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(71) Applicant: **Kyocera Corporation**
Kyoto-shi, Kyoto 612-8501 (JP)

(72) Inventors:
- **KOBAYASHI, Naoki**
Kirishima-shi
Kagoshima 899-4396 (JP)
- **IKEUCHI, Wataru**
Kirishima-shi
Kagoshima 899-4312 (JP)
- **YOSHIMURA, Kenichi**
Kirishima-shi
Kagoshima 899-4312 (JP)

(74) Representative: **Viering, Jentschura & Partner**
Patent- und Rechtsanwälte
Grillparzerstrasse 14
81675 München (DE)

(54) LIQUID-DISCHARGING HEAD AND RECORDING DEVICE USING SAME

(57) [Object] To provide a liquid ejecting head in which unevenness of ejection can be reduced, and increased reliability of a wiring board can be obtained, and a recording apparatus which uses the liquid ejecting head.

[Solution] A liquid ejecting head 2 which includes a flow path member 4 including pressurizing chambers 10 which are respectively arranged on the row and column at equal intervals, and a common flow path 5, and a piezoelectric actuator substrate 21 which includes a second electrode (individual electrode) 25. The common flow path 5 extends in the row direction, communicates with the pressurizing chambers 10 which align on both sides row by row, the second electrode 25 includes an electrode main body 25a, a first extraction electrode 25b-1 which is extracted from the electrode main body 25a in the first region 10-1 which is overlapped with the common flow path 5, and a second electrode 25b-2 which is extracted from the electrode main body 25a in the second region 10-2 which is not overlapped with the common flow path, any one of the two extraction electrodes is electrically connected to the wiring board 92, and the two extraction electrodes are alternately connected in the row direction.

Fig. 6(a)

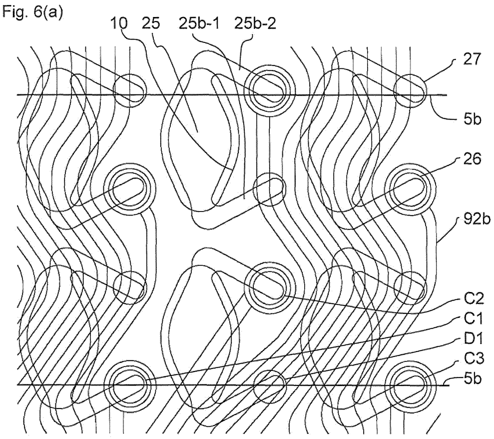
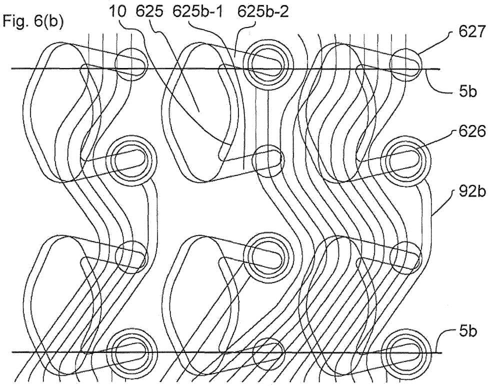


Fig. 6(b)



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Description

[Technical Field]

[0001] The present invention relates to a liquid ejecting head which ejects droplets, and a recording apparatus using the liquid ejecting head.

[Background Art]

[0002] In recent years, a printing apparatus in which an ink jet printing method is adopted such as an ink jet printer and an ink jet plotter has been widely used not only in a printer for general consumers but also in an industrial usage such as forming of an electronic circuit, manufacturing of a color filter for a liquid crystal display, and manufacturing of an organic EL.

[0003] A liquid ejecting head for ejecting liquid is mounted on such an ink jet printing apparatus as a print head. In such a print head, a thermal head type in which a heater as pressurizing means is provided in an ink flow path filled with ink, ink is heated and boiled using the heater, the ink is pressurized due to bubbles generated in the ink flow path, and is ejected as droplets from an ink ejection hole, and a piezoelectric head type in which a part of a wall of the ink flow path filled with ink is bent and displaced by a displacement element, the ink in the ink flow path is mechanically pressurized, and is ejected as droplets from the ink ejection hole, have been widely known.

[0004] In addition, in such a liquid ejecting head, there is a serial type in which recording is performed while moving the liquid ejecting head in a direction (main scanning direction) orthogonal to a transport direction (sub-scanning direction) of a recording medium, and a line type in which recording is performed on the recording medium being transported in the sub-scanning direction in a state where a long liquid ejecting head is fixed in the main scanning direction. The line type has the advantage of performing high speed recording since it is not necessary to move the liquid ejecting head, unlike the serial type.

[0005] Therfore a liquid ejecting head which is long in one direction, and is configured by laminating a flow path member including a manifold which is a common flow path, and ejection holes connected through a plurality of pressurizing chamber, respectively, from the manifold, and an actuator unit including a plurality of displacement elements which are provided so as to cover the pressurizing chambers, respectively, has been known (for example, refer to PTL 1). In the liquid ejecting head, pressurizing chambers which are respectively communicated with the plurality of ejection holes are arranged in a matrix, ink is ejected from each ejection hole by displacing the displacement element of the acutator unit which is provided so as to cover the pressurizing chamber, and printing can be performed with a resolution of 600 dpi in the main scanning direction.

[Citation List]

[Patent Literature]

[0006] [PTL 1] Japanese Unexamined Patent Application Publication No. 2003-305852.

[Summary of Invention]

[Technical Problem]

[0007] However, in the liquid ejecting head described in PTL 1, there is an influence of a relationship between a shape and an arrangement of the manifold and individual electrodes of each of the displacement elements, and there is a case where an ejection property becomes remarkably uneven. In addition, when a wiring board which supplies a driving signal to a piezoelectric actuator substrate (piezoelectric actuator unit) is going to be connected, since portions at which the individual electrode of each displacement element and the wiring board are electrically connected are arranged on the wiring board at a high density, a wiring interval of the wiring board and the wiring width should be small, and accordingly, reliability is lowered, or it is not possible to design the liquid ejecting head according to the original manufacturing design rule.

[0008] Accordingly, an object of the present invention is to provide a liquid ejecting head in which unevenness in the ejection property is smaller and reliability of a wiring board is increased, and a recording apparatus using the liquid ejecting head.

[Solution to Problem]

[0009] According to one embodiment, there is provided a liquid ejecting head which includes: a flow path member including a plurality of ejection holes, a plurality of pressurizing chambers which are respectively communicated with the plurality of ejection holes, and one, or a plurality of common flow paths which are communicated with the plurality of pressurizing chambers; a piezoelectric actuator substrate which is laminated on the flow path member so as to cover the plurality of pressurizing chambers; and a wiring board, in which the piezoelectric actuator substrate is formed by laminating a first electrode, a piezoelectric body, and a plurality of second electrodes in this order from the flow path member side; when the liquid ejecting head is viewed planarly, the plurality of pressurizing chambers are in diamond shapes with two obtuse angle portions and two acute angle portions, respectively, and are arranged on a row which goes along a diagonal line connecting the two obtuse angle portions, and on a column which goes along a diagonal line connecting the two acute angle portions, respectively, with approximately equal intervals, the common flow path extends along a direction of the row, and communicates with the pressurizing chambers which are aligned on both sides of the common flow path row by row, each of the pressurizing chambers communicating with the common flow path includes a first region which is overlapped with the common flow path, and a second region which is not overlapped with the common flow path, the plurality of second electrodes are arranged so as to overlap with the plurality of pressurizing chambers respectively, includes an electrode main body which is disposed within the pressurizing chamber, a first extraction electrode of which one end portion is connected to the electrode main body in the first region, and the other end portion is extracted to an outside of the pressurizing chamber, and a second extraction electrode of which one end portion is connected to the electrode main body in the second region, and the other end portion is extracted to the outside of the pressurizing chamber, and any one of the first extraction electrode and the second extraction electrode of the second electrode is electrically connected to the wiring board, and the first extraction electrode and the second extraction electrode are alternately connected in the row direction.

[0010] According to another embodiment, there is provided a recording apparatus which includes the liquid ejecting head, a transport unit which transports a recording medium to the liquid ejecting head, and a control unit which controls the piezoelectric actuator substrate.

[Advantageous Effects of Invention]

[0011] According to the present invention, it is possible to make reliability of a wiring board high, since it is possible to make ejection unevenness smaller, a wiring interval of the wiring board larger, and the wiring width larger.

[Brief Description of Drawings]

[0012]

[Fig. 1] Fig. 1 is a schematic configuration diagram of a color ink jet printer which is a recording apparatus including a liquid ejecting head according to one embodiment of the present invention.

[Fig. 2] Fig. 2 is a plan view of a flow path member and a piezoelectric actuator which configure the liquid ejecting head in Fig. 1.

[Fig. 3] Fig. 3 is an enlarged view of a region surrounded with one dot dashed line in Fig. 2, and is a diagram in which a part of flow paths is omitted for descriptions.

[Fig. 4] Fig. 4 is an enlarged view of the region surrounded with the one dot dashed line in Fig. 2, and is a diagram in which a part of flow paths is omitted for descriptions.

[Fig. 5] Fig. 5 is a vertical cross-sectional view taken along line V-V in Fig. 3.

[Fig. 6] Fig. 6(a) is an enlarged plan view of the liquid ejecting head illustrated in Figs. 2 to 5, and Fig. 6(b) is an enlarged plan view of a liquid ejecting head according to another embodiment of the present invention.

[Fig. 7] Fig. 7 is an enlarged plan view of the liquid ejecting head according to another embodiment of the present invention.

[Fig. 8] Fig. 8 is an enlarged plan view of the liquid ejecting head illustrated in Figs. 2 to 5.

[Fig. 9] Fig. 9 is a further enlarged plan view of Fig. 6(a).

[Description of Embodiments]

[0013] Fig. 1 is a schematic configuration diagram of a color ink jet printer which is a recording apparatus including a liquid ejecting head according to one embodiment of the present invention. The ink jet color printer 1 (hereinafter, referred to as printer 1) includes four liquid ejecting heads 2. These liquid ejecting heads 2 are aligned along a transport direction of a printing sheet P, and the liquid ejecting head 2 which is fixed to the printer 1 has a long shape in the depth direction from the front in Fig. 1. The long direction is referred to as the longitudinal direction.

[0014] The printer 1 is provided with a sheet feeding unit 114, a transport unit 120, and a sheet receiving unit 116 in order along a transport path of the printing sheet P. In addition, a control unit 100 for controlling operations in each unit of the printer 1 such as the liquid ejecting head 2, or the sheet feeding unit 114 is provided in the printer 1.

[0015] The sheet feeding unit 114 includes a sheet accommodating case 115 which can accommodate a plurality of the printing sheets P, and a sheet feeding roller 145. The sheet feeding roller 145 can send out the uppermost printing sheet P among the printing sheets P which are accommodated in the sheet accommodating case 115 by being laminated one by one.

[0016] Two pairs of sending rollers 118a and 118b, and 119a and 119b are arranged between the sheet feeding unit 114 and the transport unit 120 along the transport path of the printing sheet P. The printing sheet P which is sent out from the sheet feeding unit 114 is guided by these sending rollers, and is sent out to the transport unit 120.

[0017] The transport unit 120 includes an endless transport belt 111, and two belt rollers 106 and 107. The transport belt 111 is wound around the belt rollers 106 and 107. The transport belt 111 is adjusted to a length which is stretched with a predetermined tension when being wound around the two belt rollers. Due to this, the transport belt 111 is stretched without sagging along two planes which include a common tangent of the two belt rollers, and are parallel to each other. Between the two planes, a plane on a side which is closer to the liquid ejecting head 2 is a transport face 127 on which the printing sheet P is transported.

[0018] As illustrated in Fig. 1, a transport motor 174 is connected to the belt roller 106. The transport motor 174 can rotate the belt roller 106 in a direction of an arrow A. In addition, the belt roller 107 can rotate in conjunction with the transport belt 111. Accordingly, the transport belt 111 moves along the direction of the arrow A when the belt roller 106 is rotated by driving the transport motor 174.

[0019] A nip roller 138 and a nip receiving roller 139 are arranged so as to pinch the transport belt 111 therebetween in the vicinity of the belt roller 107. The nip roller 138 is urged downward due to a spring which is not illustrated. The nip receiving roller 139 under the nip roller 138 accepts the nip roller 138 which is urged downward through the transport belt 111. The two nip rollers are rotatably arranged, and rotate in conjunction with the transport belt 111.

[0020] The printing sheet P which is sent out from the sheet feeding unit 114 to the transport unit 120 is nipped between the nip roller 138 and the transport belt 111. Due to this, the printing sheet P is pressed against the transport face 127 of the transport belt 111, and is fixed onto the transport face 127. In addition, the printing sheet P is transported in a direction toward the liquid ejecting head 2 according to the rotation of the transport belt 111. In addition, the outer peripheral surface 113 of the transport belt 111 may be treated with a process using sticky silicone rubber. In this manner, it is possible to reliably fix the printing sheet P onto the transport face 127.

[0021] The liquid ejecting head 2 includes a head main body 2a at the lower end. The lower face of the head main body 2a becomes an ejection hole face 4-1 on which a plurality of ejection holes which eject liquid are provided.

[0022] Droplets (ink) of the same color are ejected from liquid ejection holes 8 which are provided in one liquid ejecting head 2. Liquid is supplied to each liquid ejecting head 2 from an external liquid tank (not illustrated).

[0023] Since the liquid ejection holes 8 of each liquid ejecting head 2 are open to a liquid ejection hole face, and are arranged in one direction (direction that is parallel to printing sheet P, is orthogonal to transport direction of printing sheet P, and is in longitudinal direction of liquid ejecting head 2) at equivalent intervals, it is possible to perform printing with no spaces in one direction. A color of liquid which is ejected from each liquid ejecting head 2 is, for example, magenta (M), yellow (Y), cyan (C), and black (K). Each liquid ejecting head 2 is arranged between a lower face of a main body 13 of the liquid ejecting head and the transport face 127 of the transport belt 111 with a minute interval.

[0024] The printing sheet P which is transported by the transport belt 111 passes through a gap between the liquid ejecting head 2 and the transport belt 111. At this time, droplets are ejected toward the upper face of the printing sheet P from the head main body 2a which configures the liquid ejecting head 2. In this manner, a color image based on stored image data is formed on the upper face of the printing sheet P using the control unit 100.

[0025] A separation plate 140, and two pairs of sending rollers 121a and 121b, and 122a and 122b are arranged between the transport unit 120 and the sheet receiving unit 116. The printing sheet P on which a color image is printed is transported to the separation plate 140 using the transport belt 111. At this time, the printing sheet P is separated from the transport face 127 using the right end of the separation plate 140. In addition, the printing sheet P is sent out to the sheet receiving unit 116 using the sending rollers 121a to 122b. In this manner, the printed printing sheet P is sequentially sent to the sheet receiving unit 116, and is piled on the sheet receiving unit 116.

[0026] In addition, a sheet face sensor 133 is provided between the liquid ejecting head 2 which is on the most upstream side in the transport direction of the printing sheet P and the nip roller 138. The sheet face sensor 133 is configured of a light emitting element and a light receiving element, and can detect a tip end position of the printing sheet P on the transport path. A detection result using the sheet face sensor 133 is sent to the control unit 100. The control unit 100 can control the liquid ejecting head 2, the transport motor 174, or the like, so that a transport of the printing sheet P and printing of an image are synchronized using the detection result which is sent from the sheet face sensor 133.

[0027] Subsequently, the liquid ejecting head 2 according to the present invention will be described. Fig. 2 is a plan view of the head main body 2a. Fig. 3 is an enlarged view of a region surrounded with the one dot dashed line in Fig. 2, and is a plan view in which a part of the flow path is omitted for descriptions. Fig. 4 is an enlarged view of the region surrounded with the one dot dashed line in Fig. 2, and is a diagram in which a part of the flow path which is different from that in Fig. 3 is omitted for descriptions. In addition, in Figs. 3 and 4, a diaphragm 6, the ejection holes 8, the pressurizing chambers 10, and the like, which should be drawn using a dashed line under the piezoelectric actuator substrate 21 are drawn using a solid line in order to make the drawings easy to understand. In addition, in Fig. 5, only one of the two extraction electrodes 25b is illustrated. Fig. 5 is a vertical cross-sectional view taken along line V-V in Fig. 3. Fig. 6 is an enlarged plan view of the head main body 2a illustrated in Figs. 2 to 5, and illustrates a relationship among the pressurizing chambers 10, the individual electrode 25 which is the first electrode, and the connection electrode 26. In addition, the ejection holes 8 in Fig. 4 are drawn to be larger than an actual diameter in order to make a position thereof easy to understand. Fig. 6(a) is an enlarged plan view of the liquid ejecting head illustrated in Figs. 2 to 5.

[0028] The liquid ejecting head 2 includes a reservoir, or a metallic housing in addition to the head main body 2a. In addition, the head main body 2a includes the flow path member 4, and the piezoelectric actuator substrate 21 in which the displacement element (pressuring unit) 30 is fabricated.

[0029] The flow path member 4 which configures the head main body 2a includes a manifold 5, a plurality of the pressurizing chambers 10 which are communicated with the manifold 5, and a plurality of the ejection holes 8 which are communicated with the plurality of pressurizing chambers 10, respectively, the pressurizing chambers 10 are open to the upper face of the flow path member 4, and the upper face of the flow path member 4 becomes a pressurizing chamber face 4-2. In addition, an opening 5a which is communicated with the manifold 5 is provided on the upper face of the flow path member 4, and liquid is supplied from the opening 5a.

[0030] In addition, the piezoelectric actuator substrate 21 including the displacement element 30 is bonded onto the upper face of the flow path member 4, and each displacement element 30 is provided so as to be positioned on the respective pressurizing chambers 10. In addition, a signal transmission unit 92 such as a flexible printed circuit (FPC) which is a wiring board for supplying signals to each of the displacement elements 30 is connected to the piezoelectric actuator substrate 21. In Fig. 2, an outer shape of the signal transmission unit 92 in the vicinity of a position at which the signal transmission unit is connected to the piezoelectric actuator substrate 21 is denoted by a dotted line so that a state in which the two signal transmission units 92 are connected to the piezoelectric actuator substrate 21 is understood. The signal transmission unit 92 is arranged along the piezoelectric actuator substrate 21, and since a connection between the signal transmission unit 92 and the piezoelectric actuator substrate 21 is performed at a portion other than the pressurizing chambers 10, displacement of the displacement element 30 is not suppressed. A plurality of wiring 92b are arranged along a short direction of the head main body 2a in a region in which the signal transmission unit 92 faces the piezoelectric actuator substrate 21, and the wiring 92b is connected to a portion which is not illustrated on the left and right in Fig. 2. The signal which is sent from the control unit 100 passes through another circuit board as necessary, is transmitted through the signal transmission unit 92, and is supplied to the displacement element 30.

[0031] The piezoelectric actuator substrate 21 side of the wiring 92b becomes an electrode which is electrically connected to the piezoelectric actuator substrate 21, and the electrode is arranged at an end portion of the signal transmission unit 92 in a rectangular shape. The two signal transmission units 92 are connected so that respective ends thereof come to a center portion of the piezoelectric actuator substrate 21 in the short direction. The two signal transmission units 92 extend toward the long side of the piezoelectric actuator substrate 21 from the center portion.

[0032] In addition, a driver IC is mounted on the signal transmission unit 92. The driver IC is mounted so as to be pressed against a metallic housing, and heat of the driver IC is transferred to the metallic housing, and is dissipated to the outside. A driving signal which drives the displacement element 30 on the piezoelectric actuator substrate 21 is generated in the driver IC. A signal which controls a generation of the driving signal is generated in the control unit 100, and is input from an end of a side which is opposite to a side on which the signal transmission unit 92 is connected to the piezoelectric actuator substrate 21. A circuit board, or the like, is provided between the control unit 100 and the signal transmission unit 92, in the liquid ejecting head 2 as necessary.

[0033] The head main body 2a includes one piezoelectric actuator substrate 21 which includes the planar flow path member 4, and the displacement element 30 which is connected onto the flow path member 4. The planar shape of the piezoelectric actuator substrate 21 is a long shape, and a long side of the rectangular shape is arranged on the upper face of the flow path member 4 so as to go along the longitudinal direction of the flow path member 4.

[0034] Two manifolds 5 are formed in the flow path member 4. The manifold 5 has a long slender shape which extends from one end side to the other end side of the flow path member 4 in the longitudinal direction, and a manifold opening 5a which opens to the upper face of the flow path member 4 is formed on both end portions thereof. When liquid is supplied to the flow path member 4 from both the end portions of the manifold 5, a short supply of liquid rarely occurs. In addition, since it is possible to reduce a difference in pressure loss which occurs when liquid flows in the manifold 5 to be approximately half compared to a case where liquid is supplied from one end of the manifold 5, it is possible to reduce unevenness of a liquid ejecting property.

[0035] In addition, in the manifold 5, the center portion of a region which is communicated with at least the pressurizing chambers 10 in the length direction is partitioned by the partitioning wall 15 which is provided with an interval in the width direction. The partitioning wall 15 has the same height as that of the manifold 5 at a center portion in the length direction which is a region communicated with the pressurizing chambers 10, and completely partitions the manifold 5 into the plurality of submanifolds 5b. In this manner, it is possible to provide the ejection holes 8 and a descender which is communicated with the pressurizing chambers 10 from the ejection holes 8 so as to be overlapped with the partitioning wall 15 when viewed planarly.

[0036] In Fig. 2, the entire manifold 5 except for both end portions is partitioned using a partitioning wall 15. The manifold 5 may be partitioned using the partitioning wall 15 except for one end portion between both the end portions, in addition to the above described manner. In addition, the partitioning wall may be provided from the opening 5a toward the depth direction of the flow path member 4, without partitioning only the vicinity of the opening 5a which is open to the upper face of the flow path member 4. In any case, since a resistance in the flow path becomes smaller, and a supply amount of liquid becomes larger due to a portion which is not partitioned, it is preferable that both end portions of the manifold 5 not be partitioned with the partitioning wall 15.

[0037] There is a case where the manifold 5 which is divided into the plurality of manifolds is referred to as a submanifold 5b. According to the embodiment, two manifolds 5 are provided independently, and the openings 5a are provided at both respective end portions. In addition, seven partitioning walls 15 are provided at one manifold 5, and the manifold is divided into eight submanifolds 5b. The width of the submanifold 5b is larger than the width of the partitioning wall 15, and due to this, it is possible to make a large amount of liquid to flow to the submanifold 5b. In addition, the length of the seven partitioning walls 15 becomes large when being close to a center in the width direction, and on both ends of the manifold 5, an end of the partitioning wall 15 which is closer to the center in the width direction becomes closer to the end of the manifold 5. In this manner, it is possible to get a balance between a flow path resistance which occurs due to an outer wall of the manifold 5 and a flow path resistance which occurs due to the partitioning wall 15, and it is possible to make a pressure difference in liquid small at an end of a region in which an individual supply flow path 14 is formed, which is a portion communicated with the pressurizing chambers 10, in each of the submanifolds 5b. Since the pressure difference in the individual supply flow path 14 leads to a pressure difference which is added to liquid in the pressurizing chambers 10, when the pressure difference in the individual supply flow path 14 is reduced, it is possible to reduce unevenness of ejection.

[0038] The flow path member 4 is formed by the plurality of pressurizing chambers 10 which are expanded two-dimensionally. The pressurizing chambers 10 are hollow regions in a planar shape which is approximately a diamond shape with two acute angle portions 10a and two acute angle portions 10b in which a curve is provided at a corner portion.

[0039] The pressurizing chambers 10 are communicated with one submanifold 5b through the individual supply flow path 14. Two rows of a pressurizing chamber row 11 which is a row of the pressurizing chambers 10 communicated with the submanifold 5b so as to go along one submanifold 5b are provided in total, on both sides of the submanifold 5b, respectively. Accordingly, sixteen pressurizing chambers 11 are provided with respect to one manifold 5, and thirty two pressurizing chamber rows 11 are provided in the entire head main body 2a. An interval in the longitudinal direction of the pressurizing chambers 10 in each pressurizing chamber row 11 is the same, and for example, is an interval of 37.5 dpi.

[0040] A dummy pressurizing chamber 16 is provided at an end of each pressurizing chamber row 11. The dummy pressurizing chamber 16 is communicated with the manifold 5, but is not communicated with the ejection holes 8. In addition, a dummy pressurizing chamber row in which the dummy pressurizing chamber 16 is linearly aligned is provided on the outer side of the pressurizing chamber rows 11 of thirty two rows. The dummy pressurizing chamber 16 is communicated neither with the manifold 5 nor with the ejection holes 8. Since a structure (rigidity) at the periphery of the pressurizing chambers 10 which is in the inside by one from the end becomes closer to a structure (rigidity) of other pressurizing chambers 10 due to the dummy pressurizing chamber, it is possible to make a difference in the liquid ejecting property smaller. In addition, since an influence of a difference in a peripheral structure, an influence of the pressurizing chambers 10 which is close, and is neighboring in the length direction is remarkable, the dummy pressurizing chamber is provided at both ends in the length direction. Since the influence is relatively small in the width direction, the dummy pressurizing chamber is provided only at a portion which is closer to the end of the head main body 21a. In this manner it is possible to make the width of the head main body 21a smaller.

[0041] The pressurizing chambers 10 which are communicated with one manifold 5 are arranged at the approximately equal interval, respectively, on the row and column along the row direction which is the longitudinal direction, and the column direction which is the short direction of the liquid ejecting head 2. The row direction is a direction which goes along a diagonal line which connects the obtuse angle portions 10b of the pressurizing chambers 10 in the diamond shape, and is also a direction which is generated by connecting an area center of gravity of the respective pressurizing chambers 10 which are aligned by causing the obtuse angle portions 10b to face each other. In the diamond shapes of the pressurizing chambers 10, the length of a side may be different by approximately 10%. In addition, the direction of the diagonal line which connects the obtuse angle portions 10b and the row direction may be arranged in a state where the respective pressurizing chambers 10 are rotated in the plane, or may be provided with an angle of approximately 10 degrees or less due to the difference in length of the side. The column direction is a direction which goes along the diagonal line which connects the acute angle portions 10a of the pressurizing chambers 10 in the diamond shape, and is also a direction which is generated by connecting the area center of gravity of the respective pressurizing chambers 10 which are aligned by causing the acute angle portions 10a to face each other. The direction of the diagonal line which connects the acute angle portions 10a and the column direction may be arranged in a state where the respective pressurizing chambers 10 are rotated in the plane, or may be provided with an angle of approximately 10 degrees or less due to the difference in length of the side. That is, it is a state where an angle of the diagonal line in the diamond shape of the respective pressurizing chambers 10 to the row direction and the column direction is small. By arranging pressurizing chambers 10 in a lattice shape, and arranging the respective pressurizing chambers 10 in the diamond shape with such an angle, it is possible to reduce crosstalk. The reason why the crosstalk is reduced is that, since the angle portions are in a state of facing each other in any of the row direction and column direction with respect to one of pressurizing chambers 10, vibration rarely comes through the flow path member 4 compared to a case where the sides face each other. In addition, here, it is possible to arrange the pressurizing chambers 10 with a high density in the longitudinal direction by causing the obtuse angle portions 10b to face each other in the longitudinal direction, and in this manner, it is possible to make the density of the ejection holes 8 in the longitudinal direction high, and to make the liquid ejecting head 2 with a high resolution. When an interval of the pressurizing chambers 10 on the row and column is set to the equal interval, it is possible to reduce crosstalk without an interval which is smaller than others, however, the interval may be different by approximately +/-20%.

[0042] When setting the piezoelectric actuator substrate 21 to a rectangular shape with an outer side which goes along the row and column by arranging the pressurizing chambers 10 in a lattice shape, it is possible to prevent deformation of the piezoelectric actuator substrate 21 from occurring when forming the individual electrode 25, since the individual electrode 25 which is formed on the pressurizing chambers 10 from the outer side of the piezoelectric actuator substrate 21 is arranged at an equal distance. There is a concern that, when the deformation is large, stress is added to a displacement element 30 which is closer to the outer side, and unevenness may occur in a displacement property at a time of bonding the piezoelectric actuator substrate 21 to the flow path member 4, however, it is possible to decrease the unevenness by reducing the deformation. In addition, it is possible to reduce the influence of the deformation, since a dummy pressurizing chamber row of the dummy pressurizing chamber 16 is provided at the outside of the pressurizing chamber row 11 which is closest to the outer side. The pressurizing chambers 10 which belong to the pressurizing chamber row 11 are arranged at equal intervals, and columns of the individual electrodes 25 corresponding to the pressurizing chamber row 11 are also arranged at equal intervals. The pressurizing chamber rows 11 are arranged at equal intervals in the short direction, and the columns of the individual electrode 25 corresponding to the pressurizing chamber row 11 are also arranged at equal intervals in the short direction. In this manner, it is possible to eliminate portions at which the influence of the crosstalk becomes remarkable, in particular.

[0043] It is possible to suppress the crosstalk by arranging pressurizing chambers 10 which belong to one pressurizing chamber row 11 so as not to overlap with pressurizing chambers 10 which belong to a neighboring pressurizing chamber row 11 in the longitudinal direction of the liquid ejecting head 2, when the flow path member 4 is viewed planarly. Meanwhile, when there is a distance between pressurizing chamber rows 11, since the width of the liquid ejecting head 2 becomes larger, an influence of precision of an arranging angle of the liquid ejecting head 2 with respect to the printer 1, or an influence of precision of a relative position of the liquid ejecting head 2 when using a plurality of the liquid ejecting heads 2 with respect to a printing result becomes remarkable. Therefore, it is possible to reduce influence of the precision on the printing result by setting the width of the partitioning wall 15 to be smaller than that of the submanifold 5b.

[0044] Pressurizing chambers 10 which are communicated with one submanifold 5b configure pressurizing chamber rows 11 of two rows, and ejection holes 8 which are communicated with the pressurizing chambers 10 which belong to one pressurizing chamber row 11 configure one pressurizing chamber row 11. Ejection holes 8 which are communicated with pressurizing chambers 10 which belong to pressurizing chamber rows 11 of two rows open to different sides of the submanifold 5b, respectively. In Fig. 4, the partitioning wall 15 is provided with pressurizing chamber rows 11 of two rows, however, ejection holes 8 which belong to the respective pressurizing chamber rows 11 are communicated with the submanifold 5b on a side which is closer to the ejection holes 8 through the pressurizing chambers 10. Since it is possible to suppress crosstalk between flow paths which communicate the pressurizing chambers 10 with the ejection holes 8 when being arranged so as not to overlap with the ejection holes 8 which are communicated with the neighboring submanifold 5b through the pressurizing chamber row 11 in the longitudinal direction of the liquid ejecting head 2, it is possible to further reduce crosstalk. When the entire flow path communicating the pressurizing chambers 10 and the ejection holes 8 is arranged so as not to overlap with the liquid ejecting head 2 in the longitudinal direction, it is possible to further reduce crosstalk.

[0045] In addition, it is possible to make the width of the liquid ejecting head 2 smaller by arranging the pressurizing chambers 10 and the submanifold 5b so as to overlap with each other in a planar view. It is possible to make the width of the liquid ejecting head 2 smaller by setting a ratio of the overlapping area to the area of the pressurizing chambers 10 equal to or greater than 80%, and equal to or greater than 90%. In addition, a rigidity of a base of the pressurizing chambers 10 at a portion at which the pressurizing chambers 10 and the submanifold 5b overlap with each other is low compared to a case of not being overlapped with the submanifold 5b, and there is a concern that an ejection property may become uneven due to the difference. It is possible to reduce unevenness of the ejection property due to the change in rigidity of the base which configures the pressurizing chambers 10, by setting a ratio of the area of the pressurizing chambers 10 which overlap with the submanifold 5b to the entire area of the pressurizing chambers 10 to be approximately the same in each of the pressurizing chambers 10. Here, approximately the same means that the difference in the ratio of the area is equal to or less than 10%, and is equal to or less than 5% in particular.

[0046] Since a group of the pressurizing chambers is configured of the plurality of pressurizing chambers 10 with which one manifold 5 is communicated, and there are two manifolds 5, there are two groups of the pressurizing chambers. The arrangement of the pressurizing chambers 10 related to ejection in each pressurizing chamber group is the same, and the pressurizing chamber is arranged by being moved in parallel in the short direction. In these pressurizing chambers 10, there is a portion at which an interval becomes a little wide between the pressurizing chamber groups, or the like, in a region facing the piezoelectric actuator substrate 21 on the upper face of the flow path member 4, however, the pressurizing chambers are arranged approximately over the entire surface. That is, the pressurizing chamber group which is formed by these pressurizing chambers 10 occupies a region which has approximately the same size and shape as those of the piezoelectric actuator substrate 21. In addition, an opening of each of the pressurizing chambers 10 is closed when the piezoelectric actuator substrate 21 is bonded to the upper face of the flow path member 4.

[0047] A descender which is communicated with the ejection holes 8 which is open to the ejection hole face 4-1 on the lower face of the flow path member 4 extends from a corner portion facing a corner portion communicated with the individual supply flow path 14 of the pressurizing chambers 10. The descender extends in a direction separated from the pressurizing chambers 10 when viewed planarly. More specifically, the descender extends while being separated from a direction which goes along a long diagonal line of the pressurizing chambers 10, and while being deviated to the left and right with respect to the direction. In this manner, it is possible to arrange the ejection holes 8 with an interval of 1200 dpi as a whole, while arranging the pressurizing chambers 10 in a lattice shape in which an interval in each pressurizing chamber row 11 is 37.5 dpi.

[0048] In other words, when the ejection holes 8 are projected so as to be orthogonal to a virtual straight line which is parallel to the flow path member 4 in the longitudinal direction, sixteen ejection holes 8 which are communicated with each manifold 5, that is, thirty two ejection holes 8 in total are arranged at equal intervals of 1200 dpi in a range of virtual straight line R illustrated in Fig. 4. Due to this, it is possible to form an image with a resolution of 1200 dpi in the longitudinal direction as a whole, by supplying ink of the same color in the entire manifold 5. In addition, the ejection holes 8 which are communicated with one manifold 5 are arranged at an equal interval of 600 dpi in the range of virtual straight line R. In this manner, it is possible to form images of two colors with a resolution of 600 dpi in the longitudinal direction as a whole, by supplying ink of different colors to the manifold 5. In this case, when two liquid ejecting heads 2 are used, it is possible to form four color images with a resolution of 600 dpi, it is possible to increase printing precision, and to simply perform setting of printing compared to a case of using a liquid ejecting head which can perform printing with a resolution of 600 dpi.

[0049] In addition, in the liquid ejecting head 2, a reservoir may be bonded to the flow path member 4 so as to stabilize a supply of liquid from the opening 5a of the manifold 5. It is possible to stably supply liquid to two openings by causing the liquid which is supplied from the outside to be branched, and providing a flow path which is communicated with the two openings 5a in the reservoir. It is possible to make unevenness of the ejection property of droplets in the liquid ejecting head 2 smaller, since a temperature fluctuation or a pressure fluctuation of liquid which is supplied from the outside is transmitted to the openings 5a on the both ends of the manifold 5 with little time difference, by setting the length of the flow path after being branched to be approximately the same. It is possible to further stabilize a supply of liquid by providing a damper in the reservoir. In addition, a filter may be provided so as to prevent a foreign substance, or the like, in the liquid from going toward the flow path member 4. In addition, a heater may be further provided so as to stabilize a temperature of the liquid which goes toward the flow path member 4.

[0050] The individual electrodes 25 are respectively provided at a position facing each of pressurizing chambers 10 on the upper face of the piezoelectric actuator substrate 21. The individual electrode 25 includes an individual electrode main body 25a which is slightly smaller than each of the pressurizing chambers 10, and has an approximately similar shape to that of the pressurizing chambers 10, and the extraction electrode 25b which is extracted from the individual electrode main body 25a, and the individual electrode 25 configures individual electrode columns and a group of the individual electrodes, similarly to the pressurizing chambers 10. One end portion of the extraction electrode 25b is connected to the individual electrode main body 25a, and the other end portion passes through the acute angle portion 10a of the pressurizing chambers 10, and is extracted to a region which is not overlapped with a column in which a diagonal line connecting two acute angle portions 10a of the respective pressurizing chambers 10 is extended, on the outer side of the respective pressurizing chambers 10. In this manner, it is possible to reduce crosstalk. A shape of the extraction electrode 25b will be described in detail, later.

[0051] In addition, a surface electrode for common electrode 28 which is electrically connected to the common electrode 24, which is the second electrode, through a via hole is formed on the upper face of the piezoelectric actuator substrate 21. Two rows of the surface electrode for common electrode 28 are formed along the longitudinal direction at the center portion of the piezoelectric actuator substrate 21 in the short direction, and one column is formed along the short direction in the vicinity of the end in the longitudinal direction. The illustrated surface electrodes 28 for common electrodes are intermittently formed in a straight line, however, the surface electrode may be continuously formed in the straight line.

[0052] It is preferable that, in the piezoelectric actuator substrate 21, the individual electrode 25 and the surface electrode for common electrode 28 be formed in the same process, after laminating a piezoelectric ceramic layer 21a on which a via hole is formed as will be described later, the common electrode 24, and a piezoelectric ceramic layer 21b, and firing the layers and the electrode. There is a concern that warpage may occur in the piezoelectric actuator substrate 21 when the individual electrode 25 is formed, and then is fired, and when the piezoelectric actuator substrate 21 with the warpage is bonded to the flow path member 4, the piezoelectric actuator substrate 21 is in a state of being applied with stress, and there is a concern that a displacement may become uneven due to an influence thereof, and accordingly, the individual electrode 25 is formed after being fired, since positional unevenness between the individual electrode 25 and the pressurizing chambers 10 has a great influence on an ejection property. Since there is a concern that warpage may also occur in the surface electrode for common electrode 28, similarly, when the surface electrode and the individual electrode 25 are formed at the same time, it is possible to increase precision in position, and to simplify the process, as well, the individual electrode 25 and the surface electrode for common electrode 28 are formed in the same process.

[0053] Since positional unevenness of the via hole due to shrinkage by firing, which may occur when firing the piezoelectric actuator substrate 21, mainly occurs in the longitudinal direction of the piezoelectric actuator substrate 21, the surface electrode for common electrode 28 is provided at a center of the odd-numbered manifold 5, in other words, at the center of the piezoelectric actuator substrate 21 in the short direction, and it is possible to prevent the via hole and the surface electrode for common electrode 28 from not being electrically connected due to positional deviation when the surface electrode for common electrode 28 has a long shape in the longitudinal direction of the piezoelectric actuator substrate 21.

[0054] On the piezoelectric actuator substrate 21, two signal transmission units 92 are respectively arranged so as to face the center from two long sides of the piezoelectric actuator substrate 21, and are bonded. At this time, a connection becomes easy when the connection electrode 26 and a connection electrode for common electrodes are respectively formed on the extraction electrode 25b and the surface electrode for common electrode 28 of the piezoelectric actuator substrate 21a, and are connected. In addition, at this time, when areas of the surface electrode for common electrode 28 and the connection electrode for common electrodes are set to be larger than that of the connection electrode 26, a connection in an end portion of the signal transmission unit 92 (tip end, and end of piezoelectric actuator substrate 21 in longitudinal direction) can be made strong due to the connection on the surface electrode for common electrode 28, it is possible to prevent the signal transmission unit 92 from separating from the end portion.

[0055] In addition, the ejection holes 8 are arranged at a position other than a region facing the manifold 5 which is arranged on the lower face side of the flow path member 4. In addition, the ejection holes 8 are arranged in a region which faces the piezoelectric actuator substrate 21 on the lower face side of the flow path member 4. These ejection holes 8 occupy a region with approximately the same size and shape as the piezoelectric actuator substrate 21 as one group, and can eject droplets by displacing the displacement element 30 of the corresponding piezoelectric actuator substrate 21.

[0056] The flow path member 4 which is included in the head main body 2a has a laminated structure in which a plurality of plates are laminated. These plates are a cavity plate 4a, a base plate 4b, an aperture (diaphragm) plate 4c, a supply plate 4d, manifold plates 4e to 4j, a cover plate 4k, and a nozzle plate 41 in order from the upper face of the flow path member 4. A plurality of holes are formed in these plates. It is possible to make formation precision of holes which are formed high, by setting the thickness of each plate to approximately 10 μm to 300 μm. Each plate is laminated by being aligned so that these holes communicate with each other, and configure an individual flow path 12 and the manifold 5. In the head main body 2a, each portion which configures the individual flow path 12 is arranged by being close to each other at a different position, for example, the pressurizing chambers 10 are arranged on the upper face of the flow path member 4, the manifold 5 is arranged on the lower face side in the inside, and the ejection holes 8 are arranged on the lower face, and the liquid ejecting head has a configuration in which the manifold 5 and the ejection holes 8 are communicated through the pressurizing chambers 10.

[0057] The holes which are formed in each plate will be described. These holes are as follows. First, there are pressurizing chambers 10 which are formed on the cavity plate 4a. Secondly, there is a communication hole which configures the individual supply flow path 14 which is communicated with one end of the pressurizing chambers 10 to the manifold 5. The communication hole is formed on each plate from the base plate 4b (specifically, inlet port of pressurizing chambers 10) to the supply plate 4c (specifically, outlet port of manifold 5). In addition, the diaphragm 6 which is a portion of which a cross-sectional area becomes smaller, and is formed on the aperture plate 4c is included in the individual supply flow path 14.

[0058] Thirdly, there is a communication hole which configures a flow path which communicates from the other end of the each pressurizing chambers 10 to the corresponding one of the ejection holes 8, and the communication hole is referred to as a descender (partial flow path) in the following description. The descender is formed on each plate from the base plate 4b (specifically outlet port of pressurizing chambers 10) to the nozzle plate 41 (specifically, ejection holes 8). The hole of the nozzle plate 41 as the ejection holes 8 of which a diameter which is open to the outside of the flow path member 4 is 10 μm to 40 μm, for example, is open with a diameter which becomes larger toward the inside. Fourthly, there is a communication hole which configures the manifold 5. The communication hole is formed on the manifold plates 4e to 4j. Holes are formed on the manifold plates 4e to 4j so that a partitioning wall 15 remains so as to configure the submanifold 5b. Since the partitioning wall 15 in each of the manifold plates 4e to 4j is in a state of not being maintained, when the entire portion which becomes the manifold 5 is set to a hole, the partitioning wall 15 is in a state of being communicated with the outer periphery of each of the manifold plates 4e to 4j using a tab which is subjected to half etching.

[0059] The individual flow path 12 from an inflow port (outlet port of manifold 5) of liquid from the manifold 5 to the ejection holes 8 is configured when the first to fourth communication holes are communicated with each other. Liquid which is supplied to the manifold 5 is ejected from the ejection holes 8 in the following course. First, liquid is input to the individual supply flow path 14, and reaches one end portion of the diaphragm 6 toward the upper side from the manifold 5. Subsequently, the liquid proceeds in parallel along the extending direction of the diaphragm 6, and reaches the other end portion of the diaphragm 6. The liquid goes toward the upper part therefrom, and reaches one end portion of the pressurizing chambers 10. In addition, the liquid proceeds in parallel along the extending direction of the pressurizing chambers 10, and reaches the other end portion of the pressurizing chambers 10. The liquid mainly goes toward the lower side while moving in the horizontal direction little by little from the other end portion of the pressurizing chambers 10, and proceeds to the ejection holes 8 which are open to the lower face.

[0060] The piezoelectric actuator substrate 21 has a laminated structure which is formed of two piezoelectric ceramic layers 21a and 21b which are piezoelectric bodies. These piezoelectric ceramic layers 21a and 21b have a thickness of approximately 20 μm, respectively. The thickness of the piezoelectric actuator substrate 21 from the lower face of the piezoelectric ceramic layer 21a to the upper face of the piezoelectric ceramic layer 21b is approximately 40 μm. Both the piezoelectric ceramic layers 21a and 21b are extended so as to straddle the plurality of pressurizing chambers 10. These piezoelectric ceramic layers 21a and 21b are formed of a lead zirconate titanate (PZT)-based ceramic material with ferroelectricity, for example.

[0061] The piezoelectric actuator substrate 21 includes the common electrode 24 which is formed of an Ag-Pu-based metallic material, or the like, and the individual electrode 25 which is formed of an Au-based metallic material, or the like. The individual electrode 25 includes an individual electrode 25 main body (electrode main body) 25a which is arranged at a position facing the respective pressurizing chambers 10 on the upper face of the piezoelectric actuator substrate 21, and the extraction electrode 25b which is extracted therefrom, as described above. The connection electrode 26 is formed at a portion of one end of the extraction electrode 25b which is extracted to the outside of the region which faces the respective pressurizing chambers 10. The connection electrode 26 is formed of silver-palladium including glass frit, for example, and is formed in a convex shape with a thickness of approximately 15 μm. In addition, the connection electrode 26 is electrically bonded to an electrode which is provided in the signal transmission unit 92. Though it will be described in detail later, a driving signal is provided in the individual electrode 25 from the control unit 100 through the signal transmission unit 92. The driving signal is supplied at a constant cycle by being synchronized with a transport speed of the printing medium P.

[0062] The common electrode 24 is formed in a region between the piezoelectric ceramic layer 21a and the piezoelectric ceramic layer 21b over approximately the entire surface in the plane direction. That is, the common electrode 24 extends so as to cover all of the pressurizing chambers 10 in the region facing the piezoelectric actuator substrate 21. The thickness of the common electrode 24 is approximately 2 μm. The common electrode 24 is connected to the surface electrode for common electrode 28 which is formed at a position except for an electrode group which is formed of the individual electrode 25 on the piezoelectric ceramic layer 21b thorough a via hole which is formed in the piezoelectric ceramic layer 21b, is grounded, and is maintained at a ground potential. The surface electrode for common electrodes 28 is connected to a separate electrode on the signal transmission unit 92, similarly to the plurality of individual electrodes 25.

[0063] In addition, as it will be described later, by supplying a predetermined driving signal to the individual electrode 25, selectively, a volume of the pressurizing chambers 10 corresponding to the individual electrode 25 is changed, and a pressure is applied to liquid in the respective pressurizing chambers 10. In this manner, droplets are ejected from corresponding liquid ejection holes 8 through the individual flow path 12. That is, a portion facing each of the pressurizing chambers 10 in the piezoelectric actuator substrate 21 corresponds to an individual displacement element 30 corresponding to each of the pressurizing chambers 10 and liquid ejection holes 8. That is, the displacement element 30 which is the piezoelectric actuator which has a structure illustrated in Fig. 5 as a unit structure is built using a vibrating plate 21a which is located directly above the respective pressurizing chambers 10, the common electrode 24, the piezoelectric ceramic layer 21b, and the individual electrode 25 in each of the pressurizing chambers 10 in the laminated body which is configured of the two piezoelectric ceramic layers 21a and 21b, and the plurality of displacement elements 30 which are pressurizing units are included in the piezoelectric actuator substrate 21. In addition, an amount of liquid which is ejected from the liquid ejection holes 8 due to one ejection operation in the embodiment is approximately 1.5 pl to 4.5 pl (picoliter).

[0064] The plurality of individual electrodes 25 are electrically connected to the control unit 100, individually, through the signal transmission unit 92 and wiring, respectively, so that it is possible to individually control a potential. When an electric field is applied in a polarization direction with respect to the piezoelectric ceramic layer 21b by setting a potential of the individual electrode 25 to be different from that of the common electrode 24, a portion to which the electric field is applied works as an activated portion which is warped due to the piezoelectric effect. In this configuration, when the individual electrode 25 is set so as to have a predetermined potential of positive or negative with respect to the common electrode 24 using the control unit 100 so that the electric field and the polarization are in the same direction, a portion (active portion) which is disposed between electrodes of the piezoelectric ceramic layer 21b contracts in the plane direction. Meanwhile, since the piezoelectric ceramic layer 21a which is a non-active layer is not influenced by the electric field, the piezoelectric ceramic layer tries to regulate deformation of the active portion without being contracted voluntarily. As a result, there is a difference in warpage in the polarization direction between the piezoelectric ceramic layers 21a and 21b, and the piezoelectric ceramic layer 21b deforms (unimorph deformation) so as to be convex to the pressurizing chambers 10 side.

[0065] In actual driving order according to the embodiment, the individual electrode 25 is set so as to have a higher potential than that of the common electrode 24 (hereinafter, referred to as high potential), the potential of the individual electrode 25 is set to the same potential as that of the common electrode 24 (hereinafter, referred to as low potential) temporarily, every time there is an ejection request, and is set to the high potential again at a predetermined timing thereafter. In this manner, the piezoelectric ceramic layers 21a and 21b return to the original shapes at a timing in which the individual electrode 25 has the low potential, and a volume of the pressurizing chambers 10 increases compared to the initial state (state in which potentials of both electrodes are different). At this time, negative pressure is applied in the pressurizing chambers 10, and liquid is sucked into the pressurizing chambers 10 from the manifold 5 side. The piezoelectric ceramic layers 21a and 21b deform so as to become convex on the pressurizing chambers 10 side at a timing in which the individual electrode 25 is set to the high potential again thereafter, the pressure with respect to liquid increases when the pressure in the pressurizing chambers 10 becomes positive pressure due to the decrease in volume of the pressurizing chambers 10, and droplets are ejected. That is, a driving signal including a pulse which is based on the high potential is supplied to the individual electrode 25 in order to eject droplets. For the pulse width, it is ideal to adopt an acoustic length (AL) which is a time length in which a pressure wave propagates from the diaphragm 6 to the ejection holes 8. In this manner, pressures of both are put together when the inside of the pressurizing chambers 10 are reversed to a positive pressure state from a negative pressure state, and it is possible to make droplets be ejected using stronger pressure.

[0066] In addition, in gradation printing, a gradation expression is performed using an amount of droplets (volume) which is adjusted by the number of droplets which are continuously ejected from the ejection holes 8, that is, the number of ejections of droplets. For this reason, the number of ejections of droplets corresponding to a designated gradation expression is continuously performed from the ejection holes 8 corresponding to a designated dot region. In general, when ejection of liquid is continuously performed, it is preferable that an interval between pulses which are supplied in order to eject droplets be set to AL. In this manner, a cycle of a residual pressure wave of a pressure which is generated when ejecting droplets which are previously ejected, and a pressure wave of a pressure which is generated when ejecting droplets which are ejected later matches, and it is possible to amplify the pressure for ejecting droplets due to the overlapped pressure waves. In addition, in this case, a case where the speed of droplets ejected later becomes fast is taken into consideration, however, such a case is preferable since landing points of a plurality of droplets become close.

[0067] Here, in the head main body 2a, one submanifold 5a is communicated with pressurizing chamber rows 11 of two rows which are arranged on the left and right of the submanifold 5a, respectively, when viewed planarly. The pressurizing chambers 10 which belong to the two pressurizing chamber rows 11 includes a first region 10-1 which overlaps with the submanifold 5a, and a second region 10-2 which does not overlap with the submanifold. Due to such an arrangement, it is possible to secure a quantity of flow by making the width of the submanifold larger, and to make the length of the head main body 2a in the shortl direction smaller.

[0068] However, due to such an arrangement, there is a case where the ejection property becomes uneven depending on whether the extraction electrode 25b is extracted from the first region 10-1, or is extracted from the second region 10-2 of the pressurizing chambers 10. The reason why the ejection property becomes uneven is that an influence at a time when the piezoelectric ceramic layer 21b between the extraction electrode 25a and the common electrode 24 is subjected to piezoelectric deformation becomes different in a first extraction electrode 25a-1 which is extracted from the first region 10-1, and has the submanifold 5a directly below, and in a second extraction electrode 25b-2 which is extracted from the second region 10-2, and has no submanifold 5a directly below. For example, since structural deformation easily occurs when there is the submanifold 5a directly below, there is a possibility that ejection conditions may be remarkably changed from an ideal state, the ejection speed may be lowered, and the ejection amount may decrease due to the piezoelectric deformation at a position directly below the extraction electrode 25b-1.

[0069] Therefore, by providing two extraction electrodes 25b in the individual electrodes 25 as illustrated in Fig. 6(a), setting one of the extraction electrodes to a first extraction electrode 25b-1 which is extracted from the first region 10-1 of the respective pressurizing chambers 10 which is overlapped with the submanifold 5a, and setting the other to a second extraction electrode 25b-2 which is extracted from the second acute angle portions of the respective pressurizing chambers 10 at a position which is not overlapped with the submanifold 5a, it is possible to reduce ejection unevenness. In addition, in Fig. 6(a), wiring 92b of the signal transmission unit 92 which is a wiring board connected to the piezoelectric actuator substrate 21 is also illustrated. Lines in the figure are all denoted using solid lines, though the lines are transparent in practice since the lines are complicated.

[0070] A plurality of the first extraction electrode 25b-1 may be extracted from the first region 10-1. A plurality of the second extraction electrode 25b-2 may also be extracted from the second region 10-2. At this time, if the number of the respective first extraction electrodes and the second extraction electrodes is set to be the same, or a total area is set to be the same, it is possible to make the occurrence of a difference in influence of the piezoelectric deformation difficult, and to reduce ejection unevenness.

[0071] In addition, the wiring 92b extends along the column direction, and a plurality thereof are arranged by being aligned in the row direction. In such a case, by electrically connecting any one of the two extraction electrodes 25b to the wiring 92b, and by alternating the connected side in the pressurizing chamber row 11, it is possible to make an interval of the wiring 92b larger, make the thickness of the wiring 92b larger, and to increase reliability.

[0072] Seven wiring 92b are arranged between the connection electrode 26 at a position of C1 and the connection electrode 26 at a position of C3. Due to the alternate connection which is described above, the arrangement of the wiring is relatively spacious, however, when it is not the alternate arrangement, for example, if the electrical connection is performed at a position of D1 which is another extraction electrode 525b, not the position of C2, six wiring 92b are arranged between the position of D1 and the position of C2, the width of the wiring 92b becomes smaller, and the interval of the wiring 92 also becomes smaller. Such a design leads to an increase in cost of the wiring board 92, or degradation of reliability, and when the interval is excessively small, a design may not be possible. The alternate arrangement is essential in the wiring board 92 in which the wiring 92 is a single layer.

[0073] In addition, in Fig. 6(a), the connection electrode 26 is provided in the extraction electrode 25b which is electrically connected to the wiring 92b, and a dummy connection electrode 27 is provided in the extraction electrode 25b which is not electrically connected to the wiring 92b. The connection electrode 26 protrudes from the surface of the piezoelectric actuator substrate 21, and the connection electrode is a portion to which a force is applied when bonding the piezoelectric actuator substrate 21 and the flow path member 4, it is possible to perform stable bonding by making a method of applying approximately equal force, by providing the dummy connection electrode 27 which has the similar shape. The dummy connection electrode 27 may be provided at a location except for the extraction electrode 25b, however, it is possible to prevent a difference in thickness between the connection electrode 26 and the extraction electrode 25b from occurring by providing the dummy connection electrode on the extraction electrode 25b.

[0074] Figs. 6(b) and Fig. 7 are enlarged plan views of a liquid ejecting head according to another embodiment of the present invention. A basic structure of a head main body is similar to those illustrated in Figs. 2 to 5, and individual electrodes 625 and 725 with differences will be described by being illustrated.

[0075] In Fig. 6(b), both first and second extraction electrodes 625b-1 and 625b-2 which are extracted from the first region 10-1 and the second region 10-2 of the individual electrode 625 are respectively extracted through two acute angle portions of the pressurizing chambers 10. Here, the acute angle portion is a portion which is located between linear sides of the pressurizing chambers 10 which have a diamond shape, and forms an angle between the two sides, or is a portion which forms a curve by bending the angle so as to be rounded, and in which an angle which is formed by the two sides is an acute angle (less than 90°). When being extracted from the acute angle portions, it means that the extraction electrode 625b may pass through the angle, or a portion of a curve which is bent so as to make the angle be rounded. It is possible to reduce the influence of crosstalk while reducing a decrease in displacement due to the piezoelectric deformation of a piezoelectric ceramic layer 21b directly below the extraction electrode 625b, by bending the extraction electrode 625b right before a portion which is the furthest end of the acute angle portion as illustrated in Fig. 9(b).

[0076] In Fig. 7, a first extraction electrode 725b-1 and a second extraction electrode 725b-2 are extracted in the row direction from an acute angle portion of the individual electrode main body which has appropriately the same shape as that of the pressurizing chambers 10 of an individual electrode 725, and of which the entire angle (inclination) also has approximately the same diamond shape. Here, the acute angle portion of the individual electrode main body is the same as that of the pressurizing chambers 10, and is furthest end of the individual electrode main body which has approximately the same shape as that of the pressurizing chambers 10 in the longitudinal direction. It is preferable to be extracted from the acute angle portion of the pressurizing chambers 10 in order to suppress the decrease in a displacement amount due to piezoelectric deformation directly below the extraction electrode 725b. From this point of view, it is preferable to adopt the structures in Figs. 6(a) and 6(b), and the structure in Fig. 6(a), in particular. Meanwhile, in such a structure, since the length after being extracted to the outside from the pressurizing chambers 10 becomes larger, unevenness in ejection property which is influenced by the piezoelectric deformation directly below the extraction electrode becomes remarkable. When the first extraction electrode 725b-1 and the second extraction electrode 725b-2 are extracted in the row direction from the acute angle portion of the individual electrode main body, it is possible to make the length of the first extraction electrode 725b-1 and the second extraction electrode 725b-2 smaller, and to make the unevenness in ejection property the smallest. Subsequently, crosstalk in the liquid ejecting head 2 will be described in detail. As described above, crosstalk, which occurs when vibration of the pressurizing chambers 10 is transmitted to the flow path member 4 and then transmitted to a neighboring one of the pressurizing chambers 10, can be reduced by arranging the pressurizing chambers 10 which have the diamond shapes arranged in a lattice shape, or by arranging the pressurizing chamber so that corner portions face each other.

[0077] The crosstalk is further influenced by the arrangement of the extraction electrode 25b. The piezoelectric ceramic layer 21b directly below the extraction electrode 25b is polarized in order to make a structure of the displacement element 30, or a manufacturing process of the piezoelectric actuator substrate 21 simple, and when a voltage is applied to the individual electrode main body 25a, the piezoelectric actuator substrate 21 directly below the extraction electrode 25b is also subjected to the piezoelectric deformation.

[0078] The piezoelectric deformation of the piezoelectric ceramic layer 21b directly below the extraction electrode 25b in the respective pressurizing chambers 10 influences the displacement amount of the displacement element 30. For example, when the displacement element 30 is subjected to bending deformation on the pressurizing chambers 10 side, by contracting the piezoelectric ceramic layer 21b directly below the individual electrode main body 25a in the planar direction, since the piezoelectric ceramic layer 21b directly below the extraction electrode 25b in the respective pressurizing chambers 10 also contracts in the planar direction, the displacement amount is reduced. It is possible to make the amount of decrease in displacement smaller by extracting the extraction electrode 25b from the acute angle portion 10a of the pressurizing chambers 10b. Here, since deformation thereof occurs in the vicinity of the acute angle portion 10a when the piezoelectric ceramic layer 21b directly below the individual electrode main body 25a deforms in the planar direction, the displacement amount of the displacement element 30 becomes smaller even when the same deformation force is generated, and accordingly, a decrease in the displacement amount which is a result of combining a displacement of the displacement element 30 in the direction which is the original deformation direction becomes smaller. In contrast to this, when the extraction electrode 25b is extracted in the middle of a side of the pressurizing chambers 10 which have the diamond shape, since a deformation amount in the portion becomes larger because of easy deformation of the displacement element 30, the decrease in the displacement amount as a result of combining the displacement of the displacement element 30 in the original deformation direction becomes larger. For example, in the displacement element 30 in the planar shape which is illustrated in Fig. 8, the displacement amount decreases by approximately 1% when the extraction electrode is extracted in the middle of the side, compared to the case in which the extraction electrode 25b is extracted from the acute angle portion 10a.

[0079] In addition, since the piezoelectric ceramic layer 21b directly below the extraction electrode 25b which is extracted to the outside of the pressurizing chambers 10 is also subjected to the piezoelectric deformation, a displacement of a neighboring displacement element 30 is influenced. In the influence, there is an influence which is caused by a transmitted vibration, and an influence which is caused when stress is applied to a piezoelectric ceramic layer 21b of a neighboring displacement element 30 when the piezoelectric ceramic layer 21b directly below the extraction electrode 25b is expanded and contracted in the planar direction, since the piezoelectric ceramic layer 21b has a shape covering the plurality of pressurizing chambers 10. Reduction in crosstalk described below is particularly useful in the piezoelectric actuator substrate 21 which is integrally configured between the displacement elements 30 to which the piezoelectric ceramic layer 21b is close.

[0080] Subsequently, the shape of the individual electrode 25 will be described using the individual electrode 25 which is located on the lower side in the center in Fig. 8. It is necessary for the extraction electrode 25b which is extracted from the acute angle portion 10a side of the individual electrode 25 to be extracted to a position which is separated from the pressurizing chambers 10 to some extent, when securing a portion which becomes a terminal of a certain area in order to be connected to the outside. At this time, since it is possible to make a distance between the extraction electrode and the displacement element 30 which is neighboring on the acute angle portion 10a side larger by causing one end portion of the extraction electrode 25b which is connected to the individual electrode main body 25a and the other end portion on the opposite side not to overlap with a column (virtual line LB1) in which a diagonal line which connects acute angle portions 10a is extended, crosstalk can be reduced. In order to reduce the crosstalk, the extraction electrode 25b is extracted by being bent so as to face the row direction from the column direction which is the direction to be faced when the extraction electrode is extracted from the acute angle portion 10a. In Fig. 6, a side on which the extraction electrode 25b is extracted is bent by approximately 110° which is equal to or greater than 90° until it becomes the row direction, however, the bent angle may be smaller than 90°, or may be larger than 90°.

[0081] In particular, since it is possible to make a distance between the extraction electrode 25b and the pressurizing chambers 10 which are neighboring on the acute angle portion 10a side large, when the extraction electrode 25b passes through the one acute angle portion 10a of the pressurizing chambers 10 from which the extraction electrode 25b is extracted, and is arranged on virtual line LA1 which is parallel to the diagonal line which connects the obtuse angle portions 10b of the pressurizing chambers 10, or on the pressurizing chambers 10 side rather than virtual line LA1, crosstalk can be reduced. More specifically, when a distance from the pressurizing chambers 10 which are neighboring on the acute angle portion 10a side is compared, it is possible to reduce crosstalk by setting the entire extraction electrode 25b to be farther away from the pressurizing chambers 10 neighboring on the acute angle portion 10a side, compared to a portion which is closest to the pressurizing chambers 10 neighboring on the acute angle portion 10a side in an S shape, when the same S shape (circular shape in this case) as the other end portion of the extraction electrode 25b (extracted tip end of extraction electrode 25b, and is a portion which becomes terminal in usual) is arranged at the front side of the acute angle portion 10a. It means that it is possible to reduce crosstalk by causing the extraction electrode 25b to be in a state where a distance from the pressurizing chambers 10 neighboring on the acute angle portion 10a side is farther away (state in which extraction electrode is arranged on a side closer to pressurizing chambers 10 side from which extraction electrode 25b is extracted rather than LA2), compared to a case where a terminal is provided at a place which is closest to the acute angle portion 10a of the pressurizing chambers 10.

[0082] When the extraction electrode 25b is formed in a region which is closer to the pressurizing chambers 10 from which the extraction electrode 25b is extracted, rather than the pressurizing chambers 10 which are neighboring on the obtuse angle portion 10b side of the pressurizing chambers 10 from which the extraction electrode 25b is extracted, it is possible to reduce crosstalk with the displacement element 30 which is neighboring on the obtuse angle portion 10b side. More specifically, when considering virtual line LB2 which passes through the obtuse angle portion 10b of the pressurizing chambers 10 from which the extraction electrode 25b is extracted, and is parallel to a diagonal line which connects the acute angle portions 10a, and virtual line LB3 which faces the obtuse angle portion 10b, passes through the obtuse angle portion 10b of neighboring pressurizing chambers 10, and is parallel to virtual line LB2, the extraction electrode 25b is arranged in a region which is closer to the pressurizing chambers 10 in which the extraction is performed, rather than virtual line LB4 between the virtual lines.

[0083] Fig. 9 is a further enlarged plan view of Fig. 6(a). The individual electrode 25 includes first and second extraction electrode 25b-1 and 25b-2 which are extracted to the outside of the pressurizing chambers 10 from the individual electrode main body 25a and the individual electrode 25 which are disposed in the pressurizing chambers 10 region viewed in plan.

[0084] The individual electrode main body 25a has a diamond shape which includes two acute angle portions 25aa, and two obtuse angle portions 425ab. An angle and a position of a line which connects the two acute angle portions 25aa of the individual electrode main body 25a match those of the line which connects the two acute angle portions 10a of the pressurizing chambers 10. In addition, an angle and a position of the line which connects the two obtuse angle portions 25ab of the individual electrode main body 25a match those of the line which connects the two obtuse angle portions 10b of the pressurizing chambers 10. In this manner, it is possible to make a displacement amount of the displacement element 30 larger. A position of the respective lines may be deviated by 10% or less of the maximum width of the pressurizing chambers 10, and an angle may also be deviated by 10° or less. In addition, it is possible to make the displacement amount larger by setting an area of the individual electrode main body 25a to 50% to 90% of an area of the pressurizing chambers 10, or to 60% to 80%, more preferably.

[0085] The first and second extraction electrode 25b-1 and 25b-2 (hereinafter, referred to as extraction electrode 25b by being combined) are connected to the individual electrode main body 25a using the acute angle portion 25a on one side. The connection portion is located at the acute angle portion 10a of the pressurizing chambers 10. The extraction electrode 425b is bent on the outer side of the acute angle portion 10a (region which does not overlap with pressurizing chambers 10) so as to be folded back, that is, at an angle larger than 90° and 180° or less, and becomes a linear shaped portion 25ba which is linear from the bent portion to an end portion at which the connection electrode 26 or the dummy connection electrode 27 is formed. In this manner, a position of the end portion of the extraction electrode 425ba in the column direction is close to the individual electrode main body 25a which is extracted, rather than the acute angle portion 10a of the pressurizing chambers 10 which is the source of extraction. In this manner, it is possible to make a distance from other pressurizing chambers 10 which are aligned in the column direction farther away, and to reduce crosstalk.

[0086] Subsequently, an angle of the linear shaped portion 25ba will be described. An angle of a corner which is formed by the linear shaped portion 25ba (virtual straight line LC is a line which is extended at the same angle as linear shaped portion 25ba) and virtual straight line LA3 which is stretched in the row direction is set to

C. Virtual straight lines which are formed by extending two diamond-shaped sides which encloses the acute angle portions 425aa of the extraction electrode 425a to which the extraction electrode 25b is connected are LD1 and LD2, and angles of corners which are formed by LD1 and LD2, and virtual straight line LA3 which is stretched in the row direction are set to D1 and D2, respectively. The formed angles C, D1, and D2 are acute angles, and are 90° or less.

[0087] A value of the angles D1+D2 is 90° or more, since the acute angle portion 25aa is the acute angle. The angles D1 and D2 may not be the same. That is, angles of the line which connects the diamond-shaped acute angle portions 25aa of the individual electrode main body 25a, and the line which connects the obtuse angle portions 25ab may be deviated from the angles of the pressurizing chambers 10 in the row direction and in the column direction. When the deviation in angles is set to 20° or less, it is possible to reduce crosstalk, since the pressurizing chambers 10 which are neighboring in the column direction and the sides do not face each other.

[0088] When the angles D1 and D2 are set to 55° to 75°, it is possible perform a dense arrangement in the row direction so as to obtain high resolution of printing, since a dimension in the row direction can be made smaller while making a displacement amount larger. It is possible to increase formation precision of the linear shaped portion 25ba by making the angle C smaller than the angles D1 and D2, and to prevent unevenness of a formation position, unevenness of the ejection property which is caused by unevenness of a resistance value, a short circuit, or the like, which may occur due to formation unevenness from occurring.

[0089] It is possible to manufacture the individual electrode 25 at low cost when the electrode is formed by firing a conductive paste which is subjected to screen printing, and it is preferable since high productivity can be obtained. In the screen printing, printing is performed by attaching a mesh in which a metallic wire, or the like, is knitted in a lattice shape to a rectangular frame, forming an opening portion on a resist which is attached to the mesh, and pushing the conductive paste from the opening portion using a squeegee. In addition, when performing such printing, the thickness of the individual electrode 25 at a portion corresponding to the opening portion becomes thicker in a lattice shape, or a shape on the outer periphery of the individual electrode 25 is slightly deviated in a lattice shape.

[0090] In the screen printing, since unevenness occurs in a printing state due to changes in printing conditions, when the length on which a printing target and the squeegee come into contact through a screen is changed while the squeegee is moving, or a position with respect to the screen frame is changed, basically, the squeegee is set so as to move in parallel to the frame of the screen, and the printing target is set so that there is little change in the width of the screen in the movement direction. In addition, when an angle of the lattice-shaped mesh with respect to the frame of the screen is 0°, and printing is repeated, there is a great influence of the screen which is slipped off in the printing direction by the squeegee, therefore, a certain angle is provided.

[0091] In addition, in the printing, a portion at which a wire is present is not directly supplied with the conductive paste, and printing is performed when the conductive paste flows in from the periphery. For this reason, when the outer periphery of a conductive pattern and an angle of the wire become close, and the positions also become close, a supply of the conductive paste is performed only from the wire side, unevenness easily occurs in a shape of the conductive pattern. Therefore, it is preferable to adjust an angle of the mesh so that printing precision on the outer periphery of the individual electrode main body 25a in which positional accuracy is particularly required becomes good.

[0092] In the angle of the mesh, it is preferable to make a difference so that an angle of the diamond-shaped side of the individual electrode main body 25a does not match the angles D1 and D2. That is, all of angles of the wire of the mesh which are orthogonal may be set to be larger than an angle (90-D1) and an angle (90-D2), may be set to be smaller than the angles D1 and D2, and it is preferable to be set to 45°. In addition, the angle C of the linear shaped portion 425ba may become larger by separating the linear shaped portion 25ba from the neighboring pressurizing chambers 10 so that crosstalk is reduced. Since formation precision of the linear shaped portion 25ba can be lowered compared to the individual electrode main body 425a, it is possible to reduce crosstalk by setting the angle C to (90-D1)° or more, or (90-D2)° or more. On the other hand, since the formation precision is lowered when the angle C exceeds 45°, it is preferable to set the angle to be 45° or less. A range of the angle C which is more preferable is larger than (90-D1)° and (90-D2)° by 5° or more, smaller than 45° by 5° or more, and $95\text{-}D1 \leq C$, $95\text{-}D2 \leq C$, and $C \leq 40°$.

[0093] As described above, the liquid ejecting head 2 is manufactured as follows. A formation of a tape which is formed of piezoelectric ceramic powder and an organic composition is performed using a general tape molding method such as a roll coater method, and a slit coater method, and a plurality of green sheets which become the piezoelectric ceramic layers 21a and 21b are manufactured after firing. An electrode paste which becomes the common electrode 24 is formed at a part of the green sheet on the surface thereof using a printing method, or the like. In addition, a via hole is formed at a part of the green sheet as necessary, and a via conductor is filled inside the via hole.

[0094] Subsequently, a laminated body is manufactured by laminating each green sheet, the laminated body is cut into a rectangular shape after being pressed and adhered, and is fired under a highly concentrated oxygen atmosphere. Organic gold paste is printed on the surface of a piezoelectric actuator element body which is fired using screen printing, and a fired individual electrode 25 is formed. In the screen printing, the rectangular piezoelectric actuator element body is arranged so as to be parallel to the frame of the screen using a screen to which the mesh is attached at an angle of 45° with respect to the frame, and printing is performed by moving the squeegee in parallel in the longitudinal direction of the piezoelectric actuator element body. Thereafter, the piezoelectric actuator substrate 21 is manufactured by printing the connection electrode 26 using Ag paste, and firing the connection electrode.

[0095] Subsequently, the flow path member 4 is manufactured by laminating plates 4a to 41 which are obtained using a rolling process, or the like, through an adhesive layer. On the plates 4a to 41, holes which become the manifold 5, the individual supply flow path 14, the pressurizing chambers 10, the descender, and the like, are processed in a predetermined shape using etching.

[0096] It is preferable to form these plates 4a to 41 using at least one type of metal which is selected from a group of Fe-Cr, Fe-Ni, and WC-TiC, and Fe-Cr is more preferable, since it is preferable to use a material which is good in anticorrosion with respect to ink when ink is used as liquid, in particular.

[0097] The piezoelectric actuator substrate 21 and the flow path member 4 can be bonded in a laminating manner through an adhesive layer, for example. As the adhesive layer, it is possible to use a well-known matter, however, in order to prevent the piezoelectric actuator substrate 21 or the flow path member 4 from being influenced, at least one type of a thermosetting resin-based adhesive which is selected from a group of an epoxy resin, a phenol resin, and a polyphenylene ether resin of which a thermosetting temperature is 100° to 150° may be used. When heating up to the thermosetting temperature using such an adhesive layer, it is possible to heat and bond the piezoelectric actuator substrate 21 and the flow path member 4.

[0098] Subsequently, in order to electrically connect the piezoelectric actuator substrate 21 and the control circuit 100, silver paste is supplied to the connection electrode 26, an FPC which is the signal transmission unit 92 on which the driver IC is mounted in advance is placed, and the piezoelectric actuator substrate and the control circuit are electrically connected by curing the silver paste using heat. In addition, when mounting the driver IC, a flip chip is electrically connected to the FPC using soldering, and then is cured by supplying a protective resin around the soldering.

[0099] Subsequently, a reservoir is bonded so as to supply liquid from the opening 5a as necessary, a metallic housing is screwed, and then the liquid ejecting head 2 can be manufactured by sealing a bonding unit using a sealing agent.

[Reference Signs List]

[0100]

1 PRINTER
2 LIQUID EJECTING HEAD
2a HEAD MAIN BODY
4 FLOW PATH MEMBER

4a TO 41 PLATES (OF FLOW PATH MEMBER)

5 MANIFOLD (COMMON FLOW PATH)

5a OPENING (OF MANIFOLD)
5b SUBMANIFOLD

6 DIAPHRAGM
8 EJECTION HOLE
9 EJECTION HOLE ROW
10 PRESSURIZING CHAMBER

10 ACUTE ANGLE PORTION
10b OBTUSE ANGLE PORTION
10-1 FIRST REGION (REGION OVERLAPS WITH COMMON FLOW PATH)
10-2 SECOND REGION (REGION DOES NOT OVERLAP WITH COMMON FLOW PATH)

11 PRESSURIZING CHAMBER ROW
12 INDIVIDUAL FLOW PATH
14 INDIVIDUAL SUPPLY FLOW PATH
15 PARTITIONING WALL
21 PIEZOELECTRIC ACTUATOR SUBSTRATE

21a PIEZOELECTRIC CERAMIC LAYER (VIBRATION PLATE)
21b PIEZOELECTRIC CERAMIC LAYER

24 COMMON ELECTRODE
25, 625, 725 INDIVIDUAL ELECTRODE

25a, 425a, 625a, 725a INDIVIDUAL ELECTRODE MAIN BODY
25aa ACUTE ANGLE PORTION (OF INDIVIDUAL ELECTRODE MAIN BODY)
25ab OBTUSE ANGLE PORTION (OF INDIVIDUAL ELECTRODE MAIN BODY)
25b EXTRACTION ELECTRODE
25ba LINEAR SHAPED PORTION
25b-1, 625b-1, 725b-1 FIRST EXTRACTION ELECTRODE
25b-2, 625b-2, 725b-2 SECOND EXTRACTION ELECTRODE

26, 626, 726 CONNECTION ELECTRODE
27, 627, 727 DUMMY CONNECTION ELECTRODE
28 SURFACE ELECTRODE FOR COMMON ELECTRODE
30 DISPLACEMENT ELEMENT (PRESSURIZING UNIT)
92 SIGNAL TRANSMISSION UNIT (WIRING BOARD)

92b WIRING

Claims

1. A liquid ejecting head comprising:

   a flow path member including a plurality of ejection holes, a plurality of pressurizing chambers which are respectively communicated with the plurality of ejection holes, and one, or a plurality of common flow paths which are communicated with the plurality of pressurizing chambers;
   a piezoelectric actuator substrate which is laminated on the flow path member so as to cover the plurality of pressurizing chambers; and
   a wiring board,
   wherein the piezoelectric actuator substrate is formed by laminating a first electrode, a piezoelectric body, and a plurality of second electrodes in this order from the flow path member side,
   wherein, when the liquid ejecting head is viewed planarly, the plurality of pressurizing chambers are in diamond shapes with two obtuse angle portions and two acute angle portions, respectively, and are arranged on a row which goes along a diagonal line connecting the two obtuse angle portions, and on a column which goes along a diagonal line connecting the two acute angle portions, respectively, with approximately equal intervals,
   wherein the common flow path extends along a direction of the row, and communicates with the pressurizing chambers which are aligned on both sides of the common flow path row by row,
   wherein each of the pressurizing chambers communicating with the common flow path includes a first region which is overlapped with the common flow path and a second region which is not overlapped with the common flow path,
   wherein the plurality of second electrodes are arranged so as to overlap with the plurality of pressurizing chambers respectively, and include an electrode main body which is disposed within the pressurizing chamber, a first extraction electrode of which one end portion is connected to the electrode main body in the first region and the other end portion is extracted to an outside of the pressurizing chamber, and a second extraction electrode of which one end portion is connected to the electrode main body in the second region, and the other end portion is extracted to the outside of the pressurizing chamber, and
   wherein any one of the first extraction electrode and the second extraction electrode of the second electrode is electrically connected to the wiring board, and the first extraction electrode and the second extraction electrode are alternately connected in the row direction.

2. The liquid ejecting head according to claim 1, wherein, when the liquid ejecting head is viewed planarly, the other end portions of the first and second extraction electrodes are extracted to a region which is not overlapped with the column.

3. The liquid ejecting head according to claim 1 or 2, wherein the first and second extraction electrodes are extracted from the acute angle portion.

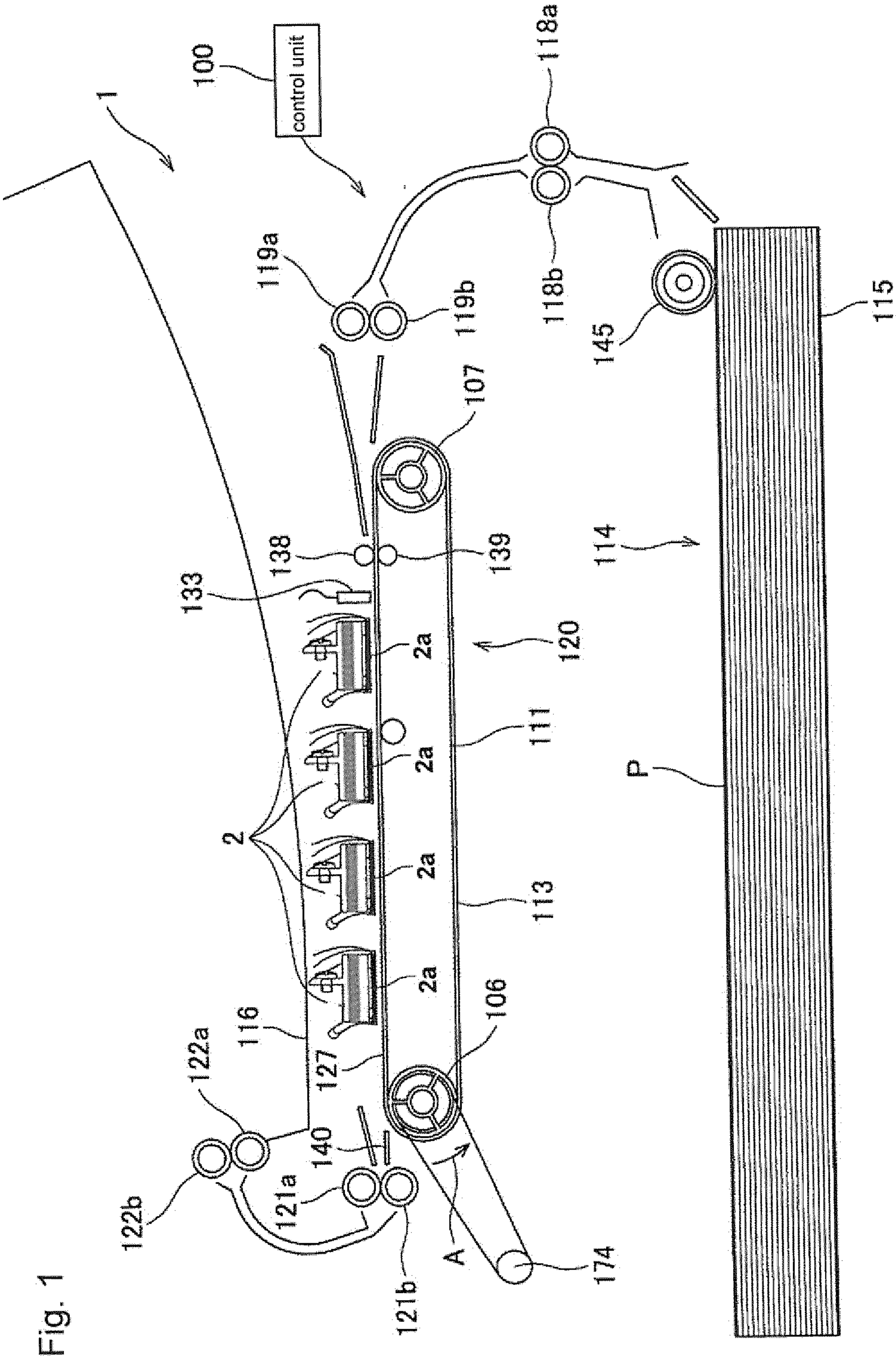
4. The liquid ejecting head according to any one of claims 1 to 3,
   wherein, when the liquid ejecting head is viewed planarly, the first and second extraction electrodes each extend in the row direction from the respective acute angle portions of the pressurizing chamber from which the extraction electrodes are extracted, and the other end portions of the extraction electrodes are provided on a virtual line which is parallel to the row which passes through the one acute angle portion, or on the pressurizing chamber side rather than the virtual line.

5. The liquid ejecting head according to any one of claims 1 to 4,
   wherein, when the liquid ejecting head is viewed planarly, the electrode main body has a diamond shape, the first and second extraction electrodes each include a linear shaped portion which extends from an outside of the acute angle portion to the other end portion, and a direction in which the linear shaped portion extends toward the other end portion is a direction in which the extraction electrode extends toward the electrode main body from which the extraction electrode is extracted in the column direction, and
   wherein, when an angle which is formed by the linear shaped portion and the row direction is set to C and angles which are respectively formed by the row direction and two sides that enclose a portion of the second electrode from which the extraction electrode is extracted are set to D1 and D2, the angles satisfy the relationship of $90\text{-}D1 \leq C$, $90\text{-}D2 \leq C$, and $C \leq 45°$.

6. The liquid ejecting head according to claim 1 or 2, wherein, when the liquid ejecting head is viewed planarly, the electrode main body has a diamond shape which is similar to the pressurizing chamber, and the first and second extraction electrodes are extracted from the acute angle portion of the electrode main body in the row direction.

7. A recording apparatus comprising:

the liquid ejecting head according to any one of claims 1 to 6;
a transport unit which transports a recording medium to the liquid ejecting head; and
a control unit which controls the piezoelectric actuator substrate.


1
100
control unit
118a
118b
119a
119b
107
145
115
138
139
133
114
120
2a
2a
2a
2a
111
P
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113
116
106
122a
127
140
121a
122b
A
174
121b

Fig. 1

Fig. 2

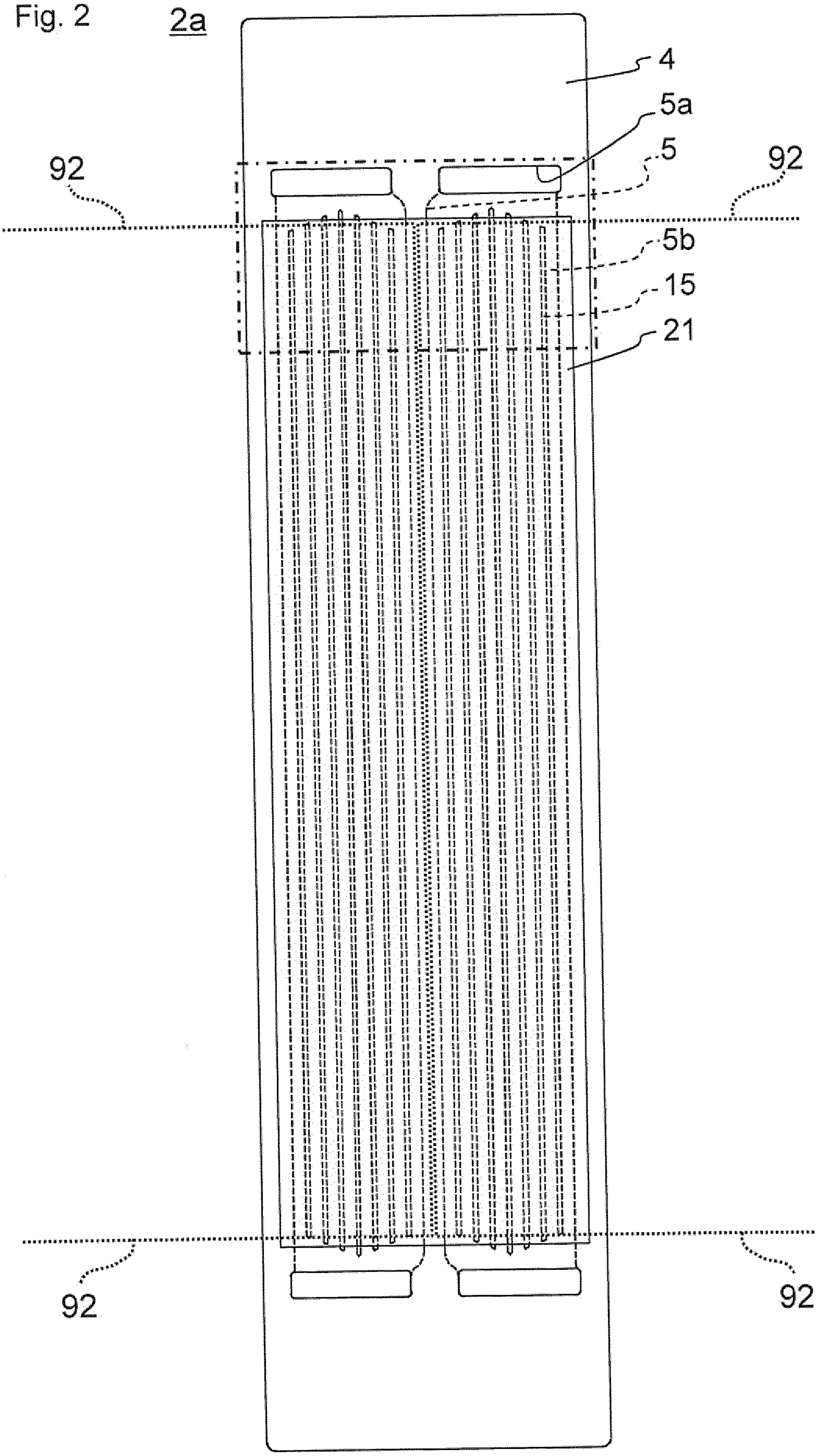


Fig. 3

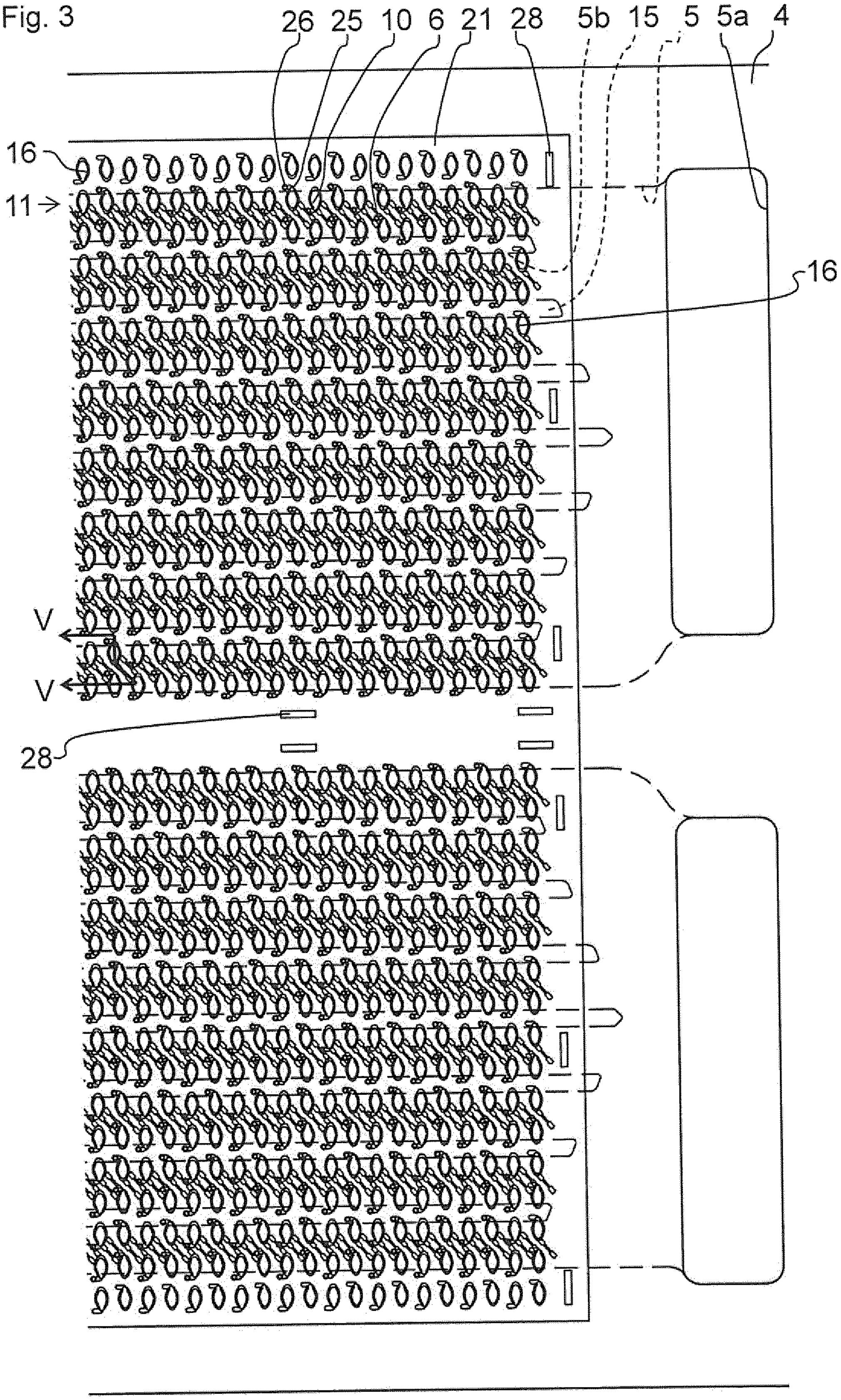


Fig. 4

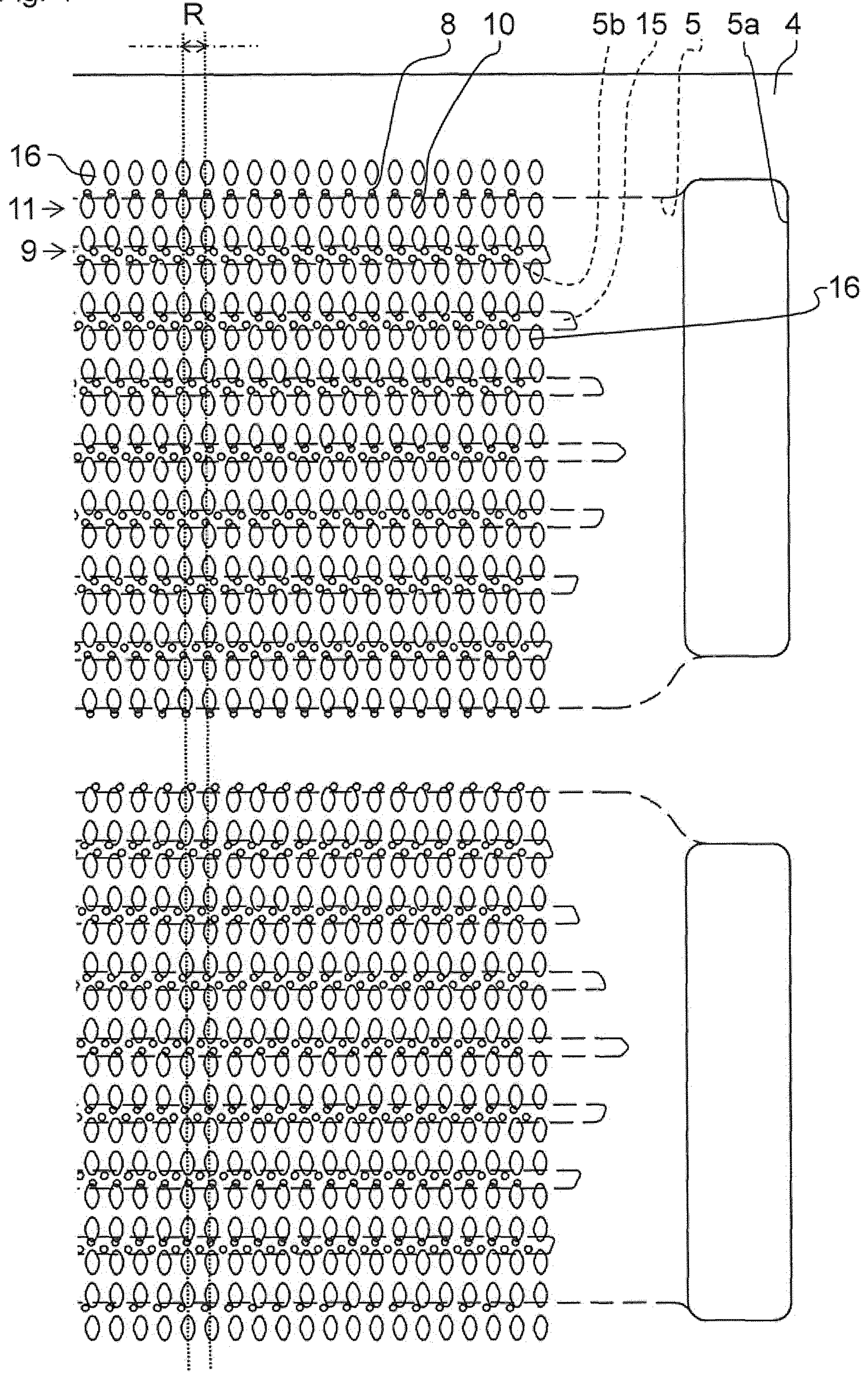
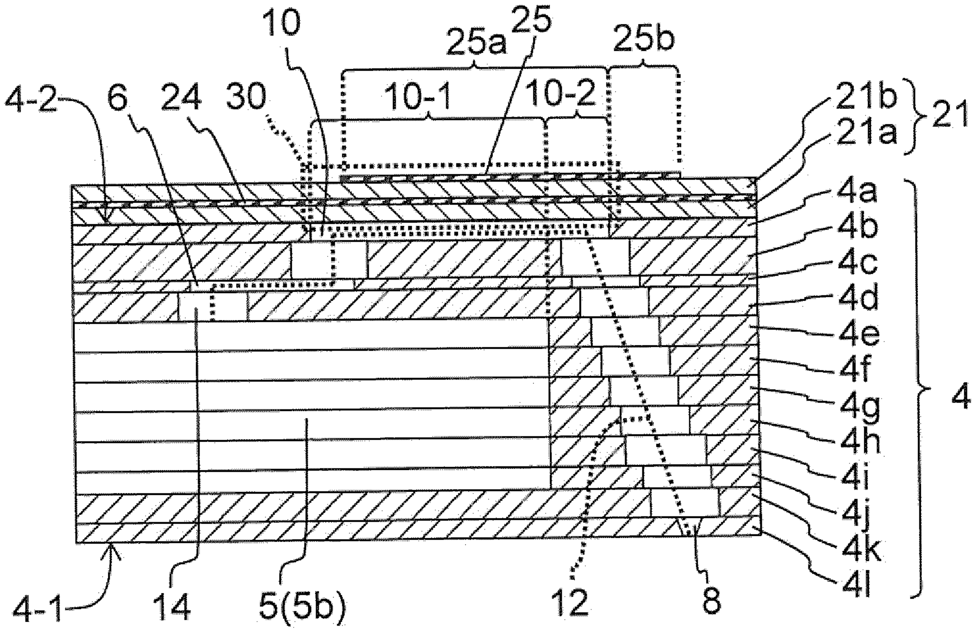


Fig. 5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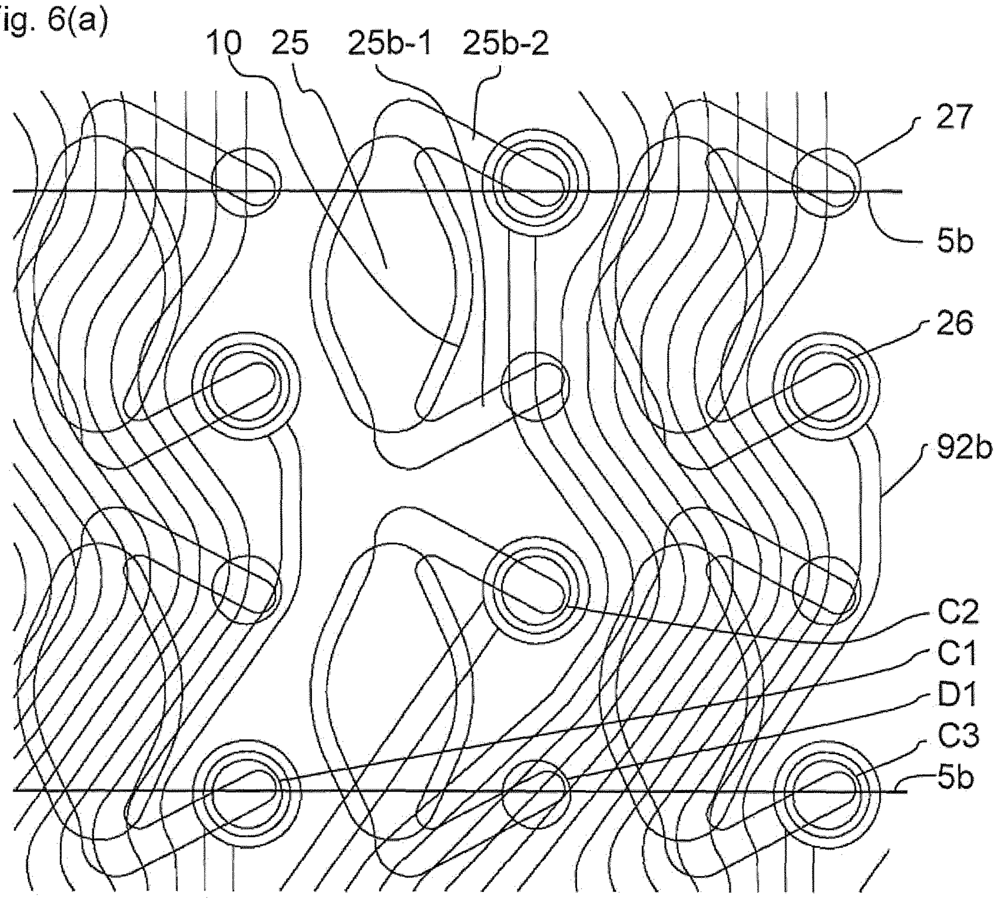
25a
25
25b
4-2
6
24
30
10-1
10-2
21b
21a
21
4a
4b
4c
4d
4e
4f
4g
4
4h
4i
4j
4k
4l
4-1
14
5(5b)
12
8

Fig. 6(a)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25
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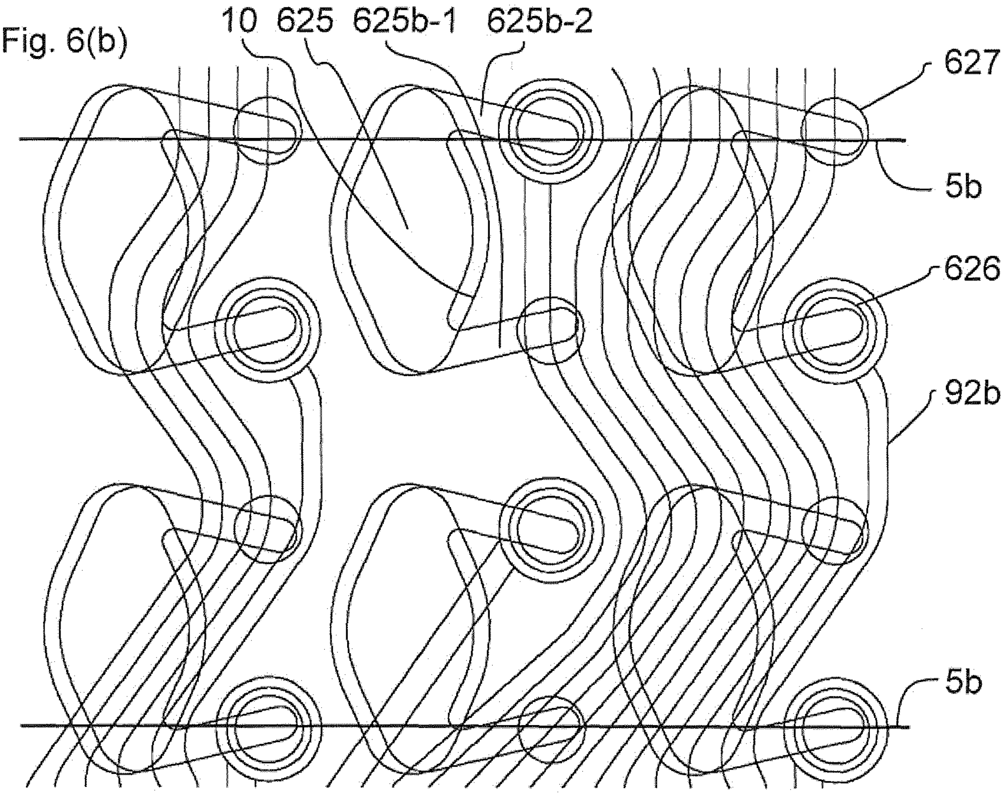
5b
26
92b
C2
C1
D1
C3
5b

Fig. 6(b)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625
625b-1
625b-2
627
5b
626
92b
5b

Fig. 7

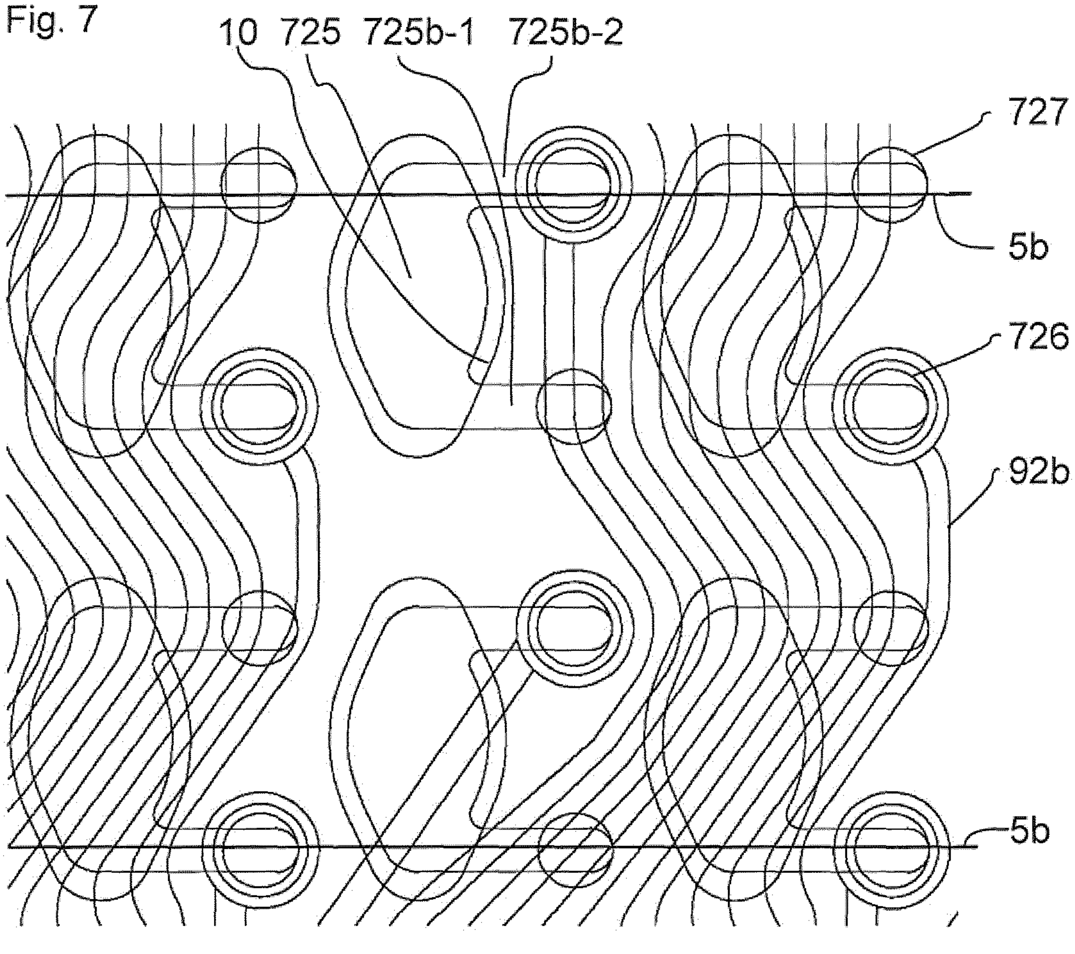


Fig. 8

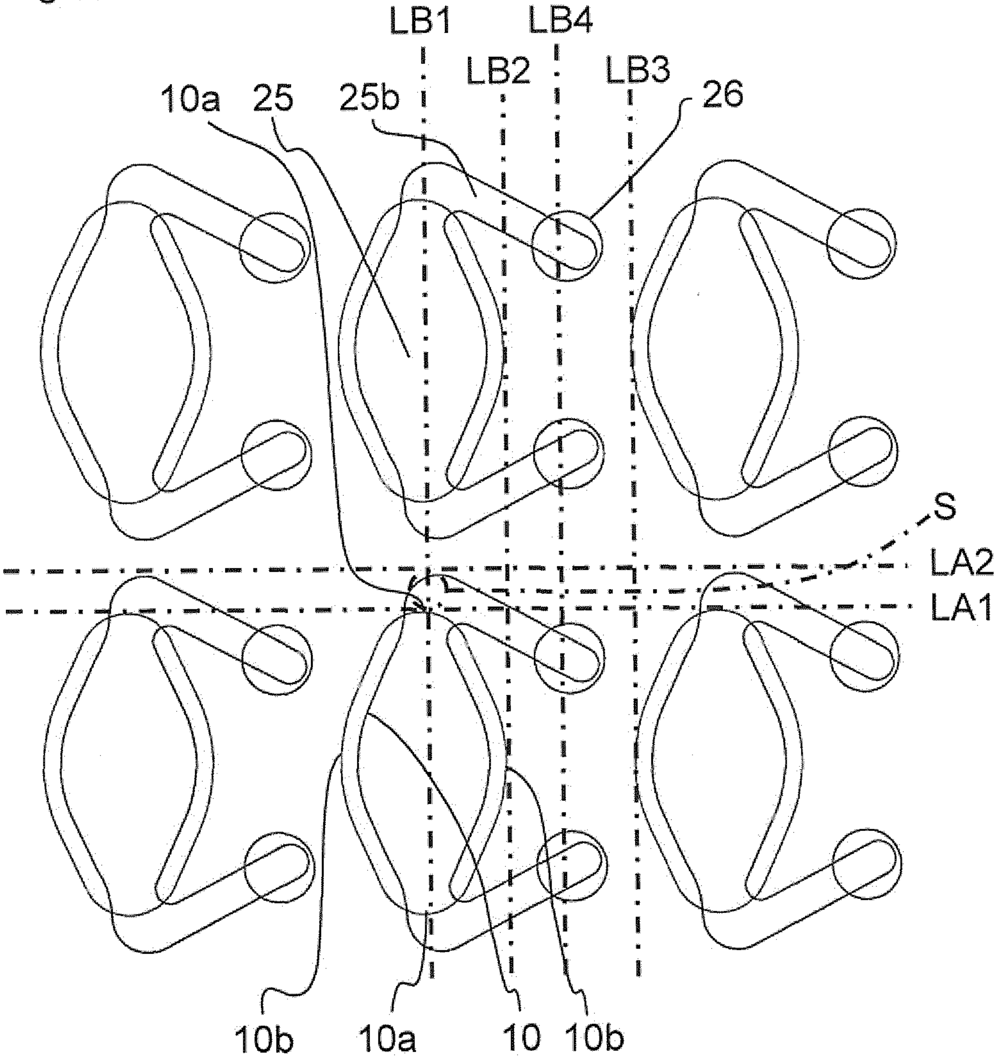
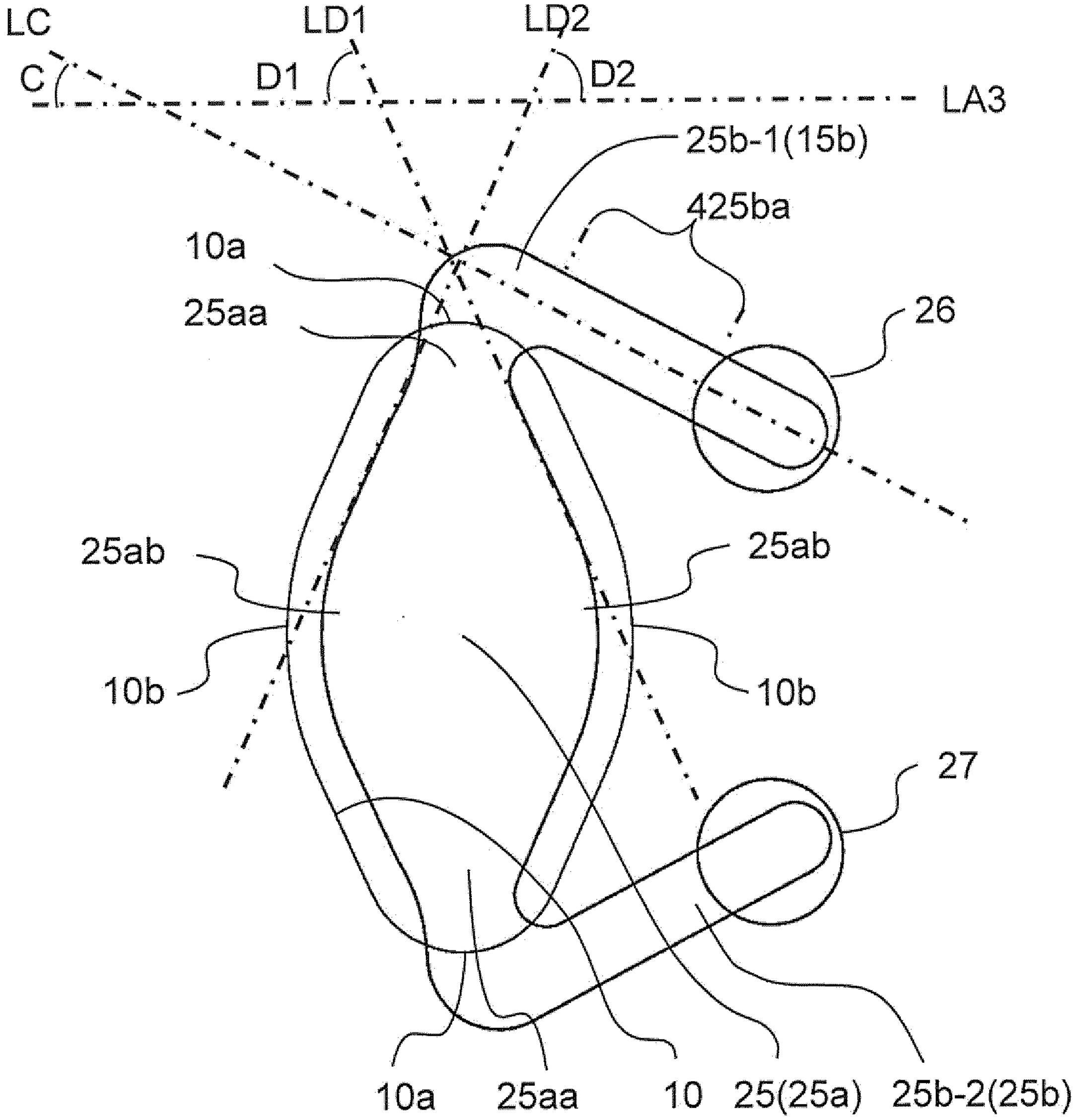


Fig. 9


LC
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LD2
C
D1
D2
LA3
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425ba
10a
25aa
26
25ab
25ab
10b
10b
27
10a
25aa
10
25(25a)
25b-2(25b)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/058573

A. CLASSIFICATION OF SUBJECT MATTER
B41J2/045(2006.01)i, *B41J2/055*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41J2/045, B41J2/055

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-59397 A (Brother Industries, Ltd.), 10 March 2005 (10.03.2005), paragraphs [0031], [0034], [0045] to [0046]; fig. 5, 8 & US 2005/0036008 A1 & EP 1512533 A1	1-7
A	JP 2006-102982 A (Fuji Photo Film Co., Ltd.), 20 April 2006 (20.04.2006), paragraph [0077]; fig. 8 & US 2006/0066677 A1	1-7
A	JP 2005-238721 A (Brother Industries, Ltd.), 08 September 2005 (08.09.2005), paragraphs [0058] to [0059], [0068] to [0070]; fig. 10(b) & US 2005/0200663 A1	1-7

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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

Date of the actual completion of the international search 07 May, 2012 (07.05.12)	Date of mailing of the international search report 22 May, 2012 (22.05.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/058573

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2008-44296 A (Seiko Epson Corp.), 28 February 2008 (28.02.2008), paragraphs [0038], [0043]; fig. 4 (Family: none)	1-7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003305852 A **[0006]**