

Liquid Ejection Recording Head

BACKGROUND OF THE INVENTION

5 Field of the Invention

This invention relates to a liquid ejection recording head, and more particularly to a liquid ejection recording head, particularly an ink jet recording head, in which liquid flow path walls formed
10 of a hardened film of photosensitive resin and/or walls surrounding a liquid chamber are formed on the surface of a substrate on which liquid discharge energy generating elements are installed and a lid plate is provided on top thereof.

15 Description of the Prior Art

A liquid ejection recording head applied to the ink jet recording system is generally provided with minute ink discharge ports (orifices), ink paths and ink discharge energy generating portions provided in a
20 part of the ink paths.

As a method of making such a conventional ink jet recording head, there is known, for example, a method of forming minute grooves in a support member of glass or metal by cutting or etching, thereafter
25 joining the support member formed with the grooves to other suitable plate and forming ink paths.

However, in the head made by such a method,

1 the roughness of the inner wall surfaces of the liquid
paths worked by cutting is too great or distortion is
created in the liquid paths due to the difference in
etching rate and thus, it is difficult to obtain liquid
5 paths of a constant path resistance and irregularity is
liable to occur to the ink discharge characteristic of
the recording head during its use. Also, during the
cutting work, breakage or planing of the plate is
liable to occur and therefore, the yield of manufacture
10 is low and on the other hand, when effecting the
etching work, there are involved a number of manufac-
turing steps, which results in an increased cost of
manufacture.

Further, a disadvantage common to the conventional
15 methods is that when a grooved plate formed with liquid
flow paths is to be cemented to a plate provided with
driving elements such as electro-mechanical converting
members (for example, piezo-electric elements) or
electro-thermal converting members (for example, heat
20 generating elements) as ink discharge energy generating
elements which generate the energy acting on ink to
eject the ink from the orifices and form flying
droplets, it is difficult to align these plates and
this is unsuitable for mass production.

25 So, as a liquid ejection recording head
constructed to overcome these disadvantages, a liquid
ejection recording head in which liquid flow path walls

1 formed of a photosensitive resin hardening film are
formed on a substrate on which ink discharge energy
generating elements are disposed and a lid plate is
provided on the flow paths is proposed, for example,
5 by Japanese Laid-open Patent Application No. 43876/1982.

This liquid ejection recording head made by
the utilization of photosensitive resin is excellent
in solving the disadvantages peculiar to the
conventional heads that the finish accuracy of the
10 liquid flow paths is low, that the manufacturing steps
are complicated and that the yield of manufacture
is low.

Figures 1 and 2 of the accompanying drawings
show two forms of such a conventional liquid ejection
15 recording head. In these Figures, reference numeral
1 designates a support member formed of glass,
ceramics, plastics or a metal. Reference numeral 2
denotes a plurality of (nine in the case of the
present example) liquid discharge energy generating
20 elements disposed on the support member 1. As the
discharge energy generating elements 2, use is made
of heat generating elements or piezo-electric elements.
Wiring for signal inputting, not shown, is connected
to these elements 2. In the case of the heat generat-
25 ing elements, the liquid near the elements in liquid
flow paths 3 in which individual elements 2 are
provided is sharply heated, whereby the energy for

1 discharging the ink is generated and the ink is dis-
charged from discharge ports 4 formed at the end of
the flow paths 3.

Also, where the discharge energy generating
5 elements 2 are piezo-electric elements, the discharge
energy for discharging the ink is likewise generated
by mechanical vibration of these elements, whereby
discharge of the ink can be accomplished.

Reference numeral 5 designates a liquid chamber
10 communicating with the individual liquid flow paths 3.
A surrounding wall 6B is formed around the liquid
chamber 5, and flow path walls 6A are formed between
the flow paths 3. The surrounding wall 6B and flow
path walls 6A may be formed of a photosensitive resin
15 hardening film by photolithography, i.e., photoengraving.

A lid plate 7 is mounted on the substrate 1 on
which the flow paths 3 and liquid chamber 5 are formed
in this manner. The lid plate 7 is generally formed
of glass, ceramics, plastics or a metal and, for
20 example, a photosensitive resin layer 8 is formed on
the joined surface of the lid plate 7.

The formation of such a layer 8 may be
provided by applying photosensitive resin liquid to
the lid plate 7 by the spinner coating method or by
25 laminating photosensitive resin dry films on the lid
plate 7. Designated by 9 are liquid supply ports formed
in the lid plate 7. Thus, a recording head 10 is

1 provided by joining the lid plate 7 formed with the
photosensitive resin layer 8 and supply ports 9 to the
upper surfaces of the surrounding wall 6B and flow path
walls 6A.

5 The example shown in Figure 1 and the example
shown in Figure 2 are similar to each other with the
exception that they differ in the shape of a part of
the surrounding wall 6B and flow path walls 6A, and the
liquid ejecting operation in the recording head 10
10 provided in this manner is generally known and therefore
need not be described.

 However, in the conventional recording head
made by the utilization of such photosensitive resin,
when adhesively securing the flow path walls 6A formed
15 of a photosensitive resin hardening film and the wall
6B for ink reservoir connected to the flow path walls
to the lid plate of hardening film, it has been
technically difficult to bring them into completely
intimate contact with each other over the entire joined
20 surface thereof and therefore, specifically, the
procedures as described below have been restored to.

 (1) Uniformly applying an epoxy adhesive agent
or an acrylic adhesive agent to a thickness of 3-4 μ m
to the joined surface of the lid plate formed of a
25 material such as glass, ceramics, a metal or plastics,
by the spinner coating method and joining it to the
upper surface of the wall of photosensitive resin

1 hardening film, thereby hardening said adhesive agent;

(2) Spinner-coating the joined surface of the lid plate 7 with said adhesive agent, and then preliminarily heating the adhesive agent to make it into
5 B-stage, and joining the lid plate to the upper surface of the walls formed of a photosensitive resin hardening film, thereby essentially hardening said adhesive agent;

(3) Directly thermally fusing the lid plate 7
10 formed of a thermoplastic resin material such as acrylic resin, ABS resin or polyethylene to the upper surface of the walls of the photosensitive resin hardening film; and

(4) Sticking a photosensitive resin layer to
15 the joined surface of said lid plate, joining it to the upper surface of the walls of said photosensitive resin hardening film, and applying a light thereto, thereby hardening the same.

However, by any of the procedures as described
20 above, bubbles may remain on the joined surface between the upper surface of the walls formed of the photosensitive resin hardening film and the lid plate 7. Also, when the two joined members are strongly
pressed against each other to bring them into
25 intimate contact with each other, the adhesive agent and the photosensitive resin provided on the joined surface of the lid plate 7 will protrude into the

liquid flow paths 4 to clog the liquid flow paths 4, and this has left a problem as to the reliability of the joined surface.

5 Also, even when the adhesion has been done completely, stress and distortion have been created by the difference in adhesion strength resulting from the difference in area of adhesion, and this has sometimes led to the occurrence of peeling-off of the lid plate
10 or distortion of recording head.

Accordingly, the invention provides a liquid ejection recording head, comprising a substrate having a plurality of wall elements formed thereon, the
15 elements together defining a liquid chamber and a plurality of liquid flow paths communicating therewith and opening through orifices to the exterior of the recording head, and having additional support wall elements arranged on both sides of, but spaced from,
20 the wall elements defining the liquid flow paths, the additional support wall elements being joined to the wall elements defining the chamber, and a lid plate sealingly attached to said wall elements to cover the chamber and the flow paths, wherein the width of the
25 wall elements at the widest point thereof is no

greater than twice the width at the narrowest point thereof.

5 The liquid ejection recording head of the present invention is free of drawbacks and high in reliability. The lid plate joins to the wall elements, formed of a hardened film of photosensitive resin on the surface of the substrate, evenly over the entire joined surface.

1 BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 are exploded perspective views showing two forms of the construction of a liquid discharge recording head according to the prior art.

5 Figure 3 is an exploded perspective view showing an example of the construction of the liquid discharge recording head of the present invention.

Figure 4 is a plan view schematically showing an example of the defective state occurring in the
10 joined surface of the liquid discharge recording head according to the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will
15 hereinafter be described with reference to the drawings.

In the present embodiment, of the previously described cementing procedures, the procedures of providing a photosensitive resin layer on the joined surface of a lid plate, joining it to the upper surface
20 of a wall portion formed of a photosensitive resin hardening film, and sensitizing hardening it are adopted. Figure 3 shows an embodiment of the present invention. Reference numeral 1 designates a substrate

1 formed of glass or ceramics. A desired number of
liquid discharge energy generating elements 2 are
disposed on the substrate 1, and a wiring portion
for signal inputting, not shown, is connected to
5 these elements 2.

Reference characters 6A, 6B and 6C denote wall
portions formed of photosensitive resin hardening
film. The wall portions 6C are support walls which are
not in direct contact with liquid but are provided at
10 necessary positions from the view point of the joining
to the lid plate 7, and the photosensitive resin
hardening film forming these wall portions 6A, 6B and
6C can be made by the well-known photolithography
method.

15 In the present embodiment, the wall widths LA,
LB and LC of these wall portions 6A, 6B and 6C are
substantially equal to one another. That is, in the
case of Figure 1, the wall width LA of the flow path
wall 6A and the wall width LB of the surrounding wall
20 6B of the liquid chamber 5 have been substantially
equal to each other, but the wall width LC of the
corner wall 6C of the corner portion intervening
between the flow path wall 6A and the surrounding
wall 6B has been remarkably great.

25 Also, in the case of Figure 2, the wall
width LA of the flow path wall 6A and the wall width
LB of the surrounding wall 6B have been different

1 from each other and the wall width LB has been greater
than the wall width LA.

In contrast, in the present invention, these
wall widths have been made substantially equal to each
5 other, whereby it has become possible to eliminate the
drawback of the joined portion as will later be
described.

Reference numeral 7 designates a lid plate
formed of glass or ceramics, and reference numeral 8
10 denotes a layer of photosensitive resin. When joining
the lid plate 7 formed with the layer 8 to the upper
surfaces of the wall portions 6A, 6B and 6C, use may
be made of a method similar to that described in
connection with the prior art.

15 Paying attention to the fact that such
conditions regarding the wall widths greatly affect
the occurrence of the drawback of the joined portion,
the inventor carried out cementing experiments by
variously varying the widths of the individual walls
20 formed of the aforementioned photosensitive resin
hardening film when joining the lid plate to the
substrate.

The then cementing conditions and the result
of the examination of the state after the cementing
25 will be shown in Table 1 below.

Table 1

Cementing conditions (Ten samples for each condition)					Other conditions	Result of examination of cementing conditions (Average value of ten samples)			
No.	Width of each wall of photosensitive resin hardening film			Pressure of Cementing		Number of drawbacks by joined regions			Total number of drawbacks
	LA	LB	LC			Portion 3a	Portion 3b	Portion 3c	
1	100(μ)	500(μ)	1000(μ)	1.0 (Kg/cm2)	a glass plate of t = 0.7 mm was used as the cover.	0	72	60	132
2	"	300	-	"		0	41	-	41
3	"	200	200	"		0	2	2	4
4	"	100	100	"		0	1	1	2
5	"	50	50	"		0	0	0	0
6	50	500	1000	"		0	95	82	177
7	"	300	-	"		0	70	-	70
8	"	200	-	"		0	18	-	18
9	"	100	100	"		0	0	1	1
10	"	50	50	"		0	0	0	0
11	"	25	25	"		0	0	0	0

1 The examination after the cementing was carried
out with observation being effected from the upper
surface of the lid plate 7 by means of a metallurgical
microscope and the number of places in which drawbacks
5 such as residual air occurred was counted. Figure 4
schematically shows an example of the drawback which
occurred near the corner wall 6C of Figure 1. That is,
portions 20 indicated by hatching in Figure 4 show the
non-intimate contact portions which occurred due to the
10 presence of residual air.

As is apparent from Table 1, in the examples
wherein the dimensional ratio between the smallest
portion and the largest portion of the flow path walls,
the surrounding wall and the support wall which are
15 formed of the photosensitive resin hardening film is
3 or greater (i.e., Experiments Nos. 1, 2, 6, 7 and 8),
a number of drawbacks occurred, whereas in the examples
wherein said dimensional ratio is 2 or less (i.e.,
Experiments Nos. 3, 4, 5, 9 10 and 11), the number of
20 drawbacks is sharply decreased. Particularly, in the
examples wherein said dimensional ratio is 1 (i.e.,
Experiments Nos. 4 and 10) and the examples wherein
said dimensional ratio LA/LB is 2 (i.e., Experiments
Nos. 5 and 11), the number of drawbacks is remarkably
25 small and the reliability of the joined surface may be
said to be very high.

In the present embodiment, as the cementing

1 method, description has been made of a case where a
photosensitive resin layer is provided on the joined
surface of the lid plate 7 and this is joined to the
upper surface of the above-described walls formed of
5 the photosensitive resin hardening film, whereafter
light is applied thereto to harden the same, whereas
the present invention is not restricted to the
product made by such a cementing method, but of course
can also be effective for a product made by the
10 following method:

(1) spinner-coating the joined surface of the
lid plate with an epoxy or acrylic adhesive agent to
a thickness of 3-4 μ , joining it to the upper surface
of the wall of said photosensitive resin hardening
15 film, and hardening the adhesive agent;

(2) spinner-coating the adhesive agent
mentioned under item (1) above, preliminarily heating
the adhesive agent and transforming it into a so-called
B-stage, joining it to the upper surface of the wall
20 of the photosensitive resin hardening film and
essentially hardening said adhesive agent; and

(3) heat-fusing the lid plate formed of a
thermoplastic resin such as acrylic resin, ABS resin
or polyethylene directly onto the upper surface of the
25 wall of the photosensitive resin hardening film.

Also, where a hardened film of photosensitive
resin is used as the lid plate, a photosensitive resin

1 film may be simply cemented to a wall formed of a
photosensitive resin hardening film, whereafter the
photosensitive resin may be hardened by light.

Further, where a photosensitive resin film is
5 used for the joining of the lid plate, it is desirable
to provide photosensitive resin films on the opposite
surfaces of the lid plate. This is because the
contracting force or the like resulting from the
hardening of the photosensitive resin films is offset
10 to enable more reliable joining to be accomplished.

Of course, the hardening of the photosensitive
resin may be accomplished not only by the application
of light energy but also by the application of heat
energy used with the application of light energy.

15 According to the present invention, as
described above, liquid flow paths and/or a liquid
chamber communicating therewith is formed between wall
portions formed of a hardened film of photosensitive
resin and a substrate and a lid plate provided on said
20 wall portions, and the maximum wall width of the wall
portions of the liquid discharge recording head which
can be made unitary as a recording head is two times
or less the minimum wall width and therefore, when
joining the lid plate to the upper surface of the wall
25 portions of the substrate side, occurrence of drawbacks
such as residual bubbles can be suppressed to ensure a
good adhering state to be maintained, and this leads to

1 the provision of a highly reliable recording head.

Further, according to the present invention,
not only the peeling-off of the lid plate but also the
distortion of the recording head resulting from the
5 difference in area of adhesion is eliminated, and this
also leads to the provision of a highly reliable
recording head having an excellent recording
characteristic.

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CLAIMS

1. A liquid ejection recording head, comprising a substrate having a plurality of wall elements formed thereon, the elements together defining a liquid chamber and a plurality of liquid flow paths communicating therewith and opening through orifices to the exterior of the recording head, and having additional support wall elements arranged on both sides of, but spaced from, the wall elements defining the liquid flow paths, the additional support wall elements being joined to the wall elements defining the chamber, and a lid plate sealingly attached to said wall elements to cover the chamber and the flow paths, wherein the width of the wall elements at the widest point thereof is no greater than twice the width at the narrowest point thereof.
2. A liquid ejection recording head according to claim 1, wherein said lid plate is formed of a hardened film of photosensitive resin.
3. A liquid ejection recording head according to claim 1, wherein said lid plate is formed of a glass, ceramics, metal or plastics material.



4. A liquid ejection recording head according to claim 1, having discharge energy generating elements used to discharge liquid from the orifices and form flying droplets.

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5. A liquid ejection recording head according to claim 4, wherein said discharge energy generating elements are electro-thermal converting members.

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6. A liquid ejection recording head according to claim 4, wherein said discharge energy generating elements are electro-mechanical converting members.

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7. A liquid ejection recording head according to claim 3, wherein a photosensitive resin hardening film is provided between said lid plate and said wall portions.

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8. A liquid ejection recording head according to claim 3, wherein an adhesive layer is provided between said lid plate and said wall portions.

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9. A liquid jet recording head, substantially as described with reference to Figure 3 of the drawings.
