

1 TITLE OF THE INVENTION

Ink Jet Recording Method and Color Ink Jet Recording
Device for Practicing the Same

5 BACKGROUND OF THE INVENTION

Field of the Inveniton

This invention relates to an ink jet recording
method and a color ink jet recording device which are
applied to copying machines, facsimiles, printers for
10 image processing, and other printers in general. More
particularly, it pertains to a scanning type ink jet
recording device equipped with a plural number of
recording heads having a plural number of discharge
ports arrayed in the sub-scanning direction and to a
15 recording method of said device.

Related Background Art

In the prior art, for improvement of gradation
or density of recorded images, it has been practiced to
form a plural number of picture elements for forming
20 the image on a recording medium with a plural number
of overlapping ink droplets, or for improvement of
adjacent picture element densities, to shoot a
plural number of ink droplets at a high density.
When this is applied to color, there is the advantage
25 that color reproducibility can be improved.

Further, in the case when the recording medium
is a transparent film for transmission type OHP (overhead



1 projector), etc., the image recorded thereon is required
to be increased in transmission density as a whole, and
also in this case the above system is effective.

5 In these systems, emission of ink droplets for
emitting a plurality of ink droplets on one picture
element is performed by scanning of the recording
head for plural times while the recording medium is
fixed as such. Accordingly, scanning for plural times
10 corresponding to higher densification or scanning for
plural times corresponding to the ink colors to be
mixed is required for the recording range per one
scanning in scanning type recording, and no high
speed recording can be practiced. In other words,
if a high density image or a color image is formed
15 for ordinary printing, a printing time is required
which is as long as 2-fold to 4-fold of the time
required for ordinary printing.

20 Accordingly, for the purpose of making faster
even by little the recording speed, in order to increase
the recording range per one scanning, it is effective
to enlarge the recording head by formation of a multi-
nozzle, but since it is limited to make the head
lengthy, the ratio of shortening of the printing
time is little in scanning type ink jet recording.

25 In contrast, U.S. Patent 4,320,406 discloses
a constitution which miniaturizes the head constitution
itself of a color device by dividing the nozzles



1 (discharge port) of the single recording head itself
formed into a multi-nozzle into four nozzle units
predetermined for different inks, but since the
recording speed depends on only one recording head,
5 the ink discharge range of one color is reduced to
great extent, whereby the advantage of the recording
formed into a multi-nozzle will be lost.

The present inventors have investigated about
the prior art and found the following problems.

10 When image density is enhanced or color
formation is effected by scanning for plural times
continuously for the recording range to be recorded
by one scanning, because the picture element is formed
by ink discharge for plural times, the ink amount per
15 one picture element becomes larger, and therefore in
the case of recording medium of which ink receptive
amount is limited such as film for OHP or one having
poor ink absorptivity, the amount or the rate of
ink absorption is limited, whereby ink may be some-
20 times overflowed from the picture element, resulting
in deterioration of the image quality.

Particularly, a plural number of recording
heads corresponding to the respective inks had a
constitution arranged in the scanning direction,
25 and therefore in the case when different inks
were overlapped, the emission density per unit
time became greater, whereby the above problem



1 of ink overflow became marked.

Generally speaking, recording papers with increased ink absorption amount have been known, and recording is possible only on expensive and specific converted papers and only for limited recording.

5 However, when users employ another paper or sheet, defective recording may be brought about, and in the worst case, users sometimes judged that the recording head was defective to make the recording head useless.

10 Anyway, even by use of a multi-nozzle head, because scanning is performed for plural times by stopping of paper feeding of the recording medium, the recording speed cannot be lowered, and also, when only a recording medium excellent ink absorp-
15 tivity is used, the disadvantages of the users by limitation of the recording will be brought about, such as the disadvantage of failing to use a diversity of recording media.

Further, as the problem of fixability, boundary
20 region, the following facts have been found out, and it has been found that the difference in recording characteristics becomes marked when using different recording media.

More specifically, a great difference in ink
25 absorption ability occurs at the boundary portion of the scanning line in overlapped recording, whereby density irregularity due to nonuniform ink absorption



1 is liable to be generated.

Also, in the constitution which performs recording for plural times on the same picture element through the same discharge port, irregularity in density and shooting precision between
5 the discharge ports may be sometimes intensified to lower the picture element.

Further, since the ink densities change at the same time over the whole region of the width of
10 the discharge port (scanning region), and therefore stretching and shrinkage of the recording medium accompanied with ink absorption will occur at the same time, whereby the change amount becomes greater.

On the other hand, divided recording is a
15 system which is to be used for a recording medium inferior in absorption characteristic, and even after the final scanning (ink emission), the recorded surface cannot be touched before elapse of a certain time. Therefore, the members such as
20 discharge rollers, press rollers, etc. are required to be departed from the above-mentioned recording region by the head width or more, whereby enlargement of the device or lowering in paper feeding precision may be brought about.

25 Further, the problem of stretching and shrinkage of the recording medium as mentioned above also occurs in divided recording.



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1 SUMMARY OF THE INVENTION

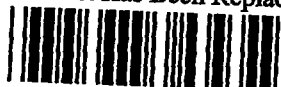
 The present invention is intended to provide
an ideal ink jet recording device which has solved
the problems as described above in the case of using
5 a plural number of recording heads equipped with a
plural number of discharge ports (also called multi-
nozzle head).

 A first object of the present invention is to
provide an ink jet recording device which can make
10 recording speed faster than in the prior art and can
improve overlapped recorded image or high density
recorded image with the so called multi-nozzle ink
jet recording head.

 A second object of the present invention is
15 to provide a recording method improved in fixability
which can also make the enlarged portion in use of
a plural number of recording heads miniaturized as
the whole device.

 A further object of the present invention in
20 cancelling the problems as described above is to
provide an ink jet recording device which can
prevent deterioration of image quality according
to ink absorptivity of the recording medium without
lowering recording speed, and also is capable of
25 good recording on a diversity of recording media.

 Still another object of the present invention
is to provide an ink jet recording device which can



1 perform preferably recording of high speed and high
image quality depending on the kind of the recording
medium by utilizing the advantage of the multi-nozzle
recording head to the maximum.

5 Still other objects of the present invention
will be understood from the following description.

Here, representative embodiments of the
present invention are set forth specified below.

One embodiment of the present invention is
10 an ink jet recording device comprising:

a carriage having a plural number of ink jet
recording heads each having a plural number of dis-
charge ports mounted thereon;

15 a means for giving recording ink signals to
the ink discharge energy generating elements corres-
ponding to all or a part of the respective plural
number of discharge ports of said plural number of
recording heads; and

20 a control means, which increases the number
of recording heads to be used during recording of
the recordable region formed by the total sum of
all the discharge regions of said plural number of
recording heads from initiation of recording onto a
recording medium, reducing the number of recording
25 heads to be used during recording of said recordable
region in the recording completion region of the
recording medium, and has one scanning width to be



1 recorded by scanning by the recording head during
recording as the feeding pitch of the recording medium.

Another embodiment of the present invention is
an ink jet recording device which has a plural number
5 of recording heads having discharge ports for discharging
ink arrayed thereon, and performs recording of images by
discharging ink through said discharge ports accompanied
with the scanning movement of said plural number of
recording heads,

10 characterized in that said device has a first
recording head and a second recording head provided
adjacent to the upstream side and down stream side
relatively with respect to the conveying direction
of the recording medium, and arranged in the positional
15 relationship with the respective discharge ports not
overlapping each other in the upstream side region
and the downstream side region, and a recording
mode which performs recording so that at least the
image of first ink droplets on the recording medium
20 by the first recording head relatively on the upstream
side and the image of the second ink droplets on the
recording medium by the second recording head relatively
on the downstream side may be overlapped with each other.

More preferably, another embodiment is an ink
25 jet recording device which has a plural number of
recording heads having discharge ports for discharging
ink arrayed thereon, and performs recording of images



1 by discharging ink through said discharge ports
accompanied with the scanning movement of said
plural number of recording heads,

characterized in that each of said plural
5 number of recording heads and at least another of
said plural number of recording heads are arranged
so that said discharge ports arrayed on each may
not overlap each other in said scanning direction,

and said device is provided with a paper
10 feeding means which performs paper feeding with the
width of the recording regions by said scanning
movement of the recording heads arranged so as not
to overlap each other, and

a recording signal supplying means which
15 supplies recording signals for discharge to the
respective recording heads of said plural number of
recording heads corresponding to the paper feeding
by said paper feeding means.

.Still another embodiment is an ink jet
20 recording device, which has a plural number of
recording heads, each constituted by arraying a
plural number of discharge ports for discharging
ink in the sub-scanning direction or a direction
different from the scanning direction, in the
25 scanning direction, and performs recording of
images by discharging ink through said discharge
ports accompanied with the scanning movement of



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1 said plural number of recording heads,
characterized in that said device is provided
with a conveying means which conveys the recording
medium with the width of the equally divided region
5 of the recording region by scanning of said plural
number of recording heads per every time of said
scanning movement, and

a recording signal supplying means which
supplies recording signals to only the discharge
10 ports predetermined corresponding to said equally
divided regions in response to said conveying by
said conveying means.

There is also provided an ink jet recording
device, which has a recording head constituted by
15 arranging a discharge port for discharging ink in
the sub-scanning direction or a direction different
from the scanning direction, arranged in the scanning
direction, and performs recording of images by dis-
charging ink through said discharge port accompanied
20 with the scanning movement of said plural number of
recording heads,

characterized in that said device is provided
with a conveying means which performs conveying the
recording medium with the width of the equally divided
25 region of the recording region by scanning of said
recording heads per every time of said scanning
movement, and



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1 a recording signal supplying means which
supplied recording signals to only the discharge ports
predetermined corresponding to said equally divided
regions in response to said conveying by said conveying
5 means,

In either one of the above inventions, in
using a plural number of recording heads having a
plural number of discharge ports, the ratio of the
recording medium moved can be made greater than in
10 the prior art, and therefore the recording speed
can be improved, whereby excellent image can be
formed by utilizing all or a part of the plural
number of discharge ports or a part of the recording
medium defined depending on the material, and there-
15 fore the image quality can be made further stable.

Also, in performing overlapped recording,
the recording time can be reduced, and also the
joining portion of images can be made better.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side sectional view of the ink jet
recording device according to a first embodiment of
the present invention;

Fig. 2 is a block diagram showing the control
25 constitution according to recording of the device
shown in Fig. 1;

Figs. 3A and 3B are conceptual views of the

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1 recording method in the first embodiment;

Fig. 4 is a graph showing the ink absorption characteristics of the recording medium;

5 Fig. 5 is an illustration showing the image evaluations corresponding to the ink densities of the recording medium;

Fig. 6 is an illustration of image blotting of Fig. 6A and Fig. 6B;

10 Fig. 7 is an illustration of overlapping of inks in the embodiment of the present invention;

Fig. 8 is a perspective view showing an ink jet cartridge of 4 heads integrated in the second embodiment of the present invention;

15 Fig. 9A and Fig. 9B are conceptional views of the recording method in the second embodiment;

Fig. 10 is a perspective view of the ink jet recording device according to the second embodiment of the present invention;

20 Figs. 11A and 11B are conceptional views of the recording method in the third embodiment of the present invention;

Fig. 12 is a side sectional view of the ink jet recording device according to the fourth embodiment of the present invention;

25 Fig. 13 is a block diagram showing the control constitution according to recording of the device shown in Fig. 12;

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1 Fig. 14A and Fig. 14B are conceptional views
of the recording method in the fourth embodiment;

 Fig. 15A and Fig. 15B are conceptional views
showing the recording mode of the prior art, which is
5 applicable to the seventh embodiment of the present
invention;

 Fig. 16 is a perspective view showing the
ink jet cartridge of 4 heads integrated in the fifth
embodiment;

10 Fig. 17A and Fig. 17B are conceptional views
of the recording method in the fifth embodiment;

 Fig. 18 is a perspective view of the ink
jet recording device according to the fifth embodiment
of the present invention;

15 Fig. 19 is a conceptional view of the recording
method in the sixth embodiment of the present invention;

 Fig. 20 is a schematic illustration of the
pertinent portion of the seventh embodiment of the
present invention;

20 Fig. 21 is a schematic illustration of the
pertinent portion of the operation panel to be used
in the seventh embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 Referring now to the drawings, the embodiments
of the present invention are described in detail.

 Fig. 1 is a side sectional view showing the



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1 principal portion of the ink jet recording device
according to an embodiment of the present invention.
In the Figures, 1 to 4 are recording heads each having
64 ink discharge ports, and the ink passage communicated
5 to these discharge ports has an electrothermal trans-
ducer for generating energy for discharging ink arranged
therein. Also, the recording heads 1, 2, 3 and 4 are
recording heads for discharging respectively inks of
red (R), green (G), blue (B) and black (B), and
10 they are respectively held on the carriage 5. With
such arrangement, the directions of the discharge
port array in the respective recording heads forms
the sub-scanning direction as described below with
reference to Fig. 3A, and they are arrayed so that
15 the recording region by scanning may be the same.

The carriage 5 is engaged slidably with a
pair of guide shafts and is also movable in the
scanning direction (the direction perpendicular
to the drawing) by the carriage motor as described
20 below.

The recording heads 1 to 4 are connected
electrically through the carriage to the main
control section as described below with reference
to Fig. 2, and otherwise connected to the ink tanks
25 of the respective colors at the ink tank portion 7
by the ink tube bundle 6 corresponding flexibly to
the movement of the carriage 5 so that ink supply

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1 can be done. On the other hand, the recording medium
8 is conveyed by the conveying roller pair 9 through
the paper feeding guide 10 at a predetermined timing
successively in the arrowhead direction in the Figure
5 to the recording portion. At the recording portion,
the recording medium 8 is adsorbed through the
electrostatic attracting force of the adsorption
conveying belt 11, and adsorption supporting conveying
is done while being synchronized with the conveying
10 roller pair 9 with movement of the belt 11, and the
medium stops successively at predetermined positions
to perform recording.

Fig. 2 is a block diagram showing the recording
control in the ink jet recording device shown in Fig. 1.
15 In the same Figure, 5A is the carriage motor for
driving the carriage 5 through a carriage driving
mechanism such as belt, pooley, etc., and 20 is the
head driver for generating discharge signals for the
respective discharge ports based on the recording
20 data supplied from the control section. 30 is the
paper feeding driving section for driving the
conveying roller 9 and the adsorption conveying
belt 11, and is constituted mainly of a motor, etc.

The control section shown in the Figure has
25 CPU 100 which practices processing according to
control of the device while performing giving and
receiving of the data between the host device or

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1 the respective sections of the recording device,
RAM100A which becomes the work area in processing
of CPU100, and ROM100B which memorizes the processing
procedure such as recording actuation, etc. as shown
5 in Fig. 3A and Fig. 3B.

Figs. 3A and 3B are conceptional views for
illustration of the recording method in the embodiment
shown in Fig. 1. In Fig. 3A, the recording heads 1
to 4 for discharging respectively the inks of the
10 respective colors of R, G, B and K are, as mentioned
above, supported and fixed so that the respective
discharge port arrays 3 may become perpendicular to
the scanning direction (sub-scanning direction)
relative to the both surfaces of the head supporting
15 portion 12.

In the same Figure, the discharge port array ...
13 cannot be seen as it is, but the recording head
is shown as perspective from the rear thereof. More
specifically, the array is made so that the widths
20 of the discharge port arrays of the recording head
(in the Figure, RL=GL=BL=KL) may be connected to one
another without gap, and the respective recording
regions (R, G, B, K) by one scanning becomes con-
tinuous with the same width. When the recording
25 medium is conveyed as described above to the
recording regions (R, G, B, K), the carriage 5
scans to initiate recording.

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1 The recording medium 8 stops at the position
of (the first scanning) in Fig. 3A by the conveying
roller pair 9 and the adsorption conveying belt 11.
This position is under the state where the tip portion
5 of the recording medium 8 is in the recording region
K, and the recording medium has not reached other
recording regions R, G, B. Therefore, in the first
head scanning, recording is performed only with the
K head.

10 After the first scanning, the recording
medium 8 is again conveyed by the conveying roller
pair 9 and the adsorption conveying belt 11. As is
apparent from Fig. 3A, the conveying distance PL
is set the same as the width(RL, GL, BL, KL) of
15 the discharge port array. In the second scanning,
the region recorded in response to the recording
signal K_1 by the head 4 of K ink in the first
scanning has moved to the B recording region, and
recording is performed in response to the recording
20 signal B_1 with the head 3 of B ink.

On the other hand, at the portion conveyed
newly to the K recording region, recording is per-
formed in response to the next recording signal K_2
with the head 4 of K ink. Here, since the recording
medium 8 has not yet reached the R and G recording
25 regions, still no recording is performed with the
head 1 of R ink and the head of G ink.

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1 After the second scanning, the recording
medium is again conveyed by the PL width. In the
third scanning, at the portion where recording was
performed with the recording signals of B_1 and K_1 ,
5 recording in response to the recording signal G_1 is
done. At the portion where recording was performed
with the recording signal K_2 , recording is done in
response to the recording signal B_2 with the head 3
of B ink. Also, at the K recording region, the
10 recording signal K_3 is recorded with the head 4 of
K ink.

 After the third scanning, the recording
medium is similarly conveyed by the PL width and the
fourth scanning is performed. In the fourth scanning,
15 at the portion where recording was performed in
response to the recording signals of K_1 , B_1 , G_1 ,
recording is done in response to the recording
signal R_1 with the head 1 of R ink. Thus, the recording
medium is successively recorded at every PL width
20 with inks of black, blue, green and red colors.

 Fig. 3B shows the recording signals of the
respective heads for every head scanning when record-
ing of A4 size is performed with the recording head
of this embodiment, and at the rear end of the
25 recording medium, the recording signals are
successively lost from the K head. After completion
of recording of the final scanning, the recording



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1 medium 8 is discharged out of the machine.

Whereas, Fig. 4 shows the ink absorption characteristics of recording media, with square root of absorption time ($\sqrt{S}$) being shown on the axis of abscissa, and absorption amount of ink (aqueous) (nl/mm²) on the axis of ordinate. It can be understood that, in the coated paper having an ink receptive layer provided on the surface layer, a large amount of ink can be absorbed within a short time, while in the non-coated paper used in this embodiment, initial absorption is low and a long time is required for absorption of ink.

Fig. 5 shows the results of examination of blotting degree of images when inks of two colors are emitted onto the recording medium substantially simultaneously (sharpness of the boundary portion between the inks of two colors) in Table. In this Table, the mark O shows one which is judged as practically useful, the mark Δ one which is slightly inferior in image quality and the mark x one which is entirely practically useless.

From this experiment, it can be seen that the ink amount which can be recorded within a short time is 20 nl/mm² or less in the non-coated paper and 25 nl/mm² or less in the coated paper. This phenomenon can be estimated to occur according to the mechanism shown in Fig. 6.

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1 More specifically, the absorption of ink onto
paper, as shown in Fig. 6A may be considered to be
effected in the order of contact, collision, dot
formation, permeation, drying. As shown in Fig. 4,
5 in the case of the non-coated paper, in a time of
 $0.2\sqrt{S}$ or shorter, no ink of 11 to 12 nl/mm² or
more can be absorbed and therefore, if an ink more
than that is emitted substantially simultaneously,
the ink will be overflowed and, as shown in Fig. 6B,
10 the overflowed ink is attracted to the adjacent ink
which has reached previously onto the paper, whereby
blotting may be considered to occur at the boundary
portion.

15 In contrast, in the present embodiment, since
head scanning is performed successively with the
recording regions for the respective heads being
separated in one scanning, blotting at the boundary
portion becomes smaller as shown in Fig. 7.

20 . For verifying the effect of this embodiment,
the recording test was performed under the conditions
shown below and consequently good recorded images
with little blotting at the boundary portion could
be obtained. In contrast, when recording was per-
formed simultaneously with the arrangement of heads
25 being constituted so that the respective head
recording regions were overlapped with each other
as in the ink jet recording device in the prior art,

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1 images which were entirely practically useless were
obtained.

To describe in detail, this embodiment can
perform recording of 7 colors by use of 4 colors of
5 R, G, B, K, and recording was performed on a recording
medium of A4 size at a recording density of 360 DPI
and a driving frequency of 5.4 kHz. For this record-
ing medium, a two-fold paper on which the diameter
of the ink droplet emitted is expanded to 2-fold is
10 used.

In this case, because the recording density
is 360 DPI, the picture element size becomes 70.56 μm
square, and the dot diameter embedding the picture
element as a whole becomes 100 μm . Accordingly, the
15 droplet diameter emitted onto the 2-fold paper
becomes 50 μm , namely its volume becomes 65.5 pl.

When recording is performed under such
conditions, the plane density of mono-color (one
discharge) becomes 13.2 nl/mm², and the plane density
20 of two colors (two discharges) becomes 26.3 nl/mm²,
and when two colors are overlapped or adjoined at
the same time as shown in Fig. 5, the image becomes
bad.

As is apparent from the above description,
25 this embodiment, which has been made to have a
constitution excluding overlapping or adjoining
of two colors within a short time, is also effective



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1 for a recording medium with poor water absorption as
the non-coated paper.

Also, according to the above-mentioned recording
conditions, since in this embodiment the recording
5 region in one scanning is divided into 4, and therefore
scanning for 68 times is required for recording of A4
size. This means that the scanning times are increased
only by 3 as compared with the device constitution of
the prior art, thus resulting in substantially no
10 lowering in recording speed.

In contrast, for recording of the same A4 size,
if the recording region is made the same as in the
prior art and the boundary blotting is prevented by
overlapping scanning for 4 times at the same position,
15 scanning of 260 times which is 4-fold is required.

Also, for example, in the case of recording
only of K ink, the recording medium may be discharged
without performing the 66th to 68th scanning, and by
doing so, there is no lowering in recording speed at
20 all in the case of mono-color recording.

In the case when the recording medium is a
transparent film formed of PET or PET coated with
an water absorptive material, the present embodiment
is also effective.

25 Further, the present embodiment is effective
for obtaining recording of higher image quality
even in the case of a recording medium having ink

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1 absorptivity such as the coated paper.

Fig. 8 is a perspective view showing the second
embodiment of the present invention, and this embodi-
ment has a constitution of recording heads corresponding
5 to recording of full color. That is, it has recording
heads 1A, 2A, 3A and 4A corresponding to the respective
colors of yellow (Y), magenta (M), black (K) and cyan
(C).

Each of these recording heads has 128 discharge
10 ports arrayed in the sub-scanning direction. Also, it
is a recording head of the cartridge type which consti-
tutes integrally the ink tanks of the respective colors,
and therefore when there is no more ink, the whole
recording head is exchanged with another cartridge.

15 When high resolution recording is performed
as in this embodiment, the positional precision between
the heads is required to be higher, and by exchange of
the head with 4 colors integrated as in the head of
this embodiment, it becomes possible to effect strict
20 registration during shipment, and even in a device
of the head exchange system, high image quality
recording extracting fully the performance of the
head is rendered possible.

Figs. 9A and 9B are conceptional views showing
25 the recording method by the recording head shown in
Fig. 8, which are similar to Figs. 3A and 3B,
respectively.



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1 This embodiment shows the constitution in which
recording at a recording density of 600 DPI is performed
on a 2-fold paper. Thus, since the recording density is
600 DPI, the picture element size $42.33 \mu\text{m}$ is determined,
5 and similarly as described above, the droplet diameter
becomes $30 \mu\text{m}$ and its volume 14.2 pl .

As the result, the plane density when mono-
color, 2 colors, 3 colors and 4 colors are emitted
overlappingly or adjoiningly become respectively 7.9
10 nl/mm^2 , 15.8 nl/mm^2 , 23.7 nl/mm^2 and 31.6 nl/mm^2 .
Again, as is apparent from Fig. 5, the permissible
range where no blotting of ink occurs in this
embodiment is up to 2 colors.

Accordingly, as shown in Fig. 9, it becomes
15 possible that the recording heads corresponding to 2
colors make the recording regions the same. In the
case of the same Figure, as shown in Fig. 9A, the
recording heads 2A and 4A of M ink and C ink have
the same recording regions as the recording heads
20 1A and 3A of Y ink and K ink, respectively, and
recording of A3 size is performed by scanning for
77 times in the data mode as shown in Fig. 9B.

Fig. 10 is a perspective view of an ink jet
recording device which can mount the recording heads
25 shown in Fig. 8 and Fig. 9, and the carriage 5 is
engaged slidably with a pair of guide shafts, and
makes scanning of the recording regions with the

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1 recording heads 1A, 2A, 3A, 4A possible by driving of
the carriage motor 5A.

Figs. 11A and 11B are conceptional views showing
the recording method according to the third embodiment
5 of the present invention. As is apparent from Fig. 11A,
the recording head of this embodiment has the respective
recording heads 1 and 4 corresponding to B ink and K
ink arranged in the sub-scanning direction with an
interval between their discharge port arrays corres-
10 ponding to the amount of paper feeding.

More specifically, the recording condition in
this embodiment is a recording density of 300 DPI,
and in this case, the droplet volume in the same
process as in the second embodiment as described
15 above is determined as 113 pl. At this time, the
plane density of mono-color ink becomes 15.8 nl/mm^2 .
This is, as shown in Fig. 5, the range where no
blotting of image occurs even in the case of the
non-coated paper, but because it is a value appro-
20 ximate to the critical value of blotting, blotting
may also sometimes occur.

Therefore, by providing an interval corresponding
to the paper feeding amount between the respective
recording heads, ink absorption is accelerated by
25 the time of one scanning and paper feeding. By
doing so, ink blotting can be surely cancelled.

The constitution of this embodiment has



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1 recording heads each having 50 discharge ports, and
recording of A4 size is performed at a head driving
frequency of 4 kHz. In this case, scanning is per-
formed for 72 times as shown in Fig. 11B.

5 In the embodiments as described above, ink
is discharged by heat energy of electrothermal trans-
ducer, etc., but the discharge energy generation means
is not limited thereto, as a matter of course.

As is apparent from the above description,
10 the recording regions of each recording head in one
scanning are divided.

By this, it becomes possible to perform
recording corresponding to paper feeding and the
respective recording regions per one scanning.

15 As the result, overlapping recording with
time intervals can be done without lowering the record-
ing speed as a whole, whereby not only image quality
deterioration such as overlapping recording can be
prevented, but also it has become possible to
20 correspond to a diversity of recording media.

In the embodiments as described above,
description has been made about the recording method
and the recording device by utilizing the advantage
of multi-head nozzle to the maximum by changing the
25 arrangements of a plural number of recording heads.
In the latter half of the following embodiments,
other than the modification examples of the above



1 embodiments, the device, the recording method which
can obtain the effects of the present invention while
using the ordinary arrangement of a plural number of
recording heads are to be described. The following
5 embodiments have the merit of accomplishing miniaturi-
zation of recording heads than the previous embodiments.

Fig. 12 is a side sectional view showing the
principal part of the ink jet recording device according
to the fourth embodiment of the present invention.

10 In Fig. 12, description of the same constitutions
as in Fig. 1 is redundant and hence omitted here. In the
following, only the characteristic constitutions are to
be described.

Fig. 12 has recording heads 1 to 4 mounted on
15 a carriage in parallel to the scanning direction as
shown in Fig. 14. Also, to the recording heads 1 to
4 is connected the control portion shown in Fig. 13.

Fig. 13 is a block diagram showing the
recording control in the ink jet recording device
20 shown in Fig. 12. In the same Figure, 5A is the
carriage motor for driving the carriage 5 through a
carriage driving mechanism such as belt, pulley,
etc., and 200 is the head driver for generating dis-
charge signals for the respective discharge ports
25 based on the recording data supplied from the control
section. 300 is the paper feeding driving section
for driving the conveying roller 9 and the belt 11,



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1 and the paper discharge roller pair 16.

The control section 7 shown in the Figure has
CPU100 which practices processing according to control
of the device while performing giving and receiving of
5 the data between the host device or the respective
sections of the recording device, RAM100A which becomes
the work area in processing of CPU100, and ROM100B which
memorizes the processing procedure such as recording
actuation, etc. as shown in Fig. 14A and Fig. 14B.

10 Figs. 14A and 14B are diagrams for illustration
of the recording method in the embodiment shown in Fig.
12. In Fig. 14A, the recording heads 1 to 4 for dis-
charging respectively the inks of the respective colors
of R, G, B and K are supported and fixed on the
15 carriage 5 so that the respective recording regions
by scanning of the carriage 5 may become the same.
In the same Figure, the discharge port arrays 12 to
15 cannot be seen as they are, but for convenience
of description, they are shown as perspective from
20 above.

The recording heads 1 to 4 perform recording
on a recording medium by discharging ink through the
discharge ports 12 to 15 corresponding to the recording
signals inputted as synchronized with the movement of
25 the carriage 5.

In this embodiment, printing is performed with
the discharge port arrays 12 to 15 each divided into

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1 four recording regions. The four recording regions (1)
(4) have the width of the width L of the discharge port
array equally divided into 4, and constituted so that
recording may be performed only with one head in each
5 recording region. The recording region (1) performs
recording with the use of the L/4 width on the paper
feeding side of the head 4 of K ink, the recording
region (2) with the head 3 of B ink, the recording
region (3) with the head 2 of G ink, and the recording
10 region (4) with the L/4 width on the paper discharge
side of the head 1 of R ink. The recording medium 8
is recorded in the order of K, B, G, R while being
conveyed for every scanning of the carriage 5 with the
same width of the recording regions equally divided by
the conveying roller pair 9 and the adsorption conveying
15 belt 11. Fig. 14B shows only the recording signals
corresponding to the recording regions as described
above. Also, in the portions not corresponding to
the recording regions of the respective heads, 0 is
inputted as the non-recording signal.

20 Based on the above constitution, in the first
scanning, recording is done corresponding to the
recording signal K1 (signal corresponding to L/4 width)
with the head 4 of K ink. Then, paper feeding of L/4
width is done, and the portion where recording of the
25 signal K1 is done in the first scanning proceeds to
the recording region (2) and is recorded overlappingly

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1 by the recording signal B1 (B component on the same
line as K1) with the head 3 of B ink. At the same
time, recording of the recording signal K2 (K com-
ponent of the line subsequent to K1) is done with the
5 head of the recording region (1). After the second
scanning, the recording medium, after paper feeding
of L/4 width, transfers to the third scanning. In
the third scanning, recording of K3, B2, G1 is practiced
in the respective recording regions similarly. Further,
10 in the fourth scanning, recording of K4, B3, G2, R2 is
practiced, and on the first line of the recording
medium is formed a color image according to the
recording signals of K1, B1, G1, R1. Thus, by carriage
scanning (color recording in response to recording
signals) and paper feeding of L/4, color images are
15 successively formed.

In this embodiment, since the recording region
is divided into 4, scanning corresponding to 3 times
becomes necessary as superfluous scanning as compared
with the prior art. After completion of all scanning,
20 the recording medium 8 is discharged out of the machine
by the paper discharge roller pair 16. The function
of the paper discharge roller 16 is stabilization
(aiding of adsorption conveying belt, protection
of unnecessary force applied from outside of the
25 machine) of the recording medium at the recording
section and discharging of the terminal end.

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1 Now, as shown in Fig. 4, Fig. 5, depending on
the recording medium, the amount of ink absorbes differs
greatly. Accordingly, it is preferable to change the
amount of ink discharge according to the recording
5 medium. This has not been done at all in the prior art.
In the present invention, from this experiment, the
ratio of divided use of the recording heads is determined
so that the ink amount which can be recorded within a
short time may become 20 nl/mm^2 or less in the non-
10 coated paper and 25 nl/mm^2 or less in the coated paper.

To describe again, the absorption of ink onto
paper, as shown in Fig. 6A may be considered to be
effected in the order of contact, collision, dot
formation, permeation, drying. As shown in Fig. 4,
15 in the case of the non-coated paper, in a time of
0.2 S or shorter, no ink of 11 to 12 nl/mm^2 or more
can be absorbed and therefore, ink is discharged in
an amount smaller than this range. Accordingly, in
the present invention, such problem can be prevented
that the ink will be overflowed and, as shown in Fig.
20 6B, the overflowed ink is attracted to the adjacent
ink which has reached previously onto the paper,
whereby blotting occurs at the boundary portion.

In short, in the present embodiment, since
head scanning is performed successively with the
25 recording regions for the respective heads being
adequately separated depending on the recording

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1 medium in one scanning, blotting at the boundary
portion as shown in Fig. 7 can be reduced to great
extent.

5 For verifying the effect of this embodiment,
the recording test was performed under the conditions
shown below and consequently good recorded images little
blotting at the boundary portion could be obtained. In
contrast, when recording was performed simultaneously
10 with the arrangement of heads being constituted so
that the respective head recording regions were over-
lapped with each other as in the ink jet recording
device in the prior art, images which were entirely
practically useless were obtained.

15 To describe in detail, this embodiment can
perform recording of 7 colors by use of 4 colors of
R, G, B, K, and recording was performed on a recording
medium of A4 size at a recording density of 360 DPI
and a driving frequency of 5.4 kHz. For this recording
medium, a two-fold paper on which the diameter of the
ink droplet emitted is expanded to 2-fold is used.

20 In this case, because the recording density
is 360 DPI, the picture element size becomes $70.56 \mu\text{m}$
square, and the dot diameter embedding the picture
element as a whole becomes $100 \mu\text{m}$. Accordingly, the
droplet diameter emitted onto the 2-fold paper becomes
25 $50 \mu\text{m}$, namely its volume becomes 65.5 pl.

When recording is performed under such conditions,

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1 the plane density of mono-color (one discharge) becomes
13.2 nl/mm², and the plane density of two colors (two
discharges) becomes 26.3 nl/mm², and when two colors
are overlapped or adjoined at the same time as shown
5 in Fig. 5, the image becomes bad.

Also, as in the constitution of the prior art
shown in Figs. 15A and 15B, when recording is performed
without dividing the recording region so that paper
feeding may be performed per every carriage scanning
for 4 times, because the recording medium 8 contacts
10 the paper discharge roller pair 16 immediately after
ink emission of the fourth color, image disturbance
will occur by the contact onto the paper discharge
roller. For this reason, as shown by the broken line
in Fig. 12, it becomes necessary to constitute the
15 paper discharge roller pair with the width L of the
discharge port array or longer apart from the recording
section, whereby the device becomes enlarged and also
the aiding effect for the conveying belt 11 (stabi-
lization of the recording medium) is also lowered
20 to make it necessary to expand the opposed distance
between the head and the recording medium, resulting
in deterioration of the shooting precision of ink.

In contrast, since this embodiment is a con-
stitution such that the recording medium reaches the
25 paper discharge roller after scanning for 3 times on
completion of all recording of the first portion, the

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1 image fixing is stabilized during this period and no
image disturbance will occur.

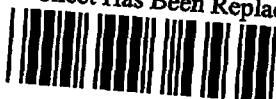
Also, for example, in the case of recording
only of K ink, recording may be performed in the whole
head region, and paper feeding may be done with L width,
5 whereby the recording speed can be made greater in the
case of mono-color recording.

In the case when the recording medium is a
transparent film formed of PET or PET coated with an
water absorptive material, the present embodiment is
10 also effective.

Also, the present embodiment is effective for
obtaining recording of higher image quality even in
the case of a recording medium having ink absorptivity
such as the coated paper.

15 Further, even in the case of performing mono-
color recording with one multi-nozzle head, there is
the effect in making the image quality higher similarly
as in the present embodiment. That is, by use of a
head with discharge amount set small so that the same
20 picture element may be formed with two ink droplets,
by recording ink of the same color with divided nozzles,
the image deterioration by connection of the ink in the
nozzle array direction can be reduced. Thus, the emission
of ink of the same color divided each into 6.6 nl/mm^2 ,
25 with the droplet volume being made about half under
the same conditions as in the present embodiment, further

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1 higher image quality can be accomplished. Also, with
the discharge amount being made the same as in the
present embodiment, by emission of ink of the same
color in double amount without blotting, high density
5 recording becomes possible.

Fig. 16 is a perspective view showing the fifth
embodiment of the present invention, and this embodiment
has a constitution of recording heads corresponding to
recording of full color. That is, it has recording heads
10 1A, 2A, 3A and 4A corresponding to the respective colors
or yellow (Y), magenta (M), black (K) and cyan (C).

Each of these recording heads has 128 discharge
ports arrayed in the sub-scanning direction. Also, it
is a recording head of the cartridge type which constitutes
integrally the ink tanks of the respective colors, and
15 therefore when there is no more ink, the whole recording
head is exchanged with another cartridge.

When high resolution recording is performed as
in this embodiment, the positional precision between the
heads is required to be higher, and by exchange of the
20 head with 4 colors integrated as in the head of this
embodiment, it becomes possible to effect strict
registration during shipment, and even in a device
of the head exchange system, high image quality
recording extracting fully the performance of the
25 head is rendered possible.



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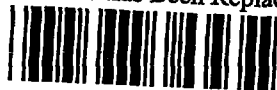
1 Figs. 17A and 17B are conceptional views showing
the recording method by the recording head shown in Fig. 16
which are similar to Figs. 14A and 14B, respectively.

This embodiment shows the constitution in which
5 recording at a recording density of 600 DPI is performed
on a 2-fold paper. Thus, since the recording density is
600 DPI, the picture element size $42.33 \mu\text{m}$ is determined,
and similarly as described above, the droplet diameter
becomes $30 \mu\text{m}$ and its volume 14.2 pl .

10 As the result, the plane density when mono-color,
2 colors, 3 colors and 4 colors are emitted overlappingly
or adjoiningly become respectively 7.9 nl/mm^2 , 15.8 nl/mm^2 ,
 23.7 nl/mm^2 and 31.6 nl/mm^2 . Again, as is apparent from
Fig. 5, the permissible range where no blotting or ink
15 occurs in this embodiment is up to 2 colors.

Accordingly, as shown in Fig. 17A, it becomes
possible that the recording heads corresponding to 2 colors
make the recording regions the same. That is, the
recording heads 2A and 4A of M ink and C ink have the same
20 recording regions as the recording heads 1A and 3A of Y
ink and K ink, respectively, and recording of A3 size is
performed by scanning for 153 times in the data mode as
shown in Fig. 17B.

Fig. 18 is a perspective view of an ink jet
25 recording device which can mount the recording heads shown
in Fig. 16 and Fig. 17, and the carriage 5 is engaged
slidably with a pair of guide shafts, and makes scanning



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1 of the recording regions with the recording heads 1A, 2A,
3A, 4A possible by driving of the carriage motor 5A.

Thus, the number of the recording regions divided
can be set as desired, and this setting is done by
5 varying the paper feeding amount and the recording signal
supplied to the recording heads in the control constitution
shown in Fig. 13. By doing so, the method can correspond
to recording media inferior in ink absorption character-
istic, such as plain paper or transparent paper for OHP,
10 whereby recording media can be diversified.

Among plain papers, some are also poor in color
formability of ink, and it may be sometimes necessary to
increase the density, particularly in the case of record-
ing with a mono-color ink. In this case, for example,
15 the discharge ports of the recording head of K ink are
divided into two, and the same recording as in the
constitution shown in Fig. 17A is practiced. The
recording signals at this time are shown below.

	Head scanning	1	2	3	...	...	150	151	152	153
20	K(2) region	0	K ₁	K ₂	...	...	K ₁₄₉	K ₁₅₀	K ₁₅₁	K ₁₅₂
	K(1) region	K ₁	K ₂	K ₃	...	...	K ₁₅₀	K ₁₅₁	K ₁₅₂	0

According to this embodiment, it becomes possible
to diversify the recording media by diversifying of the
recording mode. Also, although image deterioration
25 through the difference in shooting precision, discharged
amount, etc. existing between the discharge ports is
intensified by overlapping recording with the same ports,



1 it will not be intensified in overlapping recording by use
of divided discharge ports, but alleviated in most cases.

Fig. 19 is a conceptional view of the recording
method according to the seventh embodiment of the present
5 invention.

This embodiment has a constitution taken in the
case of low recording density, and in this case, because
the ink density of mono-color becomes higher, the
possibility of blotting between the scanning lines becomes
10 higher.

The recording medium to be used in this embodiment
is a film for transmission type OHP, and in this case,
since the projected light transmits the transparent film
only once, and therefore absorption with the dye becomes
15 smaller, whereby contrast of the projected image can be
obtained with difficulty. For this reason, a thick ink
receptive layer (opaque) is provided on a film such as PET,
etc., whereby ink absorptivity can be improved, and
therefore by performing recording with 4 divided recording
20 regions, recording of high density without blotting
becomes possible.

For recording in this embodiment, inks of two
colors of R and K were employed, and two heads having 50
discharge ports were arrayed in the scanning direction.
25 Recording of A4 size was performed at a recording density
300 DPI and a driving frequency of 4kHz.

As the result, the picture element size became



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1 84.67 μm square, the picture element dot diameter 120 nm,
the droplet diameter 60 nm, the droplet volume 113 pl,
the mono-color ink plane density 15.8 nl/mm², and two-color
ink plane density 31.6 nl/mm².

5 The recording signals in the recording method
shown in Fig. 19 are shown in the following Table.

	Head scanning	1	2	3	4	5	6	7	8	9	...
	K(4) region	0	0	0	0	0	0	0	0	0	...
	K(3) region	0	0	K1	K2	K3	K4	K5	K6	K7	...
10	K(2) region	0	0	0	0	0	0	0	0	0	...
	K(1) region	K1	K2	K3	K4	K5	K6	K7	K8	K9	...
	K(4) region	0	0	0	R1	R2	R3	R4	R5	R6	...
	K(3) region	0	0	0	0	0	0	0	0	0	...
	K(2) region	0	R1	R2	R3	R4	R5	R6	R7	R8	...
15	K(1) region	0	0	0	0	0	0	0	0	0	...

As described above, when overlapping recording
is performed with inks of plural colors, the emission
amount of inks will become very high in density, and
therefore in the system as in the prior art wherein
20 recording of the next line is commenced with paper feeding
per every completion of scanning for plural times, the
difference in ink receptive amount between the lines
becomes greater. As the result, image deterioration
25 (density nonuniformity) of the joint which may be
considered to be caused to the change in absorption
phenomenon of ink of the next line is liable to be



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1 generated at the boundary portion between scanning lines,
whereby blotting of the previous line toward the paper
feeding direction is great.

In contrasts, in the seventh embodiment as
5 described above, since the ink receptive amount changes
gradually per every line, such trouble becomes little.

Also, as the problem caused by increase of ink
amount, there may sometimes occur waving phenomenon of
paper due to swelling, stretching and shrinkage by ink
10 reception of the paper, but in the present embodiment,
since the region which has become to have the maximum ink
density within the same time has become smaller as
compared with the prior art example as described above,
there is also the effect that waving is suppressed.
15 Accordingly, it is not necessary to expand specially the
interval between the head and the recording medium, whereby
shooting precision is more excellent than the prior art
example to improve image quality.

As is apparent from the above description,
20 according to the plural number of recording heads,
recording medium is conveyed with only the width of the
recording divided in every one scanning, and recording
is performed only with the predetermined discharge ports
corresponding to the recording regions in response to
25 such conveyance.

As the result, as compared with separate recording
for the respective colors with the whole head width



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1 without division of the recording region, the ink emission
region or one scanning can be made narrower substantially
without increasing the scanning times, and therefore
cockling which is the waving phenomenon of recording
5 medium can be made little. Also, since the paper
discharge portion can be made shorter, miniaturization
of the main body has been rendered possible.

Further, as compared with overlapping recording of
the recording region over the whole head width, the width
10 of the region reaching the maximum density at the same
time can be made narrower substantially without increasing
the scanning times, and therefore cockling can be made
little, and also the difference in ink receiving ability
during emission between the scanning lines can be made
15 little, whereby the density uniformity at the line
boundary portion has become better. Also, since
overlapping emissions are done through separate discharge
ports, the density irregularity due to the difference in
discharge port precision is alleviated. Also, in
20 performing overlapping recording, the recording time can
be reduced, and otherwise the joint between the images can
be made better.

Further, in addition, a desirable
diversity of recording can be provided to users, whereby
25 it has become possible to perform good recording on a
diversity of recording media.

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1 Fig. 20 shows the basic schematic view of the
device for obtaining the optimum recording speed
improvement ratio after having obtained higher density
or higher image quality by partial use of the respective
5 heads of the present invention.

400 is a means for detecting automatically or
manually the material of the recording medium (difference
in materials, including paper or resin sheet or converted
paper, semiconverted paper, those with great ink absorption
10 amount, plain paper A, B, C: see Fig. 21), and as the
automatic discrimination, various known discrimination
methods such as light transmission, attachment of different
marks according to the respective materials and
discrimination thereof, etc. can be utilized. 500 is a
15 means for determining the number for the total number
M of the discharge ports of each recording head, and in
this embodiment, the divided ratio n of the total number
M is determined in the present embodiment. Specifically,
the means 500 has determined which one of the groups G1
20 to G8 (G1 to G8 are groups each having 8 discharge ports)
suited for recording of the recording
heads 1, 2, 3, 4 suitable for the material of the
recording material should be used. According to the
specific example of the present embodiment, also by
25 referring to Fig. 21, the ink absorption amount is large
to the extent which requires no divided uses for
converted paper with large ink absorption amount,

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1 and therefore no divided driving may be practiced, but
recording speed will be thereby lowered. For this reason,
for utilizing the effect of the present invention, n may
be preferably 2 or more. For the ratio n , with the
5 discrimination result of semi-converted paper, plain paper
A, $n=2$ is employed, and recording of the embodiment
shown in Figs. 17A, 17B as described above is practiced.
On the other hand, with the discrimination result of plain
paper B, $n=4$ is employed, and recording of the embodiment
10 shown in Fig. 19 is practiced. Further, for plain paper
C or OHP sheet, $n=8$ is employed, and group G1 units with
one scanning width of discharge ports 8 are practiced
as in the above-mentioned embodiment.

600 is a recording head driving means, and the
15 recording signal imparting regions which are the discharge
ports to be used for the recording heads 1, 2, 3, 4 are
determined and driven on the basis of the ratio n
determined by the above-mentioned determining means 500.
700 is a recording medium conveying means, and for the
20 printable regions x at all the discharge ports of the
recording head, the conveying amount x/n of one scanning
unit is determined on the basis of the ratio n determined
by the determining means 500, and the pitch with respect
to the recording medium conveying direction which is the
25 sub-scanning in the recording mode determined is
continued to be delivered each by x/n .

With the constitution shown in Fig. 20,

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1 regardless of the kind of the recording medium, ink jet
recording of good quality and high speed can be surely
performed.

Fig. 21 shows the display panel 800 by which the
5 operator determines the division ratio n for conveying
the abovementioned recording heads corresponding to the
recording medium to be employed. 801 is the key for
converted paper, and by turning on the key, the recording
mode described in Fig. 21 is set. Similarly, 802 is the
10 key for semi-converted paper, plain paper A, 803 the key
for plain paper B, and 804 the key for plain paper C or
sheet for OHP. 805 displays the total discharge port
number M of the recording head, and in this embodiment
represents 64. 806 displays during print or the print
15 switch of operation.

Even if the constitution may be made as shown
in the operational panel of Fig. 21 in which the operator
can simply determine and employ the recording mode of
the present invention, the effects of the present invention
20 can be fully obtained. The all discharge port utilization
mode of the key 801 is not required in practice as a
matter of course, but may be also provided for practicing
various kinds of recording systems.

The numerical values in the foregoing embodiments
25 are not of course limiting conditions for the present
invention, and the precision of the present invention
is enough even if the number of discharge ports to be

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1 used may be determined without determination of the ratio
of the total number of discharge ports.

The present invention brings about excellent
effects particularly in recording heads, recording devices
5 of the bubble jet system among the ink jet recording
systems.

Its representative constitutions and principles
should be preferably those by use of the basic principle
disclosed in U.S. Patents 4723129 and 4740796. This
10 system is applicable to either of the so called on-demand
type and continuous type, but particularly in the case
of the on-demand type, it is effective, because by
applying at least one driving signal which gives abrupt
temperature elevation exceeding nuclear boiling to the
15 electrothermal transducers arranged corresponding to
the sheets or liquid passages on which liquid (ink) is
held, heat energy can be generated in the electrothermal
transducers to effect film boiling on the heat-acting
surface of the recording head, and consequently form
20 bubbles within the liquid (ink) corresponding one by
one to the driving signal. Even if the liquid (ink)
may be discharged through opening for discharge by
growth, shrinkage of the bubbles, at least one droplet
will be formed. By making the driving signal shaped
25 in pulse, instantly growth and shrinkage of the bubble
are effected adequately, whereby discharge of liquid
(ink) particularly excellent in response characteristic



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1 can be more preferably accomplished. As the pulse-shaped
driving signal, those as described in U.S. Patents
4463359 and 4345262 are suitable. Further recording
can be performed by employment of the conditions disclosed
5 in U.S. Patent 4313124 concerning the temperature
elevation ratio of the above-mentioned heat-acting
surface.

As the constitution of the recording head, in
addition to the combined constitution of discharge port,
10 liquid passage, electrothermal transducer as disclosed
in the respective specifications as mentioned above
(linear liquid passage or right angle liquid passage),
the constitutions by use of U.S. Patents 4558333 and
4459600 disclosing the constitution in which the heat-
15 acting portion is arranged in a flexed region are also
included within the present invention. In addition,
the present invention is also effective even if the
constitution may be made one based on the constitution
disclosed in Japanese Laid-Open Patent Application
20 No. 59-123670 which discloses the constitution comprising
a slit common to a plural number of electrothermal
transducers as the discharge portion of the electrothermal
transducers or the constitution Japanese Laid-Open
Patent Application No. 59-138461 which discloses the
25 constitution comprising opening for absorbing the
pressure wave of heat energy corresponding to the
discharge portion.



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1 In addition, the present invention is also
effective for the case of using a recording head of the
freely exchangeable chip type which enables electrical
connection to the main device or feeding of ink from
5 the main device by mounting onto the main device, or
a recording head of the cartridge type integrally
provided on the recording head itself.

Also, addition of restoration means, preliminary
aiding means, etc. to the recording head is provided
10 as the constitution of the recording device of the
present invention is preferable, because the effects
of the present invention can be further stabilized.
Specific examples of such means may include, for recording
heads, capping means, cleaning means, pressurization
15 or suction means, preliminary heating means such as
electrothermal transducer or heating element separate
from this or combination of these, and it is also
effective for performing stable recording to practice
a preliminary discharge mode which performs discharging
20 separately from recording.

Further, as the recording mode of the recording
device, not only the recording mode only of the main
color such as black, etc., but also the recording head
can be constituted integrally or according to a
25 combination of plural number, and the present invention
is extremely effective also for a device equipped with
at least one of complex colors with different colors



1 or full colors by color mixing.

The present invention can solve adequately the various problems found by the present inventors according to the constitution, driving not found in the prior art, and is an industrially effective invention.

An ink jet recording device comprises a carriage having a plural number of ink jet recording heads each having a plural number of discharge ports mounted thereon, a means for giving recording ink signals to the ink discharge energy generating elements corresponding to all or a part of the respective plural number of discharge ports of the plural number of discharge heads, and a control means, which increases the number of recording heads to be used during recording of the recordable region formed by the total sum of all the discharge regions of the plural number of recording heads from initiation of recording onto a recording medium, reducing the number of recording heads to be used during recording of the recordable region in the recording completion region of the recording medium, and has one scanning width to be recorded by scanning by the recording head during recording as the feeding pitch of the recording medium.





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1 CLAIMS:-

1. An ink jet recording device comprising:
 - a carriage having a plural number of ink jet recording heads each having a plural number of discharge ports mounted thereon;
 - a means for giving recording ink signals to the ink discharge energy generating elements corresponding to all or a part of the respective plural number of discharge ports of said plural number of recording heads; and
 - 10 a control means, which increases the number of recording heads to be used during recording of the recordable region formed by the total sum of all the discharge regions of said plural number of recording heads from initiation of recording onto a recording medium,
 - 15 reducing the number of recording heads to be used during recording of said recordable region in the recording completion region of the recording medium, and has one scanning width to be recorded by scanning by the recording head during recording as the feeding pitch of the recording
 - 20 medium.

2. An ink jet recording device according to Claim 1, wherein said control means has a means for determining number of the discharge ports, which are a part of the
- 25 respective plural number of discharge ports of said plural number of recording heads, depending on the material of the recording medium.

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1 3. An ink jet recording device according to Claim
1, wherein said ink discharge energy generating element is
an electrothermal transducer of thermal energy generating
element which causes film boiling in ink to occur.

5
 4. An ink jet recording device which has a plural
number of recording heads having discharge ports for
discharging ink arrayed thereon, and performs recording of
images by discharging ink through said discharge ports
10 accompanied with the scanning movement of said plural
number of recording heads,

 characterized in that said device has a first
recording head and a second recording head provided
adjacent to the upstream side and downstream side
15 relatively with respect to the conveying direction of the
recording medium, and arranged in the positional
relationship with the respective discharge ports not
overlapping each other in the upstream side region and the
downstream side region, and a recording mode which performs
20 recording so that at least the image of first ink droplets
on the recording medium by the first recording head
relatively on the upstream side and the image of the second
ink droplets on the recording medium by the second
recording head relatively on the downstream side may be
25 overlapped with each other.

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1 5. An ink jet recording device which has a plural
number of recording heads having discharge ports for
discharging ink arranged thereon, and performs recording of
images by discharging ink through said discharge ports
5 accompanied with the scanning movement of said plural
number of recording heads,

characterized in that each of said plural number of
recording heads and at least another of said plural number
of recording heads are arranged so that said discharge
10 ports arrayed on each may not overlap each other in said
scanning direction,

and said device is provided with a paper feeding
means which performs paper feeding with the width of the
recording regions by said scanning movement of the
15 recording heads arranged so as not to overlap each other,
and

a recording signal supplying means which supplies
recording signals for discharge to the respective recording
heads of said plural number of recording heads
20 corresponding to the paper feeding by said paper feeding
means.

6. An ink jet recording device according to Claim 1
or 2, wherein the recording regions by said scanning
25 movement of the recording heads arranged so as not to
overlap each other is continuous to each other.

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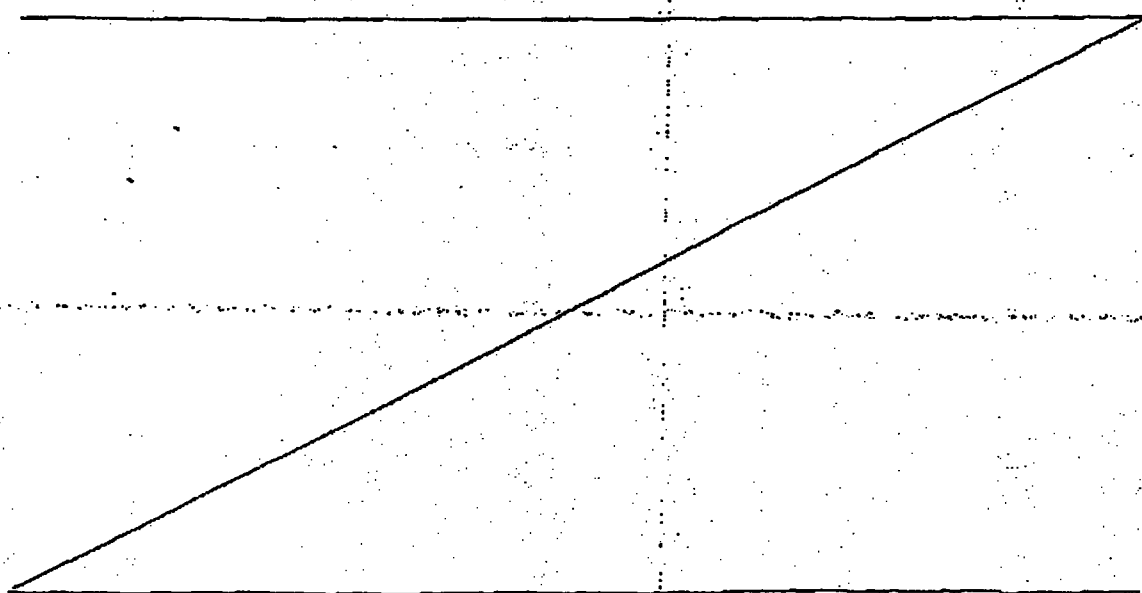
1 7. An ink jet recording device according to Claim 1
or 2, wherein the recording regions by said scanning
movement of the recording heads arranged so as not to
overlap each other have an interval of the width of said
5 recording regions multiplied by an integer.

8. An ink jet recording device according to Claim
6, wherein the discharge ports arranged on each of said
plural number of recording heads are a plural number of
10 discharge ports arranged in the sub-scanning direction.

9. An ink jet recording device according to Claim
8, wherein each of said plural number of recording heads
has an electrothermal transducer as the discharge energy
15 generating element for discharging ink.

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1 10. An ink jet recording device according to
Claim 4, wherein said second recording head makes the
second recording region recordable with respect to
said conveying direction the same recordable region and
5 also the device has further an additional recording
head arranged in said downstream side region.

 11. An ink jet recording head according to Claim
9, wherein said second recording head makes the
10 second recording region recordable with respect to said
conveying direction the same recordable region and
also the device has further an additional recording
head arranged in said downstream side region.

15 12. An ink jet recording device according to
Claim 11, wherein said first recording region and said
second recording region have the same width.

 13. An ink jet recording head according to
20 Claim 4, wherein said first and second recording heads
and additional recording heads, discharge inks of colors
different from each other, and said recording mode
performs overlapping recording as the first recording
region with the first and additional recording heads
25 after performing recording of the second recording
region with the second and additional recording heads.

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1 14. An ink jet recording device, which has a
plural number of recording heads, each constituted by
arraying a plural number of discharge ports for
discharging ink in the subscanning direction or a
5 direction different from the scanning direction in the
scanning direction, and performs recording of images by
discharging ink through said discharge ports accompanied
with the scanning movement of said plural number of
recording heads,

10 characterized in that said device is provided
with a conveying means which conveys the recording
medium with the width of the equally divided region of
the recording region by scanning of said plural number
of recording heads per every time of said scanning
15 movement, and

 a recording signal supplying means which
supplies recording signals to only the discharge ports
predetermined corresponding to said equally divided
regions in response to said conveying by said conveying
20 means.

15 15. An ink jet recording device according to
Claim 14, wherein each of said plural number of
recording heads has an electrothermal transducer as the
25 discharge energy generating element for discharging ink.

 16. A recording method of an ink jet recording
device, which has a plural number of recording heads,





1 each constituted by arranging a plural number of discharge
ports for discharging ink in the sub-scanning direction
or a direction different from the scanning direction,
arranged in the scanning direction, and performs
5 recording of images by discharging ink through said
discharge ports accompanied with the scanning movement
of said plural number of recording heads,

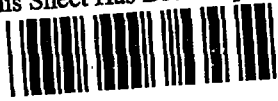
characterized in that the recording medium is
conveyed with the width of the equally divided region
10 of the recording region by scanning of said plural number
of recording heads per every time of said scanning
movement, and

recording signals are supplied to only the
discharge ports predetermined corresponding to said
15 equally divided regions in response to said conveying
by said conveying means.

17. A recording method according to Claim 16,
wherein each of said plural number of recording heads
20 has an electrothermal transducer as the discharge
energy generating element for discharging ink.

18. An ink jet recording device, which has a
recording head constituted by arraying a discharge
25 port for discharging ink in the sub-scanning direction
or a direction different from the scanning direction
in the scanning direction, and performs recording of





1 images by discharging ink through said discharge port
accompanied with the scanning movement of said plural
number of recording heads,

characterized in that said device is provided
5 with a conveying means which performs conveying the
recording medium with the width of the equally divided
region of the recording region by scanning of said
recording head per every time of said scanning movement,
and

10 a recording signal supplying means which
supplied recording signals to only the discharge ports
predetermined corresponding to said equally divided
regions in response to said conveying by said conveying
means.

15

19. An ink jet recording device according to
Claim 18, wherein each of said recording head has an
electrothermal transducer as the discharge energy
generating element for discharging ink.

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