

LIQUID STORAGE CONTAINER FOR RECORDING APPARATUS ✓

The present invention relates generally to a liquid storage container. More particularly, 5 the present invention relates to a liquid storage container for storing a liquid usable as a recording agent for a recording apparatus such as an ink jet recording apparatus, a photoelectrical copying machine, a facsimile 10 unit or the like. In addition, the present invention relates to a recording unit integrally including a liquid storing container of the foregoing type. Additionally, the present invention relates to a recording apparatus 15 having a recording unit of the foregoing type mounted thereon.

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A conventional liquid ejection recording apparatus (hereinafter referred to as an ink jet recording apparatus) is generally constructed such that a recording head for discharging ink 25 therefrom and an ink storing section associated with the recording head are separately arranged as individual components at the different positions located away from each other but they

are operatively connected to each other via an ink feeding system inclusive of an ink feeding pipe interposed therebetween.

Because of the necessity for extending a long
5 ink feeding pipe between both the components, the conventional ink jet recording apparatus constructed in the above-described manner has problems in that a piping operation is achieved for the apparatus with much difficulties, and
10 moreover, vaporized ink or air is liable to invade in the apparatus. To cope with the foregoing problems, the applicant

proposed an ink jet recording apparatus of the type in which a recording head and
15 an ink storing section are united with each other in the form of an integral unit (cartridge), as disclosed in official gazettes of Japanese Patent Application Laying-open Nos. 61-249757, 63-22653 and 63-275793. According to
20 the proposals, the aforementioned problems associated with evaporation of ink and invasion of air can be obviated, and an advantage attainable from the proposals is that any unskilled-user can easily handle an ink feeding
25 system including an ink storing section because no piping operation is required.

However, when ink in the ink jet recording apparatus is completely consumed up to a final

droplet of ink, he or she should purchase a new cartridge having a recording head and an ink tank cartridge integrated with each other so as to allow the used ink cartridge to be exchanged
5 with a new one. In practice, there often arises an occasion that ink in the cartridge is completely consumed and the recording head is unavoidably exchanged with a new one although it has still some running life. In the
10 circumstances as mentioned above, many requests have been raised from users for providing an ink jet recording apparatus which assures that a recording head including highly functional components such as piezo-electric elements,
15 silicon wafers or the like can fully effectively be utilized.

To satisfactorily meet these requests, the applicant proposed an on-carriage type ink jet recording apparatus including a recording head
20 and an ink tank cartridge integrated with each other without any necessity for performing a piping operation wherein the recording head can fully be utilized till a final time of running life, and moreover, the recording head can be
25 disconnected from the ink tank cartridge when the latter is exchanged with a new one. With this on-carriage type ink jet recording apparatus constructed in that way, the ink

tank cartridge containing no ink can repeatedly be exchanged for a new one until the recording head reaches the end of its running life. As long as ordinary documents are printed with the ink jet recording apparatus, a series of recording operation can be sequentially performed for several thousand sheets of paper with a single recording head while only the ink tank cartridge containing no ink is repeatedly exchanged for a new one. With the on-carriage type ink jet recording apparatus, when any recording operation can not be performed any more because the running life of the recording head has expired, a user is required to purchase a new recording head so that a recording operation can be restarted with the new recording head. In addition, the applicant made various kinds of proposals with respect to an ink storing container to be integrated with a recording head in practical use.

As printing techniques, hardware and software for personal computers advance year by year in the aforementioned circumstances, it becomes possible to perform each printing operation with ease and beautiful appearance. On the other hand, performances imposed on a recording apparatus are elevated with improved versatility. Although there often

arises an occasion that a selection should be made as to whether a dye based ink should be used or a pigment based ink should be used, each of both the types of inks has its own feature.

5 This makes it difficult to finally determine the type of ink to be selected. In other words, a user is required to make a decision at his discretion as to which type of ink to be used. This tendency is remarkably intensified at
10 present because users increasingly employ color printing. In addition, it is expected that various types of inks each having different physical and chemical properties are put in practical use. This fact has a significant
15 effect on designing of an ink tank cartridge. Thus, there arises a necessity for preparing an ink tank cartridge corresponding to each type of ink to be used.

Another problem is concerned with an optimal
20 working volume of ink tank cartridge which should be determined corresponding to a certain kind of ink. For example, in the case that a user frequently performs recording operations, it is desirable for him or her to print many
25 sheets of paper with the reduced number of exchanging operations each performed for exchanging an ink tank cartridge containing no ink with a new one. On the contrary, in the

case that a user prints a small number of sheets every time a recording operation is performed by him or her, it is economically unacceptable for the following reason to use an ink tank

- 5 cartridge containing a large quantity of ink. Specifically, when the recording head is kept inoperative for a long time after a small quantity of ink is consumed for each recording operation, volatile components contained in ink
10 are vaporized therefrom, causing coloring substances to be adversely transformed. For this reason, a user is required to exchange the ink tank cartridge for a new one every time a recording operation is rarely performed. This
15 leads to the result that he or she pays some money for the ink uselessly remaining in the ink tank cartridge. In the circumstances mentioned above, many requests have been raised from many users for providing an ink tank
20 cartridge which is simple in structure and contains a small quantity of ink. On the other hand, for a user who prints a large number of sheets at every recording operation, there is a need to provide an ink tank cartridge
25 containing a possibly large quantity of ink in the restrictively predetermined working volume thereof. In this case, it is desirable that each recording operation is achieved at a low

printing cost although the ink tank cartridge is produced at an expensive cost. This shows merely an example of explaining the current tendency that it is expected that various types
5 of advanced techniques will be developed with respect to the ink jet recording apparatus in future. In addition, it is anticipated that each ink tank cartridge is constructed with a different structure corresponding to a common
10 recording head.

In the case that an exchangeable type ink tank cartridge is used for the ink jet recording apparatus, it is necessary that a measure is taken for the purpose of preventing dust or
15 similar foreign materials from entering the ink jet recording head when a porous ink absorbing member molded of an elastic material is employed as means for retaining ink in the ink tank cartridge. In practice, however, since fine
20 fragments are torn or peeled away from the porous ink absorbing member during each recording operation, it is additionally necessary that a filtering member is disposed in an ink flow path in order to prevent the fine,
25 fragments from entering the recording head. To this end, it is thinkable that the filter is disposed on the ink tank side. In this case, a filter should be disposed on every ink tank

cartridge. This is because if a filter is disposed only at the recording head side, there arises a malfunction that dust or similar foreign materials are deposited on the filter, causing the latter to be clogged with the dust or the like before the running life of the recording head expires.

To assure that the ink jet recording apparatus is designed with smaller dimensions, it is obviously required that the ink tank cartridge itself is designed with smaller dimensions. To this end, the working volume of the ink tank cartridge should restrictively be determined. However, since a quantity of ink to be consumed by the recording head corresponding to a predetermined content of recording is kept constant regardless of the dimensions of the ink jet recording apparatus, it is required that a running cost of the ink tank cartridge is taken into account for the purpose of designing each ink tank cartridge with smaller dimensions on the assumption that the ink tank cartridge containing no ink is exchanged with a new one. To meet the requirement, it is highly requested that an utilization efficiency of the ink stored in the ink tank cartridge is elevated as far as possible.

However, to satisfy the foregoing request,

the ink jet recording apparatus has the following problems to be solved. Specifically, to improve reliability of each recording operation, air (bubbles) accumulated in the recording head as time elapses or introduced in an ink flow path when the ink tank cartridge is exchanged with a new one should be removed from the ink. To this end, a pump arranged in the ink jet recording apparatus is driven to removably suck the air together with the ink discharged from ink discharging orifices. An extra quantity of ink sucked together with the air with the aid of the pump is uselessly wasted as it is without any possibility that it is used for achieving a recording operation. In the case of a conventional comparatively large-sized ink jet recording apparatus, since an ink tank cartridge has certain allowance in respect of an ink storing capacity, when a power source of the ink jet recording apparatus is turned on, a pump is automatically driven once per 72 hours so as to elevate reliability of each recording operation. In addition, when the ink jet recording apparatus is designed with sufficient allowance in respect of a capacity of sucking ink per each pumping operation as well as an ink sucking pressure induced by the pump, air bubbles can reliably be removed from the

recording head and the ink tank cartridge in the ink jet recording apparatus.

However, in the case of a small-sized ink tank cartridge having a small ink storing capacity, when a large quantity of ink is uselessly wasted by performing the same pumping operation as mentioned above, a frequency of repeatedly exchanging each ink tank cartridge containing no ink with a new one is increased, causing a user to unpleasantly suffer from a troublesome exchanging operation accompanied by an increased running cost. Thus, the advantageous effect attained by designing each ink tank cartridge with smaller dimensions is degraded or lost. To cope with the foregoing problem, a proposal was made as to a process of minimizing a quantity of ink to be uselessly pumped out together with air bubbles per each pumping operation.

To assure that an ink tank cartridge can be disconnected from a recording head on a printer carriage, it is inevitably necessary to dispose a valve mechanism in the ink tank cartridge in order to prevent ink from leaking from the ink tank cartridge by quickly sealably closing an ink flow path with the valve mechanism after the ink tank cartridge is disconnected from the recording head. In addition, a filter is

disposed in the recording head on the downstream side of the valve mechanism. When it is assumed that a volume between the ink storing section and the filter is called a valve space, in the case that the ink tank cartridge and the recording head are connected to and disconnected from each other several times for some reason, there arise malfunctions that air bubbles invade in the valve space, resulting in each recording operation being unstably achieved after the ink tank cartridge is connected to the recording head, and moreover, ink feeding is interrupted due to the invasion of the air bubbles in the course of certain recording operation. To obviate the foregoing malfunctions, it suffices that the pump is driven in the same manner as the conventional ink jet recording apparatus. However, in the case that a quantity of ink to be uselessly wasted per each pumping operation is restrictively reduced for the small-sized ink jet recording apparatus in the above-described manner, there arises a problems as noted below.

The foregoing problem will be described below with reference to Figs. 3A to 3C and Figs. 4A to 4C. For example, in the case that an ink tank cartridge 2-1 and an ink jet recording head 2-2 are frequently connected to and disconnected from each other or in the case that an assembly

of the ink tank cartridge 2-1 and the ink jet recording head 202 is kept inoperative for a long time of several months, there arises an occasion that a large part of the ink held in the space defined between the ink jet recording head 2-2 to a valve space 2-3 is lost due to vaporization of the ink. In this case, ink cannot satisfactorily be fed to the ink jet recording head 2-2 merely by a single pumping operation achieved by a pump 2-4 of which flow rate is set to a predetermined one. In such case as mentioned above, it is necessary to continuously perform same pumping operations several times in order to compensate the shortage of a pumping capacity.

As is apparent from Figs. 3A to 3C, in the case that the pumping operations are intermittently performed several times, the ink 2-5 once sucked in the ink jet recording head 2-2 in the course of each pumping operation is caused to return to an ink reservoir 2-7. To prevent an occurrence of ink return flow as mentioned above, it is recommendable that adequate means for preventing the ink 2-5 from reversely flowing to the ink reservoir 2-7, e.g., a cap 2-6 for retaining the ink pressure in the valve space 2-3 as shown in Figs. 4A to 4C is continuously brought in close contact with

the ink jet recording head 2-2 during a series of pumping operations. However, the arrangement of the cap 2-6 with high reliability maintained during the pumping operations prevents the ink jet recording apparatus from being designed with smaller dimensions. In addition, another problem is that the ink jet recording apparatus is fabricated at an increased cost.

For example, in the case that a porous member is received in an ink tank cartridge as disclosed in an Japanese Patent Application Laying-open NO. 3-41351, it is necessary that a filter is brought in close contact with the porous member. However, in the case of an ink jet recording unit of the type including an ink jet recording head and an ink tank cartridge disconnectable from each other, when a user erroneously repeatedly connects a single ink tank cartridge to the opponent ink jet recording head and disconnect the former from the latter, the porous member received in the ink tank cartridge is adversely transformed, resulting in the filter disposed in the ink jet recording head failing to come in close contact with the porous member. Thus, there is a possibility that ink can not correctly be fed to the ink jet recording head. In addition, in the case that air bubbles invade in the ink tank cartridge,

there is a possibility that the air bubbles enter an ink feeding path during certain recording operation, causing droplets of ink to be incorrectly discharged from ink discharging
5 orifices.

In view of the fact that a large quantity of ink remains in the porous member without any feeding of the ink to the ink jet recording head, many proposals were made in order to
10 obviate the foregoing malfunction. Among the proposals, one proposal is such that a quantity of projecting of a projection from the recording head side toward the porous member is restrictively determined so as to allow the
15 projection to properly come in contact with the porous member. Another proposal is such that a plurality of ribs are caused to extend along the inner wall surface of the ink tank cartridge in order to distribute the atmospheric air
20 introduced into the ink tank cartridge via an atmospheric air intake port over the surface of the porous member.

Although the above-mentioned proposals are certainly effective for coping with various
25 kinds of requests raised from many users in the current status that ink jet recording apparatuses are increasingly put in practical use, it has been clarified by the inventors that

a mutual relationship among components each constituting an ink jet recording apparatus serving as a printer unit is not hitherto recognized as an unstable factor but has an unexpected technical significance.

5 Especially, in the case that the ink jet recording apparatus serving as a printer unit is integrally installed in information processing equipment such as a personal computer or the like so that the whole information processing equipment is constructed with
10 smaller dimensions, the real recognition of the foregoing mutual relationship is effectively useful for a fabricant associated with the ink jet recording apparatus.

 According to the present invention there is provided an ink tank cartridge containing an ink absorbing member
15 formed of a porous material and having an atmospheric air intake port and an ink outlet port, the air intake port opening to the interior of the cartridge on a wall different from the ink outlet port so as to allow ink to be supplied to the outside from said ink outlet port,
20 wherein a plurality of ribs are formed along an inner wall of said cartridge between the air intake port and the ink outlet port in a direction so as not to block a path joining the air intake port and the ink outlet port to enable atmospheric air taken through said atmospheric
25 intake port to be distributed over the surface of said ink absorbing member facing the atmospheric air intake port, at least one other surface of said ink absorbing

member, and the surface of said ink absorbing member facing the ink outlet port.

In a cartridge embodying the present invention, ink can smoothly be fed from the ink absorbing member to an
5 ink discharging energy generating section by smoothly distributing the atmospheric air taken in the ink tank cartridge over the surface of the ink absorbing member.

An embodiment of the present invention provides a liquid storage container which is simple in structure and
10 has a high utilization efficiency of liquid such as ink or the like.

An embodiment of the present invention provides an ink container which is simple in structure and can be produced at an inexpensive cost.

15 Another embodiment of the present invention provides an ink tank which assures that ink is stably fed to discharging orifices at a high ink utilization efficiency.

A still further embodiment of the present invention
20 provides a mechanism for connecting an ink jet recording head to an ink tank cartridge wherein each recording operation can be achieved at an inexpensive cost with the mechanism, the ink jet recording head can be connected to a different kind of ink tank cartridge with the aid
25 of the mechanism to meet the request raised from a user, and moreover, the mechanism can practically be used for a long time.

Yet another embodiment of the present invention provides an ink container which assures that ink to be consumed can be retained at a high efficiency.

Embodiments of the present invention will now be
5 described by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view which shows by way of example of an ink jet recording apparatus to which the present invention is applied;

10 Fig. 2 is a perspective view of an ink jet recording unit which includes an ink jet recording head and an ink tank cartridge both of which can be separated from each other;

Fig. 3 illustrates by way of sectional views
15 problems inherent to a conventional ink cartridge;

Fig. 4 also illustrates by way of sectional views problems inherent to the conventional ink cartridge;

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Fig. 5 is a perspective view of an information processing unit in which the ink jet recording apparatus of Fig. 1 is installed;

Fig. 6 is a block diagram which illustrates the structure of a circuit network for the information processing unit shown in Fig. 5 ;

Fig. 7 is a flowchart which illustrates a control sequence for a recording operation to be performed by the information processing unit shown in Fig. 5;

Fig. 8 is a partially exploded perspective view of an ink tank cartridge constructed according to a first embodiment of the present invention;

Fig. 9 is a sectional view of an ink jet recording unit constructed according to a second embodiment of the present invention;

25 -Fig. 10 is a cross-sectional view of an ink tank cartridge for an ink jet recording unit constructed according to a third embodiment of the present invention;

Fig. 11 is a sectional view of an ink tank cartridge for an ink jet recording unit constructed according to a fourth embodiment of the present invention;

5 Fig. 12 is a sectional view of an ink tank cartridge for an ink jet recording unit constructed according to a fifth embodiment of the present invention;

10 Fig. 13A is a sectional view of an ink tank cartridge for an ink jet recording unit constructed according to a sixth embodiment of the present invention;

Fig. 13B is a fragmentary perspective view of the ink tank cartridge shown in Fig. 13A;

15 Figs. 14A to 14I show by way of fragmentary sectional views the contour of each of various kinds of ribs for the ink tank cartridge shown in Fig. 13A;

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The present invention will now be described
5 in detail hereinafter with reference to the
accompanying drawings which illustrate preferred
embodiments thereof.

An ink jet recording apparatus IJRA to which
the present invention is applied will be
10 described below with reference to Fig. 1. The
ink jet recording apparatus IJRA includes a
carriage HC on which an ink jet recording unit
IJC is removably mounted. The carriage HC
includes a pin (not shown) adapted to come in
15 engagement with a spirally extending groove 5005
on a lead screw 5004. As a driving motor 5013
is rotated in the normal direction or in the
reverse direction, the lead screw 5004 is
rotated by the motor 5013 via driving power
20 transmitting gears 5011 and 5009 so as to allow
the carriage HC to reciprocally move not only in
the a arrow-marked direction but also in the b
arrow marked direction. In the drawing,
reference numeral 5002 designates a thrusting
25 plate for thrusting a recording medium such as a
paper, a film for an OHP, a fabric or the like
against a platen 5000 within the displacement
range of the carriage HC, and reference numerals

5007 and 5008 designate photo-couplers. The photo-couplers 5007 and 5008 serve as home position detecting means for optically recognizing the presence of a lever 5006 of the carriage HC so as to shift the direction of the motor 5013 from the normal direction to the reverse direction and vice versa. Reference numeral 5016 designates a supporting member for supporting a cap member 404 for capping the front surface of an ink jet recording head therewith, and reference numeral 5015 designated a suction means for sucking in the cap member 404.

The suction means 5015 evacuates waste ink via an opening 5023 within the cap member 404 so as to recover the ink jet recording head.

Reference numeral 5017 designates a cleaning blade, and reference numeral 5019 designates a displacing member for displacing the cleaning blade 5017 in the forward/rearward direction. The displacing member 5019 is supported by a support plate 5018. The configuration of the cleaning blade 5017 should not be limited only to the shown one. Alternatively, any type of conventional cleaning plate may be employed for the same purpose. Reference numeral 5012 designates a lever for starting the actuation of the suction means 5015. As a cam 5020 adapted

to be engaged with the carriage HC is displaced,
the lever 5012 is displaced so as to properly
control the driving power of the driving motor
5013 with the aid of hitherto known power
5 transmitting means such as clutch shifting means
or the like.

While the carriage HC is located within the
home position range, the lead screw 5005 is
rotated so as to allow the carriage HC to assume
10 predetermined positions corresponding to the
capping, the cleaning and the sucking as
mentioned above.

Next, an ink jet recording unit
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will be described below with reference
to Fig. 2. The ink jet recording
unit includes an ink jet recording head 301 and
an ink tank cartridge 303 both of which can be
20 separated from each other. The ink jet
recording unit constructed in that way is
employable for the ink jet recording apparatus
as shown in Fig. 1. Usually, to separatively
remove dust from an ink, a filter is
25 disposed at the intermediate position of a path
320 in the ink jet recording head 301, and an
effective pore diameter of the filter 302 is set
to 5 to 20 μm .

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Next, an ink jet recording apparatus equipped with an ink jet recording unit,

will be described below with reference to Fig. 1, and Figs. 5 to 7.

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An outline of structure of the ink jet recording apparatus IJRA (serving as a printer section) has been described above with reference to Fig. 1.

Structure of an information processing unit
(e.g.a personal computer) having the ink jet
recording apparatus associated with the ink jet
recording unit of the present invention

5 installed therein and electrical circuits
thereof will be described below with respect to
a typical example thereof.

Fig. 5 shows by way of perspective view an
outline of appearance of an information
10 processing unit 74 having the ink jet recording
apparatus (to serve as a printer section)
installed therein. In the drawing, reference
character IJP designates a printer section,
reference numeral 72 designates a key board
15 including not only keys for inputting
characters, numerals or the like thereinto but
also keys for outputting various kinds of
commands therefrom, and reference numeral 73
designates a display section including a display
20 board.

Fig. 6 is a block diagram which shows the
structure of electrical circuits arranged in the
information processing unit 74.

In the drawing, reference numeral 81
25 designates a controller for executing main
control, reference numeral 82 designates a
central processing unit designed in the form of
a microcomputer, reference numeral 83 designates

a random access memory including a working area for developing text data and image data, reference numeral 84 designates a read only memory having a working program and fixed data
5 such as font data or the like stored therein, reference numeral 85 designates a timer for governing an execute cycle for the central processing unit 82 and a timing relationship required when a recording operation is performed
10 by the printer section IJP, and reference numeral 86 designates an interface portion by way of which signals transmitted from the central processing unit 82 are outputted into peripheral equipment.

15 In addition, reference numeral 87 designates a controller for the printer section IJP, reference numeral 88 designates a head driver for delivering recording signals and electricity to an ink jet recording head H mounted on an ink
20 jet recording unit, reference numerals 89a and 89b designate motor drivers for delivering signals and electricity required for driving a carriage motor 102a and a conveyance motor 102b, reference numeral 90 designates a carriage
25 sensor for detecting the position of a carriage HC to determine whether the carriage HC is located at a home position or not, and reference numeral 91 designates a paper sensor for

detecting the presence or the absence of a recording medium P so as not to allow any recording to be effected in the region other than a recording medium P (paper) when the
5 recording medium P is not inserted into the printer section IJP or a recording operation is completed to reach the terminal end of the recording medium P.

Additionally, reference numeral 74
10 designates an external storage unit such as a floppy disc drive, a hard disc drive, a random access memory card or the like, and a reference numeral 75 designates an external interface
15 portion for making communication with another information processing unit or controlling peripheral equipments while making connection directly to buses disposed inside of each peripheral equipment.

Next, a control sequence for a recording
20 operation to be performed by the printer section IJP will be described below based on a flowchart shown in Fig. 7.

First, in response to an instruction outputted from a display actuating portion in
25 the printer section IJP by actuating a recording command key on the key board 72 for starting a recording operation or in response to an instruction transmitted from the outside via the

external interface portion 75 for starting a recording operation, a series of operations as noted below are sequentially performed.

The program starts from Step S1 in which the
5 controller 81 determines whether the display actuating section is turned on or not. Mainly, in response to an instruction transmitted from the outside for starting a recording operation via a communication system, the controller 81
10 executes the processing so as not to allow a recording operation to be started while the printer section IJP is not ready to perform the printing operation. When the controller 81 determines that the display actuating section is
15 turned on, the program goes to Step S2.

In Step S2, in response to a signal outputted from the paper sensor 91, the controller 81 determines whether a recording medium P is inserted into the printer section
20 IJP or not. The determination to be made by the controller 81 in Step S2 is intended to prevent an occurrence of malfunction that the printer section IJP such as an ink jet recording unit or the like is contaminated with scattered ink when
25 the printing operation is started without any recording medium inserted into the printing section IJP or ink serving as a recording agent is uselessly consumed.

Alternatively, the controller 87 may determine in Step S2 not only whether the printing medium P is present or absent but also whether each pinch roller and each conveying
5 roller are held in the released state or not. This determination to be made in Step S2 is intended to prevent an occurrence of malfunction that the recording medium P is incorrectly conveyed when each pinch roller is held in the
10 released state even though the recording medium P is inserted into the printer section IJP. The controller 87 can be determined with the aid of, e.g., a mechanical switch disposed on a release lever whether each pinch roller is held in the
15 released state or not. In the case that the controller 87 determines that the recording medium P is not correctly inserted into the printer section IJP, the program goes to Step S3.

20 In Step S3, the controller 87 issues a message or an instruction to an operator that he should pay more attention to the printing section IJP so as to allow the recording medium P to be correctly inserted into the printing
25 section IJP. A message or an instruction may be given to him by turning on the display actuating section so as to activate a lighting device to generate a light beam with a lamp or activate a

buzzer to generate sound therewith. When the controller 87 determines in Step S3 that the recording medium P is correctly inserted into the printer section IJP, the program goes to
5 Step S4.

In Step S4, a recording operation is started with the printer section IJP. In response to an instruction outputted from the central processing unit 82, the head driver 88 is
10 activated to drive the printer section IJP. At the same time, the motor drivers 89a and 89b drive the carriage motor 102a and the conveying motor 102b so as to perform a printing operation with the printer section IJP by displacing the
15 carriage HC in the main scanning direction, displacing the recording medium P in the auxiliary scanning direction and cleaning the recording head H.

Subsequently, the program goes to Step S5 in
20 which in response to a signal outputted from the central processing unit 82, the controller 87 instructs that the recording operation is completed. When the controller 87 determines that the number of recorded lines as measured in
25 the space of a single page in the auxiliary direction reaches a predetermined value or when the paper sensor 91 detects that the recording operation is completed in the recording range on

the recording medium P, the controller 87 determines that the recording operation is completed with the recording medium P.

After the recording operation is completed
5 in Step S6, the controller 87 activates the carriage HC so as to return it to the home position. This is intended to cap the recording head H with a suitable capping member so as to protect the ink discharging surface of the
10 recording head H from damage or injury before the supply source is turned off on completion of the recording operation.

Thereafter, the recording medium P is discharged from the printer section IJP by
15 driving the conveyance motor 102b until it is confirmed that the conveyance motor 102b is driven by a predetermined number of revolutions or until the paper sensor 91 detects that the recording medium P is discharged from the
20 printer section IJP. On completion of the recording operation, the controller 81 instructs the central processing unit 82 so as to allow the latter to activate the display actuating section or output an instruction to the
25 peripheral equipments via the external interface portion 75, whereby the recording operation is completed.

The ink jet recording

head and ink tank cartridge can be connected to each other and disconnected from each other. Since the printer section IJP is constructed such that a connecting operation or a
5 disconnecting operation can be achieved while an assembly of the recording head and the ink tank cartridge is mounted on the carriage HC or dismounted from the same, advantageous effects as noted below can be obtained.

10 Specifically, since the ink tank cartridge is mounted on the carriage HC, there does not arise a necessity for extending or arrange a tube for the purpose of feeding ink to the ink jet recording head, resulting in the recording
15 section IJP being constructed with small dimensions. When there arises an occasion that no ink is available for a printing operation, it is not required that the whole assembly of the ink jet recording head and the ink tank
20 cartridge is exchanged with a new one but merely the ink tank cartridge is to be exchanged with a new one with the result that the printer section IJP can be operated at a reduced running cost. In the case that the exchanging of one of the
25 ink jet recording head and the ink tank cartridge with a new one is required, it suffices that one of the ink jet recording head and the ink tank cartridge is exchanged with a

new one, resulting in an economical efficiency of the printer section IJP being improved.

In the case that the ink jet recording head and the ink tank cartridge are disconnected from each other by actuating a lever or the like on the carriage HC, a disconnecting operation can adequately be adjusted for the printer section IJP, and moreover, there does not arise a malfunction that ink is scattered away from the ink intake port or the ink feed port. When the ink jet recording head and the ink tank cartridge are separated from each other on the carriage HC, since there is no need of holding the ink jet recording head directly with an operator's hand, there does not arise another malfunction that a quality of each printed matter is adversely affected with the scattered ink or the printed matter is contaminated with the scattered ink.

In the case that the ink jet recording head and the ink tank cartridge are unavoidably disconnected from each other on the carriage HC, since the position where a certain intensity of force is applied to the ink tank cartridge is specifically determined on the ink tank cartridge, it is required that merely a part of the ink tank cartridge corresponding to the foregoing position is designed to have a large

thickness enough to stand against the applied force and the other part of the ink tank cartridge is designed to have small thickness. Thus, the ink tank cartridge can be constructed
5 with a reduced weight but with an increased interior volume thereof. In the case that it is necessary that the present ink color is exchanged with another one, since an assembly of the ink jet recording head and the ink tank
10 cartridge integrated with each other can be exchanged with another one as it is, an exchanging operation can easily be achieved at a high efficiency.

15 An ink tank cartridge for an ink jet recording unit constructed according to a first embodiment of the present invention will be described below with reference to Fig. 8 that is a partially exploded perspective view
20 thereof.

An ink jet recording head (not shown) including an energy generating portion operable for producing droplets of recording ink can be connected to and disconnected from an ink tank
25 cartridge 303 in which ink is stored, and a porous member 310 molded of a foamed polyurethane or the like is press-fitted into the ink tank cartridge 303. The porous member

310 represented by hatched lines in the drawing is brought in close contact with a plurality of side ribs 164 arranged along the opposite side walls of the ink tank cartridge 303. In Fig. 5 8 , reference numeral 340 designates an atmospheric air intake port. The air intake port 340 communicates with air path (not shown) which extends in the ink tank cartridge 303 in a complicated manner. In practice, the 10 air path is constructed such that ink does not flow outside of the ink tank cartridge 303 through the air intake port 340 even when the ink contained in the porous member 310 leaks from the latter due to some abnormality caused 15 with the ink tank cartridge 303. Reference numeral 166 designates a plurality of rear ribs. The rear ribs 166 are arranged at the rear end part of the ink tank cartridge 303. Similarly, the porous member 310 is brought in close 20 contact with the rear ribs 166. To assure that the air taken through the air intake port 340 is fully distributed over the whole surface of the porous member 310 at the rear end part of the latter, a plurality of cutouts 167 are formed 25 along each rear rib 166. The space formed by the rear ribs 166 serves as a buffer chamber for storing outflow ink therein when the ink contained in the porous member 310 flows outside

of the porous member 310 due to some abnormality. In this embodiment, the side ribs 164 and the rear ribs 166 are alternately arranged in the ink tank cartridge 303. The

5 side ribs 164 extend from the position for allowing the air introduced through the air intake port 340 to be sufficiently taken in the ink tank cartridge 303 till the plane

10 positionally coincident with an ink outflow port 330 through which the ink contained in the porous member 310 is fed to the ink jet recording head. With this construction, the air introduced through the air intake port 340 flows not only in the space defined between the rear

15 inner wall surface of the ink tank cartridge 303 and the porous material 310 in the presence of the rear ribs 166 but also in the space defined between the side inner wall surfaces of the ink tank cartridge 303 and the porous material 310

20 in the presence of the side ribs 164, whereby the air is completely distributed over the porous material 310 on the air intake port 340 side as well as on the opposite side wall sides. The width and the height of each side ribs 164

25 as well as the pitch for arranging the side ribs 164 one above another are determined in such a manner as to allow the inflow air to be sufficiently distributed over the side surface

of the porous member 310. It is recommendable that each rib exhibits one of sectional shapes as shown in Fig. 14.A to 14I. Since the ink tank cartridge 303 is constructed in the above-
5 described manner, the ink in the porous member 310 can easily be exchanged with the inflow air, causing a quantity of ink remaining in the ink tank cartridge 303 to be substantially reduced. In other words, the ink contained in the porous
10 member 310 can be used at a high efficiency.

The results derived from measurement conducted on a quantity of ink remaining in the ink tank cartridge which varied depending on a length of each side rib 164 are shown in Table
15 1. Each measurement was conducted for each of rates representing a volume assumed by all the ribs in the ink tank cartridge in terms of percentages on the assumption that the ink tank cartridge had a whole length of 40 mm and a
20 length of each side rib was represented by x . As is apparent from table 1, when the length of each side rib was set to 70 % or more based on the total length of the ink tank cartridge, a good result of 1 gram or less representing a
25 quantity of ink remaining the ink tank cartridge was obtained.

Table 1

rib length × 40	quantity of ink initially filled in ink tank cartridge	quantity of ink remaining in ink tank cartridge after usage	negative pressure at full page printing
50 %	5 g	1.52 g	130 to 150 mm aq
60 %	5 g	1.34 g	125 to 140 mm aq
70 %	5 g	0.91 g	115 to 130 mm aq
80 %	5 g	0.82 g	105 to 125 mm aq
90 %	5 g	0.81 g	100 to 120 mm aq
100 %	5 g	0.78 g	100 to 120 mm aq

5 Note: Each ink tank cartridge having a rib length (x/40) lying within the range of 70 % to 100 % and exhibiting a remaining ink quantity of 1 gram or less was recognized as an acceptable ink tank cartridge.

10 inner dimensions of ink tank cartridges each

employed for measurements : $40 \times 20 \times 20$ (mm)

ink absorbing member : foamed polyurethane resin having 85 to 105 voids formed therein per inch

5 sectional shape of side rib : width of 1 mm
height of 2 mm
as measured from each of the opposite inner side walls of each ink tank cartridge

10 An ink jet recording unit constructed according to a second embodiment of the present invention will be described below with reference to Fig. 9 that is a sectional view thereof.

15 As air is introduced into an ink tank cartridge 303 through an atmospheric air intake port 340, it is uniformly distributed over the whole rear surface of a porous member 310. The ink tank cartridge 303 includes upper and lower
20 ribs 201 so as to allow the inflow air to be subsequently distributed over the upper and lower surfaces of the porous member 310 with the aid of both the upper and lower ribs 210. In this embodiment, both the upper and lower ribs
25 210 extend from the position where a sufficient quantity of air is taken in the ink tank cartridge 303 across the porous member 303 to reach an ink jet recording head 301. With this

construction, an ink can practically be used at a high efficiency.

An ink tank cartridge for an ink jet
5 recording unit constructed according to a
third embodiment of the preset invention will
be described below with reference to Fig. 10 .

An atmospheric air intake port (not shown)
and an ink outlet port (not shown) are formed
10 through the opposite surfaces of the
parallelepiped-shaped ink tank cartridge 303.
Fig. 10 is a cross-sectional view of the ink
tank cartridge 303 taken along a plane in
parallel with the front end surface having the
15 ink outlet port formed thereon. In this
embodiment, the ink tank cartridge 303 includes
a plurality of longitudinally extending ribs
371, 372, 373 and 374 on the right-hand side
wall, the lower wall, the left-hand side wall
20 and the upper wall thereof, respectively. With
this construction, as the atmospheric air
introduced through the air intake port flows in
the space formed by the rear ribs (not shown)
between the rear wall of the ink tank cartridge
25 303 and a porous member 310 and then reaches the
front end surface of the ink tank cartridge 303
having the ink outlet port formed thereon
through the space defined between the porous

member 310 and the ribs 371, 372, 373 and 374 each extending across the porous member 310 in the longitudinal direction. In this embodiment, any particular problem does not arise when the
5 volume of the porous member 310 is slightly reduced because the porous member 310 is held within the ribs 371, 372, 373 and 374 as if it is surrounded by them. In view of the foregoing fact, it is recommendable that the porous member
10 310 is employed for the ink tank cartridge 303 having a comparatively large volume. The air can easily be substituted for the ink contained in the porous member 310 as the contacting area defined by both the inner wall of the ink tank
15 cartridge 303 and the porous member 310 is reduced more and more resulting in reducing the remaining ink in the porous member 310. Since a plurality of ribs are arranged around the inner wall of the ink tank cartridge 310 in the above-
20 described manner, the air can uniformly be distributed over all the surfaces exclusive of the surface having the ink outlet port formed thereon, resulting in the ink contained in the porous member 303 being utilized at a highly
25 improved efficiency. The width and the height of each of the ribs 371, 372, 373 and 374 may variably be determined in consideration of various working conditions given to the ink tank

cartridge 303. For example, in the case as shown in Fig. 10, the ribs 372 formed on the lower wall of the ink tank cartridge 303 are dimensioned to have the height lower than that of the other ribs. This is intended to easily recover by absorbing the leaked ink in the small space between the lower wall of the ink tank cartridge 303 and the porous member 310 when some ink flows outside of the porous member 310 due to some abnormality and it is then stored in the foregoing small space. Alternatively, the respective ribs 371, 372, 373 and 374 may be designed such that the height of each rib is varied, and moreover, each rib is tapered toward the ink outlet port side from the air intake port side with some height difference therebetween in order to change compressibility of the porous member 310 across the length of the ink tank cartridge 303 so as to allow the ink to be concentratively collected in a certain region in the porous member 310.

An ink tank cartridge for an ink jet recording unit constructed according to a fourth embodiment of the present invention will be described below with reference to Fig. 11 that is a sectional view thereof.

In the drawing, reference numeral 501

designates a rib. The rib 501 may be formed either along the upper wall of the ink tank cartridge 303 or along the lower wall of the same in the longitudinal direction. A

5 characterizing feature of this embodiment consists in that one end of the rib 501, i.e., the left-hand end of the rib 501 in the shown case is tapered as represented by reference numeral 502. Since the rib 51 has a tapered
10 portion 502 in that way, when a porous member 310 is inserted into the ink tank cartridge 303 and then sealably closed with a cover 503 on the ink outlet port side in the course of production of the ink tank cartridge, the inserting
15 operation can smoothly be achieved in the presence of the tapered portion 502 without an occurrence of malfunction that the porous member 310 is damaged or injured by a sharp edge of the rib 501. It is not always necessary that all of
20 the tapered portion 502 projects to the ink outlet port side, i.e., the cover 503.

Alternatively, the tapered portion 502 may extend within the range defined by the length of the porous member 310, provided that the air
25 introduced through the atmospheric air intake port can be distributed over the whole surface of the porous material 310 without any problem in respect of an ink utilization efficiency.

An ink tank cartridge for an ink jet recording unit constructed according to a fifth embodiment of the present invention will be described below with reference to Fig. 12 that is a sectional view thereof.

The ink tank cartridge 303 includes an atmospheric air intake port 340 and an ink outlet port 330 both of which are not located in alignment with each other as seen in the longitudinal direction. In this embodiment, in view of the foregoing fact, a plurality of ribs 601 are arranged between the ink tank cartridge 303 and a porous member 310 not only along the opposite side walls of the ink tank cartridge 303 but also along the upper and lower surface of the same so that the air introduced through the air intake port 340 is uniformly distributed over the whole surface of the porous member 310 without any possibility that an ink utilization rate of the ink tank cartridge is degraded.

An ink tank cartridge for an ink jet recording unit constructed according to a sixth embodiment of the present invention will be described below with reference to Fig. 13A and Fig. 13 B.

Fig. 13A is a sectional view of the ink tank

cartridge, particularly showing the arrangement of a plurality of slantwise extending ribs 701. In practice, to assure that the air introduced into the ink tank cartridge 303 through an
5 atmospheric air intake port 340 is sufficiently distributed over the whole surface of a porous member (not shown) containing ink, it is not always necessary that each rib continuously extends within the range between the air intake
10 port 340 and an ink outlet port 330. For this reason, in this embodiment, the slantwise extending ribs 701 are arranged in the equally spaced relationship while extending in parallel with each other. In addition, as shown in Fig.
15 27B, a plurality of cutouts 702 are formed along the upper edge of each rib 701. In the shown case, each rib 701 linearly extends.

Alternatively, it is obvious that it may extend in the curved state. Therefore, this embodiment
20 is advantageously employable for carrying out the present invention, particularly, in the case that molding performances (associated with the direction of molding) required when the ink tank cartridge and the ribs are simultaneously molded
25 in the integral structure is restricted.

With the ink tank cartridge constructed in the above-described manner, since recording ink contained in the porous member received in the

ink tank cartridge can ultimately be utilized,
an advantageous effect obtainable with the ink
tank cartridge is such that reliability on
practical use of the ink can be elevated while
5 maintaining a running cost of the ink tank
cartridge at a low level.

The present invention achieves distinct
effect when applied to a recording head or a
10 recording apparatus which has means for
generating thermal energy such as electrothermal
transducers or laser light, and which causes
changes in ink by the thermal energy so as to
eject ink. This is because such a system can
15 achieve a high density and high resolution
recording.

A typical structure and operational
principle thereof is disclosed in U.S. patent
Nos. 4,723,129 and 4,740,796, and it is
20 preferable to use this basic principle to

implement such a system. Although this system can be applied either to on-demand type or continuous type ink jet recording systems, it is particularly suitable for the on-demand type apparatus. This is because the on-demand type apparatus has electrothermal transducers, each disposed on a sheet or liquid passage that retains liquid (ink), and operates as follows: first, one or more drive signals are applied to the electrothermal transducers to cause thermal energy corresponding to recording information; second, the thermal energy induces sudden temperature rise that exceeds the nucleate boiling so as to cause the film boiling on heating portions of the recording head; and third, bubbles are grown in the liquid (ink) corresponding to the drive signals. By using the growth and collapse of the bubbles, the ink is expelled from at least one of the ink ejection orifices of the head to form one or more ink drops. The drive signal in the form of a pulse is preferable because the growth and collapse of the bubbles can be achieved instantaneously and suitably by this form of drive signal. As a drive signal in the form of a pulse, those described in U.S. patent Nos. 4,463,359 and 4,345,262 are preferable. In addition, it is preferable that the rate of

temperature rise of the heating portions described in U.S. patent No. 4,313,124 be adopted to achieve better recording.

U.S. patent Nos. 4,558,333 and 4,459,600
5 disclose the following structure of a recording head, which is incorporated to the present invention: this structure includes heating portions disposed on bent portions in addition to a combination of the ejection orifices,
10 liquid passages and the electrothermal transducers disclosed in the above patents. Moreover, the present invention can be applied to structures disclosed in Japanese Patent Application Laying-open Nos. 123670/1984 and
15 138461/1984 in order to achieve similar effects. The former discloses a structure in which a slit common to all the electrothermal transducers is used as ejection orifices of the electrothermal transducers, and the latter discloses a
20 structure in which openings for absorbing pressure waves caused by thermal energy are formed corresponding to the ejection orifices. Thus, irrespective of the type of the recording head, the present invention can achieve
25 recording positively and effectively.

The present invention can be also applied to a so-called full-line type recording head whose length equals the maximum length across a

recording medium. Such a recording head may consists of a plurality of recording heads combined together, or one integrally arranged recording head.

5 In addition, the present invention can be applied to various serial type recording heads: a recording head fixed to the main assembly of a recording apparatus; a conveniently replaceable chip type recording head which, when loaded on
10 the main assembly of a recording apparatus, is electrically connected to the main assembly, and is supplied with ink therefrom; and a cartridge type recording head integrally including an ink reservoir.

15 It is further preferable to add a recovery system, or a preliminary auxiliary system for a recording head as a constituent of the recording apparatus because they serve to make the effect of the present invention more reliable. As
20 examples of the recovery system, are a capping means and a cleaning means for the recording head, and a pressure or suction means for the recording head. As examples of the preliminary auxiliary system, are a preliminary heating
25 means utilizing electrothermal transducers or a combination of other heater elements and the electrothermal transducers, and a means for carrying out preliminary ejection of ink

independently of the ejection for recording.
These systems are effective for reliable
recording.

The number and type of recording heads to be
5 mounted on a recording apparatus can be also
changed. For example, only one recording head
corresponding to a single color ink, or a
plurality of recording heads corresponding to a
plurality of inks different in color or
10 concentration can be used. In other words, the
present invention can be effectively applied to
an apparatus having at least one of the
monochromatic, multi-color and full-color modes.
Here, the monochromatic mode performs recording
15 by using only one major color such as black.
The multi-color mode carries out recording by
using different color inks, and the full-color
mode performs recording by color mixing.

Furthermore, although the above-described
20 embodiments use liquid ink, inks that are liquid
when the recording signal is applied can be
used: for example, inks can be employed that
solidify at a temperature lower than the room
temperature and are softened or liquefied in the
25 room temperature. This is because in the ink
jet system, the ink is generally temperature
adjusted in a range of 30°C - 70°C so that the
viscosity of the ink is maintained at such a

value that the ink can be ejected reliably.

In addition, the present invention can be applied to such apparatus where the ink is liquefied just before the ejection by the thermal energy as follows so that the ink is expelled from the orifices in the liquid state, and then begins to solidify on hitting the recording medium, thereby preventing the ink evaporation: the ink is transformed from solid to liquid state by positively utilizing the thermal energy which would otherwise cause the temperature rise; or the ink, which is dry when left in air, is liquefied in response to the thermal energy of the recording signal. In such cases, the ink may be retained in recesses or through holes formed in a porous sheet as liquid or solid substances so that the ink faces the electrothermal transducers as described in Japanese Patent Application Laying-open Nos. 56847/1979 or 71260/1985. The present invention is most effective when it uses the film boiling phenomenon to expel the ink.

Furthermore, the ink jet recording apparatus of the present invention can be employed not only as an image output terminal of an information processing device such as a computer, but also as an output device of a copying machine including a reader, and as an

output device of a facsimile apparatus having a transmission and receiving function.

The present invention has been described in detail with respect to preferred embodiments, and it will now
5 be that changes and modifications may be made without departing from the invention in its broader aspects, and it is the intention, therefore, to cover all such changes and modifications as fall within the scope of the following claims.

10 Reference is hereby directed toward Application No. 9315879.8 (Publication No. 2269784) which relates to an ink container having a cut-out portion and from which the present application is divided and to Applications Nos. 9606491.0 (Publication No. 2298616) and 9616110.4
15 (Publication No. 2302843) which are also divided from Application No. 9315879.8 and which relate to a liquid storing container having an end filter contacting a porous member and to a recording unit having a connecting piece between the head and the tank, respectively.

CLAIMS

1. An ink tank cartridge containing an ink absorbing member formed of a porous material and having an atmospheric air intake port and an ink outlet port, the air intake port opening to the interior of the cartridge on a wall different from the ink outlet port so as to allow ink to be supplied to the outside from said ink outlet port, wherein
- 10 a plurality of ribs are formed along an inner wall of said cartridge between the air intake port and the ink outlet port in a direction so as not to block a path joining the air intake port and the ink outlet port to enable atmospheric air taken through said atmospheric
- 15 intake port to be distributed over the surface of said ink absorbing member facing the atmospheric air intake port, at least one other surface of said ink absorbing member, and the surface of said ink absorbing member facing the ink outlet port.
- 20
2. A cartridge according to claim 1, wherein each of said ribs extends from a position where a sufficient quantity of air can be taken into said ink tank cartridge through said atmospheric air intake port to a location
- 25 coincident with the wall having said ink outlet port without formation of any closed space between said ink absorbing member and the inner wall surface of said



cartridge.

3. A cartridge according to claim 1 or 2, wherein said
ink absorbing member is received in a parallelopipedal
5 or a cubic ink absorbing member receiving section of the
cartridge, and said ribs are formed on at least two inner
surfaces of said ink absorbing member receiving section.

4. A cartridge according to claim 1, 2 or 3, wherein
10 said ink absorbing member is received in a
parallelopipedal or a cubic ink absorbing member
receiving section of the cartridge, and said ribs are
formed on two surfaces of said ink tank absorbing member
receiving section other than the surface having said
15 atmospheric air intake port and the surface having said
ink outlet port.

5. A cartridge according to claim 1, 2, 3 or 4, wherein
70% or more of the whole surface area of said ink
20 absorbing member is exposed to air while a part of said
ink absorbing member comes into contact with said ribs.

6. A cartridge according to claim 1, wherein a
plurality of further ribs are provided on the wall at
25 which the air intake port opens to the interior of the
cartridge with each of said further ribs being formed
with a plurality of cut-outs.



7. A cartridge according to claim 1, wherein said ink absorbing member is received in a parallelopipedal or cubic ink absorbing member receiving section and ribs are provided on four walls of the interior of the receiving section.

8. A cartridge according to claim 7, wherein the ribs on a wall of the receiving section which is lowermost in use of the cartridge are of lower height than the remaining ribs.

9. A cartridge according to claim 1, wherein the ribs are tapered at one end to facilitate insertion of the ink absorbing member.

10. A cartridge according to claim 1, wherein the air intake and ink outlet ports are not aligned with one another and ribs are provided on walls of the interior of the cartridge which in use of the cartridge form lower, upper and side walls.

11. A cartridge according to claim 1, wherein the ink absorbing member is received in a parallelopipedal or cubic ink absorbing member receiving section of the cartridge and the ribs extend slantwise of the walls of the receiving section.



12. A cartridge according to claim 1, wherein the ribs have a cross-section as shown in any one of figures 14A to 14I of the accompanying drawings.

5 13. A cartridge substantially as hereinbefore described with reference to any one of figures 8 to 14I of the accompanying drawings.

10 14. A recording unit comprising a cartridge in accordance with any one of the preceding claims and an ink jet head attachable to and detachable from the cartridge.

15 15. An ink jet recording apparatus comprising a cartridge in accordance with any one of claims 1 to 13 or a recording unit in accordance with claim 14.

