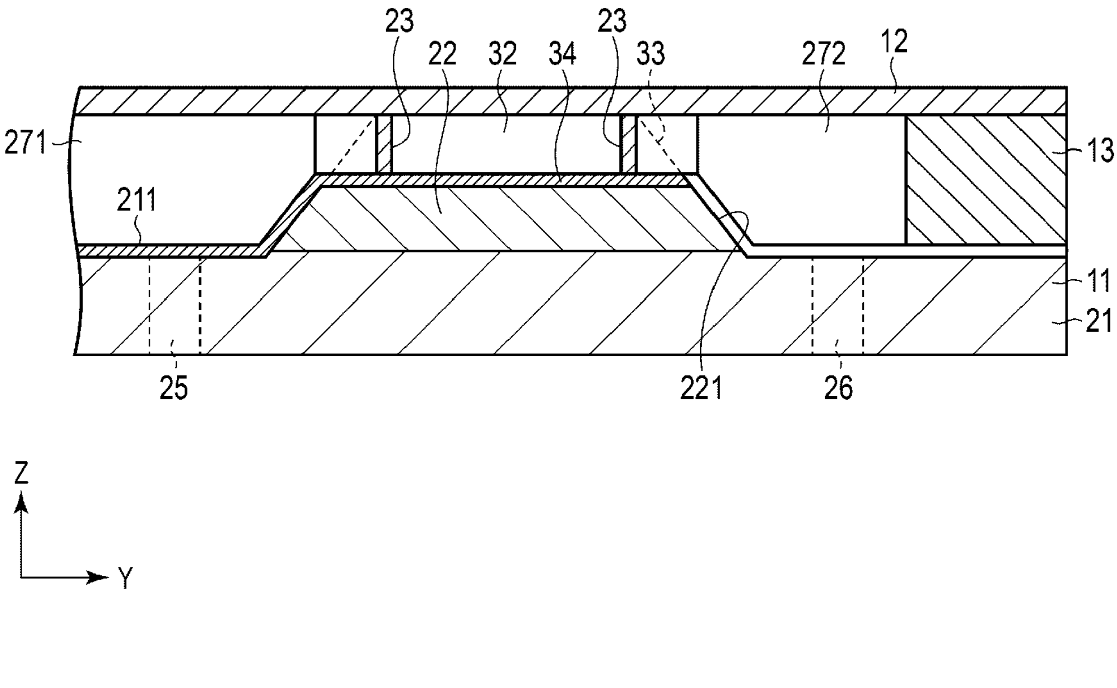
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FIG. 7

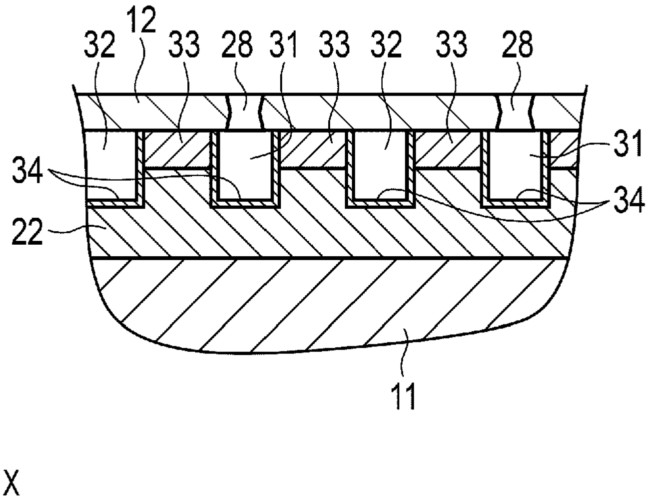
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FIG. 8

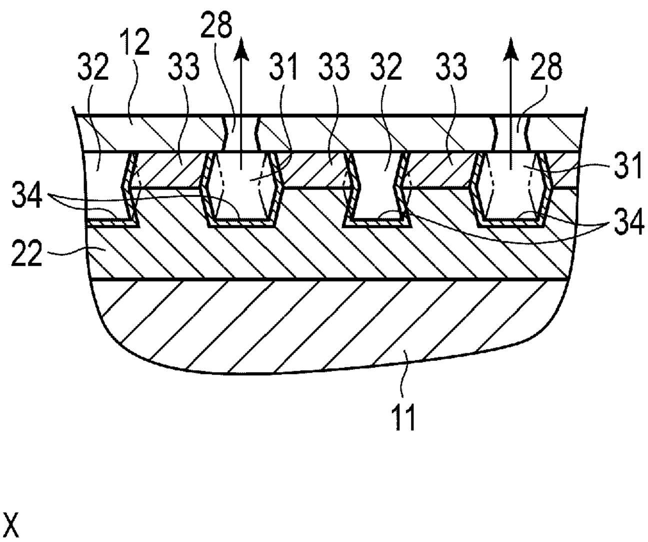
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FIG. 9

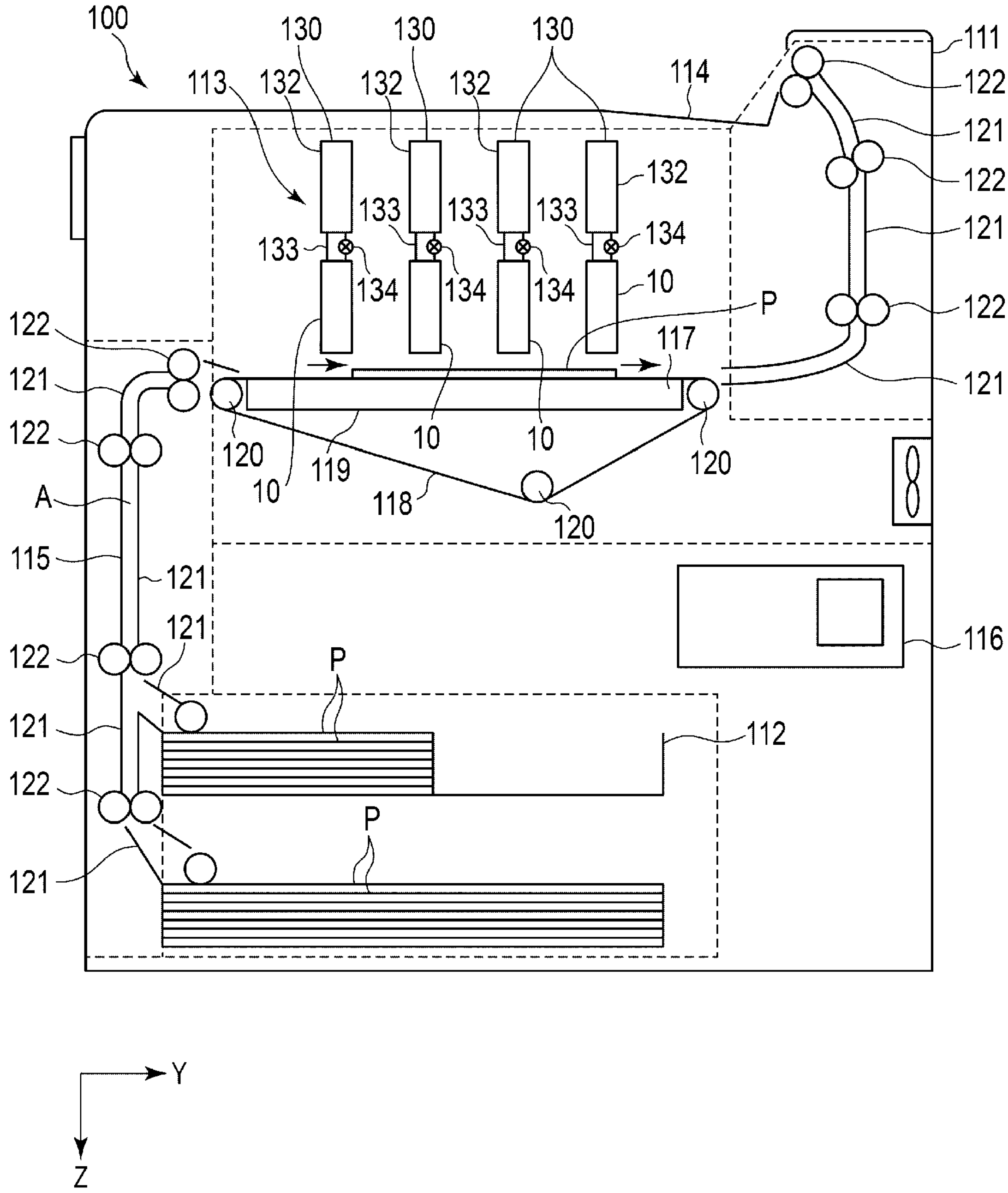
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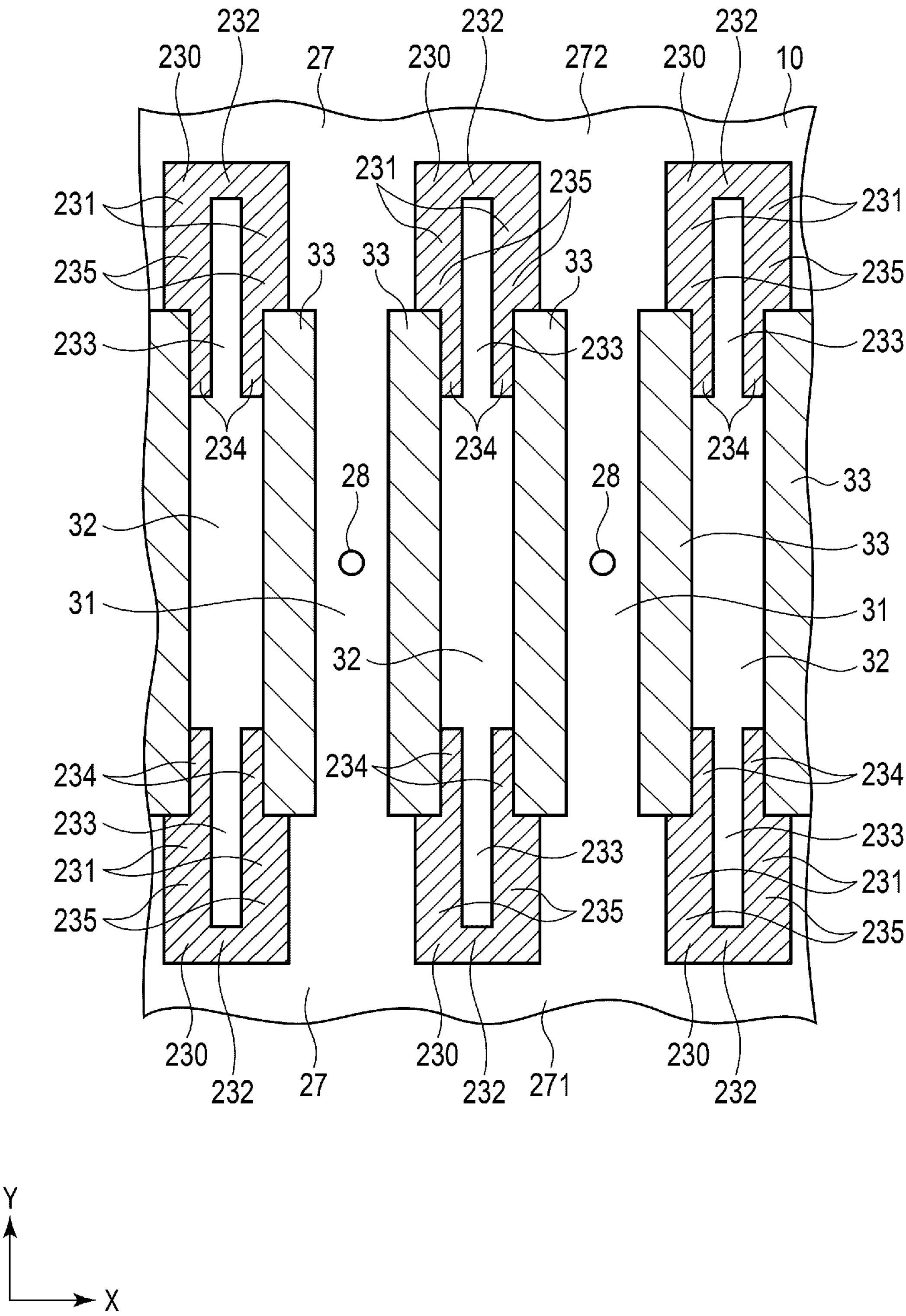
FIG. 10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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 5643

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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B41J

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	18 March 2024	Öztürk, Serkan

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18-03-2024

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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