

Process and Apparatus for Recording by Ink

BACKGROUND OF THE INVENTION

5 Filed of the Invention

This invention relates to a process for recording an image on a light-transmitting recording material by an ink, and particularly to a process for recording by an ink, which can produce a clear projection image with a sufficient image density when the image recorded on the light-transmitting recording material is projected by light.

The present invention also relates to an apparatus for recording, which can form a good image not only on a reflective recording material but also on a light-transmitting recording material serving as an original for a film strip or an overhead projector (OHP).

Description of the Prior Art

Among processes for recording by an ink so far proposed, an ink jet recording process as a non-impact process can perform high speed printing and multi-color printing with less generation of noise, because the process can perform recording while generating droplets of a recording solution according to various methods for injecting the recording solution, such as an electrostatic attraction method based on high potential application, a method for impacting mechanical vibrations or

1 displacements to the recording solution by a piezo-
electric element, a method for bubbling the recording
solution by heating and utilizing the bubbling pressure,
etc. and while sputtering and depositing the generated
5 droplets onto a recording material, such as paper, etc.

The print recorded according to said ink jet
recording process can be used in various applications,
for example, observation in the form of a reflective
image on the so called jet recording paper or fabric as
10 a recording material, or observation in the form of
projection of a recorded image from the light-transmitting
resin film as a recording material onto a screen, etc.
through an optical appliance such as a film strip, OHP,
etc., or application in the form of CMF(color mosaic
15 filter), etc. for color-resolving plates in preparing
positive plates for color printing, or for color display
in liquid crystal, etc.

When recording is applied to a recording material
according to the ink jet recording process, an image
20 to be recorded (the original) is generally divided into
so many image elements (which are essentially different
from image elements referred to herein as regards the
present invention as will be defined later), and the
original is reproduced on the recording material on the
25 basis of the individual image elements of divided image
as members for the original. However, when a reflective
print is formed on paper or fabric as mentioned above

1 according to such a recording process, a recorded image
with a sufficient image density can be obtained, that is,
a clear recorded image can be obtained, whereas, when
a light-transmitting print is formed according to the
5 same recording process, the light-transmitting recorded
image with no sufficient density can be often obtained,
that is, an unclear image with a low density can be obtained
when projected on a screen, etc.

An apparatus for recording, particularly such
10 as a color graphic printer or a video printer, has
two requirements, that is, one for the observation
of a reflected image of a print on plane paper and one
for the observation of a transmitted image of a print
on a transparent film such as so called slide, OHP, etc.

15 When printed both onto a reflective recording
material and onto a light-transmitting recording
material by one and same printer, the following disad-
vantage appears. That is, even if printing is made at
the same predetermined recording density, a satisfactory
20 print is observable on a reflective recording material,
whereas an unsatisfactory print, particularly in density,
is observable on a light-transmitting recording material
due to a difference in the manner of observation between
these two materials, so that a printed image of high
25 quality cannot be obtained at the same time.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided an image recording process comprising the steps of:

5 selecting one of a light-transmitting recording material and a light-reflecting recording material;
determining, for each image element in a regular array of such image elements making up an image field on the
10 selected recording material, whether to deposit liquid on that image element; and
depositing a predetermined number of droplets of recording liquid onto the recording material at each image element so determined in accordance with the
15 selection of recording material such that more droplets are deposited per image element so determined when a light-transmitting recording material is selected than when a light-reflecting recording material is selected.

20 According to another aspect of the invention, there is provided an image recording apparatus comprising:
means for selecting one of a recording mode for recording on a light-transmitting recording material
25 and a recording mode for recording on a light-reflecting recording material;

means for determining, for each image element in a regular array of such image elements making up an image field on a recording material, whether to deposit liquid on that image element; and

5 means for depositing a predetermined number of droplets of recording liquid onto the recording material at each image element so determined in accordance with the selection of recording mode such that more droplets are deposited per image element so
10 determined when the recording mode for light-transmitting material is selected than when the recording mode for light-reflecting material is selected.

15

According to a further aspect of the invention there is provided an apparatus for recording, which comprises a plurality of recording means for recording by deposition on recording materials, and an
20 actuation-controlling means for controlling the drive of the recording means in accordance with a first recording mode or a second recording mode, M number of the recording means being actuated in the first recording mode to record an image element on a
25 recording material, where $M \geq 1$, and N number of the recording means being actuated in the second recording

mode to record the same image element on a recording material, where $N > M$.

5 There follows a description by way of example of specific embodiments of the invention, reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a schematic structural view of an apparatus according to one embodiment of the present invention.

Fig. 2 composed of Figs. 2A and 2B is a block diagram showing the control section of the apparatus of Fig. 1.

Figs. 3(A) through (C) is a diagram showing a recording mode.

Fig. 4 composed of Figs. 4A and 4B is a flow chart showing the recording operation in the apparatus of Fig. 1.

1 Fig. 5 is a schematic structural view of an
apparatus according to another embodiment of the
present invention.

 Figs 6A(A) through (C) are diagrams showing
5 the recording operation in the apparatus of Fig. 5.

 Fig. 7 composed of Figs. 7A and 7B is a block
diagram showing the control section of the apparatus
of Fig. 5.

 Fig. 8. composed of Figs. 8A and 8B is a flow
10 chart showing the recording operation in the apparatus
of Fig. 5.

 Fig. 9 is a schematic structural view of an
apparatus according to other embodiment of the present
invention.

15 Figs. 10(A) through (C) are diagrams showing
the recording mode in the apparatus of Fig. 9.

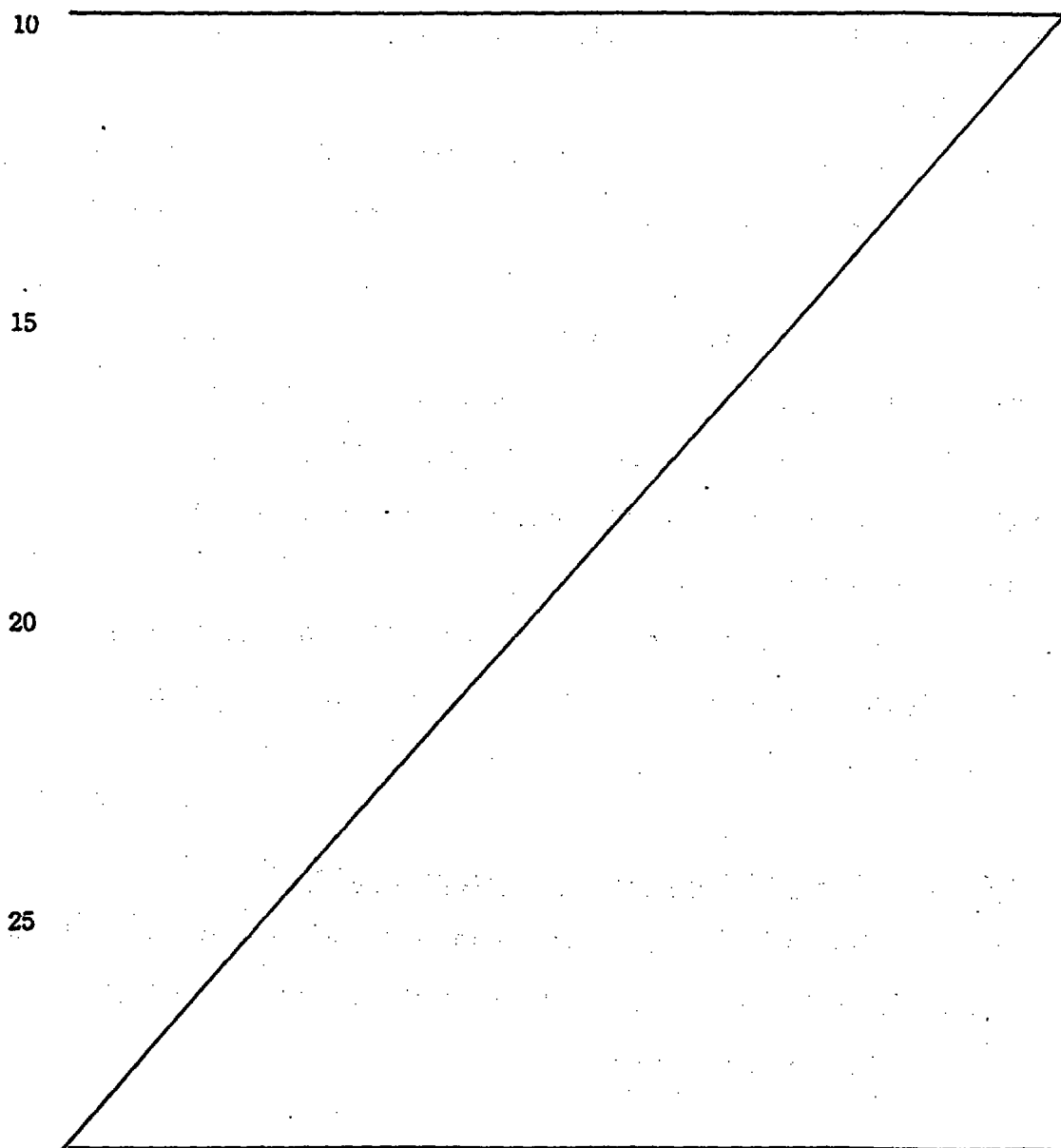
 Fig. 11 composed of Figs. 11A and 11B is a
block diagram showing the control section of the
apparatus of Fig. 9.

20 Fig. 12 composed of Figs. 12A and 12B is a
flow chart showing the recording operation in the
apparatus of Fig. 9.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

25 The present process and apparatus for recording
by an ink will be described in detail below, referring
to specific embodiments.

- 1 In the case of a reflective type of print,
almost all the light that enters and is reflected by
the recording layer of a recording material bearing
a recorded image and can undergo substantially
5 two passages through the recording layer on the
occasion of incidence and reflection, where the
transmitted light is thoroughly absorbed and
reflected according to the colors of recording



1 agent components in a recording liquid. In the case of
a light-transmitting print, on the other hand, almost
all the light that enters the recording layer of a
recording material bearing a recorded image undergoes
5 only one passage through the recording layer, and
it is presumable that the absorption of the transmitted
light through the recording layer according to the colors
of recording agent components in a recording liquid is
not enough for impacting a sufficient optical recording
10 density to a projected image.

To impact a sufficient image density to a recorded
image, one way is available, that is, to increase the
concentrations of recording agent components in the
recording liquid, but such way still has a drawback
15 that the recording liquid with high recording agent
concentrations is not stable, etc. and consequently special
measures must be taken into consideration when a recording
liquid with good characteristics is prepared.

Under these circumstances, the present inventors
20 have regarded a relationship between dots formed by
droplets of a recording liquid deposited onto a recording
material and an image element concentration as important,
and have made extensive studies on it and have found
an ink jet recording process, which can record a print with
25 a sufficient recorded image density observable as a
transmitted image by producing a higher image element
density.

1 That is, the present invention provides a
process for recording an image by depositing droplets
of a recording liquid onto a light-transmitting material,
which comprises depositing at least two droplets, per
5 image element, of a recording liquid of same color in
recording.

 According to the present recording process,
recording is made on a light-transmitting recording
material with a recording liquid, where a sufficient
10 image density can be impacted to an image projected
from the recorded image through light transmission.

 The image element referred to in the present
invention is defined by a minimum region shared with
same color when an image is recorded, and an assembly
15 of the image elements forms a recorded image. Thus,
the image element referred to in the present invention
is essentially different from the image element as one
unit of the divided original as mentioned before.

 To impact a sufficient image density to an
20 image recorded according to the ink jet process, it is
generally necessary to obtain a sufficient image element
density. The image element density can be increased
basically by sufficiently increasing a density of
recorded (ink) dots or by recording the dots so as to
25 share a region as broad as possible within one image
element.

 In view of these requirements, recording is

1 made in the present recording process by depositing at
least two droplets, per image element as defined above,
of a recording liquid of same color onto a light-
transmitting recording material.

5 In the present invention, a first mode of
depositing a recording liquid onto the recording
material is the said ink jet process, which comprises,
more particularly, sputtering droplets of a recording
liquid according to any of various methods for injecting
10 a recording liquid, such as electrostatic attraction
by a high potential application, impacting of mechanical
vibrations or displacements to a recording liquid by
a piezoelectric element, bubbling a recording liquid
by heating and utilizing the bubbling pressure, etc.,
15 thereby depositing the droplets onto a light-
transmitting recording material as dots. A second mode
of depositing a recording liquid onto the recording
material is the so called heat image transferring process.

Any recording liquid can be used in the first
20 mode of the present process, so long as it can be used
in the ink jet recording process.

The recording material used in the present
invention has sufficient light transmissivity, and may
be a light-transmissive plastic film coated by a water
25 soluble polymer for accepting the recording liquid thereon.

In the present invention, at least two droplets
of a recording liquid of same color can be deposited

1 within one image element by depositing droplets of a
first recording liquid onto all the image elements
to be recorded, then depositing droplets of a second
recording liquid onto all the image elements on which
5 the droplets of the first recording liquid have been
deposited, and repeating these operations to successively
deposit the droplets of other recording liquid of the
same color, or alternatively by successively depositing
droplets of a first recording liquid, droplets of a
10 second recording liquid, droplets of a third recording
liquid and so forth for each image element.

Recording of dots into an image element can be
carried out under control by signals transmitted
corresponding to an image to be recorded (original).

15 At least two droplets of a recording liquid
of same color deposited within one image element can be
recorded in the form of at least one dot including
at least two partially superposed dots, or in the form
of a plurality of dots. To obtain a higher image element
20 density without impairing the resolvability of the
recorded image, it is preferable to record at least two
dots including at least an overlapped part thereof.

The image thus recorded as a superposition
of dots according to the present recording process can
25 satisfy at least one of said requirements for obtaining
a higher image element density, and can be a clear
image having a sufficient image element density.

1 That is, when a plurality of dots of the same color
are recorded, as superposed or partially superposed,
within one image element, it is needless to say that
the recording agent components of a recording liquid are
5 deposited more at the superposed part of the dots than
at the non-superposed parts, and thus the density of the
dots can be increased and consequently the recording density
throughout the image can be increased. Even if a
plurality of dots of the same color are recorded apart
10 from one another within one image element, the region
which the dots can share within one image element can
be broadened, and thus the quantity of light passing
through the recording layer of a recording material can
be increased, and consequently the quantity of light
15 absorbed depending on the colors of the recording agent
components can be increased, giving a sufficiently high
image element density.

 According to the present ink jet recording process
with a light-transmitting recording material, a clear
20 projected image with a sufficient image density can be
obtained when an image recorded on the light-transmitting
recording material is projected through light trans-
mission, and a print suitable for the observation of
transmitted image can be recorded.

25 The recording process of the present invention
will be described below in detail referring to the examples
of an ink jet system.

1 Example:

Printing (sputtering) was carried out in two runs onto a light-transmitting recording material prepared by applying gelatin onto a 100 μm -thick polyester film to a layer thickness of 20 μm as dried after the application by means of an ink jet color printer JP-1210 (trademark manufactured by Canon K.K., Japan) so that dots of same color can be superposed at one and same position to form a test pattern (in which black, yellow, Magenta and Cyan were printed to be solid successively in this order 4 squares of 2 cm x 2 cm arranged side by side on the recording material) and a circle graph (a circle graph having segments colored successively with yellow, Magenta, Cyan, Red and Green in this order, with country names, Japan, USA, Germany, Britain and France printed in black letters successively in this order in the segments starting from the yellow segment, and with the title "circle graph" printed under the circle graph). Two runs of typing so as to superpose dots of the same color in one and the same position were carried out by depositing droplets of a first recording liquid onto all the predetermined image elements, to record dots, and then depositing droplets of a second recording liquid to superpose the dots on the dots recorded with the first recording liquid. The recording liquid used had the same color.

The recorded test pattern and circle graph were

1 evaluated for the recording states in the following
manner, and the results are shown in the Table 1.

Transmitted optical density of the recorded images
was measured for the printed solid part of the test
5 pattern with the respective colors by a photodensitometerc
(NLM-STD-Tr, made by Narumi Co., Ltd. Japan).

Furthermore, the projected image was evaluated
according to a panel test. The panel test was carried
out as follows: The circle graph as obtained above was
10 projected onto a screen by OHP (overhead projector)
and the projected image was visually examined evaluated
for its visual observability by ten panellists. When
at least 8 panellists judged in visual observation
that the projected image was wholly clear, the coloring
15 of each color was projected good and the country name
and title in black letters were displayed clear and easily
readable, the panel test result was evaluated "satisfactory"
as marked by "0", whereas, when 7 or less panel'ists
made the same judgement as above, the panel test result
20 was evaluated "unsatisfactory", as marked by "X".

Furthermore, three runs of printing (sputtering)
were carried out in the same manner as above to superpose
dots of same color at one and same position, and the same
test pattern and circle graph as above were recorded.
25 The recording states of the recorded test pattern and
circle graph were evaluated in the same manner as above.
The results are shown in the following table.

1 Comparative Example:

Test patterns and circle graphs were recorded in the same manner as in Example except that only one run of printing (sputtering) was carried out within the predetermined image elements with ink dots of same color. The resulting recorded image was evaluated in the same manner as in Example, and the results are shown in the following Table.

T A B L E

		Transmitted optical density				Evaluation by panellists
		Black	Yellow	Magenta	Cyan	
Example	2 runs	0.46	0.48	0.40	0.41	O
	3 runs	0.68	0.78	0.58	0.61	O
Comp. Ex.	1 run	0.21	0.23	0.18	0.19	X

15 A first embodiment of the present apparatus for recording will be described in detail below, referring to Figures.

Fig. 1 shows one embodiment of an ink jet printer according to the present invention, where numeral 1 is a cassette containing the ordinary recording paper or transparent resin film; numeral 5 is a pickup roller for feeding the recording paper or the transparent resin film from the cassette; numeral 7 is a pair of timing rollers; numerals 8 and 9 are pairs of feed rollers; numerals 11, 12, 13, 14 and 15 are feed guides which constitute routes for conveying the recording paper or film 4, and convey them smoothly; numeral 16 is an ink

1 jet recording head provided in a direction substantially perpendicular to the conveyed recording paper or film.

An aqueous ink is supplied to the ink jet recording head 16 from an ink storage tank not shown in the drawing, and an image is reproduced on the recording paper or film conveyed from the cassette 1 according to an image signal supplied from an image reading means. The recording head is constituted as the so called full multi-head arranged in full line in a direction perpendicular to the conveying direction of recording paper or film, that is, in a perpendicular direction to the paper surface in the drawing.

Numeral 18 is a suction fan; numeral 19 is a porous guide plate which attracts the recording paper or film by suction of the suction fan 18 to keep the flatness of the recording paper or film, and thereby to keep the best distance between the recording material and the recording head 16.

Numeral 20 is a pair of discharge rollers and numeral 21 is a discharge tray. After recording by the recording head 16, the recording paper or film is conveyed to the pair of the discharge rollers 20 through the pair of feed rollers 9, and then discharged into the discharge tray 21 through the pair of discharge rollers 20.

25 Numerals 23 and 24 are a first sensor and a second sensor, respectively, for detecting the recording material, provided on the route for conveying the recording material.

1 The first sensor 23 is provided in the conveying direction
just before the recording position of the ink jet recording
head 16, and driving control of the recording head 16 is
conducted by the detection output from the first sensor
5 23. The second sensor 24 is provided in the conveying
direction just before the pair of discharge rollers 20,
and driving of the pair of discharge rollers 20 and the
pair of feed rollers 9 is controlled on the basis of the
detection output from the second sensor 24.

10 In Fig. 2 is shown a control system in the
apparatus of Fig. 1, wherein numeral 100 is a control
circuit for controlling the driving of the individual
sections, numeral 101 is a read-only memory (ROM) en-
casing a control program, etc.; numeral 102 is a random-
15 access memory (RAM); numeral 103 is an operating section.
The operating section has, together with an operating
section switch panel for designating the normal recording
conditions, etc. such as number of recording copies,
recording image density, etc., first and second mode-
20 designating switches 104-1 and 104-2 for designating
plane paper recording mode and film recording mode,
respectively, and further has a display section 105 for
displaying recording conditions, etc.

The input signal from the operating section 103
25 is supplied to the control section 100 through a buffer
circuit 106 for data input and output. Furthermore,
a driving circuit 107 is subjected to driving control

1 from the control circuit 100 through the buffer circuit
106, whereby display is controlled in the display section
105.

Numeral 111 is motors as driving sources for the
5 respective rollers and numeral 112 is a driving circuit
for on-off control of the motors 111. Numerals 113
through 116 are motor clutches for transferring motor
revolution power to the pickup roller 5 and pairs of
rollers 7, 8, 9 and 20, and are subjected to on-off
10 control through driving circuit 118 through 121,
respectively.

Numeral 122 is a driving circuit for on-off control
of the suction fan 18. In the control circuit 100,
driving signals are supplied to the respective driving
15 circuits through an output buffer circuit 124 on the basis
of the detection signals supplied from both sensors 23
and 24 through an input buffer circuit 123 to control
driving of the conveying system.

Numeral 130 is a driving circuit for driving the
20 ink jet recording head 16, and an image signal corres-
ponding to the image information read by the image reading
means not shown in the drawing is supplied to the driving
circuit 130 through an image input interface 132 and an
image memory 133. Furthermore, a driving signal from
25 the control circuit 100 is supplied to the driving circuit
130 through an image-controlling circuit 134. The head
16 is energized by the driving circuit 130 on the basis of
these two signals to form an image on the recording paper

1 or film conveyed from the cassette 1.

Now, the plane paper recording mode and film recording mode will be described below:

As shown in Fig. 3(A), the recording head 16
 5 is driven by a clock ϕ of definite cycle to inject ink droplets onto the surface of a recording material. In the plane paper recording mode, the head 16 is driven at every interval of three pulses in the clock ϕ (timing $T_1, T_2, T_3 \dots$). In Fig. 3(B) and Fig. 3(C), symbol S
 10 shows a recording material, and full line D ($D_1, D_2, D_3, \dots$) shows the injected ink droplets.

In the film recording mode, on the other hand, printing is carried out at the timing $T_1, T_2, T_3 \dots$ and also printing is carried out at the timing T_1', T_2', T_3'
 15 As a result, dots $D_1', D_2', D_3' \dots$ are printed in a state superposed with dots $D_1, D_2, D_3, \dots$ shown by dotted line in Fig. 3(B) and Fig. 3(C). Thus, ink injection is carried out in two runs onto one and the same image element in this manner. According to said
 20 film recording mode, a reproduced image having a transmission density substantially equal to that for the plane paper can be obtained on a film whose image density would be insufficient owing to a high transmittance of the film if recorded in an equal recording density to
 25 that for the plane paper.

In the foregoing description, two runs of printing are carried out on a recording material conveyed at a

- 1 constant speed for one and the same image element in the
manner as given above, but it is needless to say that
two runs of printing can be carried out for one and the
same image element, for example, by intermittently
5 conveying the recording material or by passing the
recording material twice over the printing position
of head 16.

Fig. 4 shows recording operation onto a sheet
of recording material in the apparatus of Fig. 1,
10 where the step S1-1 judges which of the mode-designating
switches 104-1 and 104-2 is on. When the switch 104-1
is on, the step S1-2 follows, and the recording mode is
set to plane paper recording mode, whereas, when switch
104-2 is on, step S1-3 follows to set film recording
15 mode. After the mode setting in this matter, the step
S2 follows to start the revolution of the pickup
roller 5, and any of the recording materials, i.e.
recording paper or film, is conveyed from the cassette 1
toward the pair of timing rollers 7. Step S3 is provided
20 with a sufficient conveying time until the leading edge
of the recording material has been engaged into the pair
of timing rollers 7, and step S4 stops revolution of
pickup ruller 5. Then, steps S5, S6, S7 and S8 follow
successively to start revolution of the pair of timing
25 rollers 7, the pairs of feed rollers 8 and 9, and the
pair of discharge rollers 20 and to turn on the suction
fan 18 at the same time. As a result, the recording

1 material can reach the pair of feed rollers 8 through
the pair of timing rollers 7 and can be further conveyed
through the pair of feed rollers 8.

Step S9 judges whether or not the leading edge
5 of the conveyed recording material is detected by the
first sensor 23. When the leading edge is detected,
signal "yes" is transmitted, and step S10 follows to
stop revolutions of the pair of timing rollers 7.
Then, in step S11, the ink jet recording head 16 is driven
10 to start printing onto the recording material. Since
the recording mode is set in steps S1-2 and S1-3 as
described above, printing is carried out according to
the set mode.

The printing operation is continued until the
15 trailing edge of the recording material has been detected
by the first sensor 23. That is, when the trailing edge
of the recording material is detected in step S12, step
S13 follows to stop the printing operation.

The recording material with an image thus formed
20 on its surface is conveyed toward the pairs of discharge
rollers 20 through the pair of feed roller 9 and is
discharged further toward the discharge tray 21 through
the pair of discharge rollers 20. When the trailing edge
of the recording material is detected by the second sensor
25 24 in step S14, step S15 follows to provide a sufficient
conveying time until the recording material have been
discharged into the discharge tray 21. Then, steps S16

1 through S18 follow successively to stop driving of the
pair of feed rollers 8 and 9, the pair of discharge
rollers 20 and the suction fan 18. One sequence of
recording operation for the recording material is com-
5 pleted in the manner as described above.

In the present apparatus for recording, a first
recording mode for a reflective recording material and
a second recording mode for a light-transmitting recording
material are provided, and when a practically equal
10 image density is designated, recording can be carried
out on these two kinds of materials in the corresponding
modes, and particularly a reproduced image with a prac-
tically sufficient transmission density can be obtained
even on the light-transmitting recording material.
15 Thus, the shortcoming of insufficiency of the image
density can be removed which is met in observation
of the image formed on a light-transmitting recording
material and is caused by the high transmissivity of the
recording material.

20 In the foregoing embodiment, the ink droplet
injection (sputtering) is carried out in two runs for
one and the same image element in the film recording
mode, but the run number of the superposing deposition
is not restricted to two. Namely, when an equal density
25 is designated, a transmission density substantially
equal to that of a reproduced image by plane paper
recording must be obtained in a reproduced image by film

1 recording.

In the present apparatus for recording, the recording means is not restricted only to the ink jet recording process, but, for example, a recording means
5 of heat image transferring process can be also used.

Another embodiment of the apparatus for recording according to the present invention will be described in detail below, referring to Figures.

In Fig. 5, another embodiment of an ink jet printer
10 according to the present invention is shown, where numeral 21 is a cassette containing plane recording paper or transparent resin film; numeral 25 is a pickup roller for feeding the recording paper or transparent resin film from the cassette; numeral 27 is a pair of timing
15 rollers; numerals 28 and 29 are pairs of feed rollers; numerals 211, 212, 213, 214 and 215 are conveying guides which constitute routes for conveying the recording paper or film and also ensure its smooth conveying. Numerals 216 and 217 are first and second ink jet recording
20 heads provided in series in the direction of conveying the recording paper or film.

An aqueous ink is supplied to both ink jet recording heads 216 and 217 from an ink storage tank not shown in the drawing, and an image is reproduced
25 on the recording paper or film conveyed from the cassette 21 according to an image signal transmitted from an image reading means. These two recording

1 heads are constituted as the so called full multiheads
arranged in full line in the direction vertical to
the direction of conveying the recording paper or
film, that is, in the direction perpendicular to the
5 paper surface in the drawing.

The first ink jet recording head 216 performs
recording onto the recording material in a first re-
cording mode suitable for recording onto the recording
paper, whereas the second ink jet recording head 217
10 performs recording onto the recording material in
a second recording mode suitable for recording onto
the film. The first and second recording modes will
be described later, referring to Fig. 6.

Numeral 218 is a suction fan and numeral 219
15 is a porous guide plate. The recording paper or film
is attracted to the guide plate 219 through suction
by the suction fan 218 to keep the flatness of the
recording paper or film and also to keep the best
distance between the recording material and the recording
20 heads 216 and 217. Numeral 220 is a pair of discharge
rollers and numeral 221 is a discharge tray. After
the recording by the recording head 216 or 217, the
recording paper or film is conveyed to the pair of
discharge rollers 220 through the pair of feed rollers
25 29, and is discharged further into the discharge tray
221 through the pair of discharge rollers 220.

Numerals 222, 223 and 224 are first, second

1 and third sensors, respectively, for detecting the
recording material, which are provided in the conveying
route for the recording material. The first sensor
222 is provided in the conveying direction just before
5 the recording position by the second ink jet recording
head 217, and the driving of recording head 217 is
controlled by the detection output from the first
sensor. Likewise, the second sensor 223 is provided
just before the first ink jet recording head 216,
10 and the driving of recording head 216 is controlled
by the detection output from the second sensor. The
third sensor 224 is provided in the conveying direction
just before the pair of discharge rollers 220, and
driving of the pair of discharge rollers 220, the
15 pair of feed rollers 29, etc. is controlled on the
basis of the detection output from the third sensor.

The first recording mode and second recording
mode will be described below, referring to Fig. 6.

As shown in Fig. 6(A), the recording heads
20 216 and 217 are driven by clock ϕ of definite cycle
to eject ink droplets onto the surface of recording
material. In the first recording mode of the recording
head 216, the head 216 is driven at every interval
of 3 pulses of clock ϕ (timing T1, T2, T3,).
25 In Fig. 6(B) and (C), symbol S shows the recording
material, and the full line D (D1, D2, D3,) shows
the ejected ink droplets.

1 In the second recording mode by the second
 recording head, on the other hand, printing is performed
 at timing T1, T2, T3, and also at timing T1',
 T2', T3', As a result, dots D1', D2', D3',
 5 are printed in a state overlapped with dots D1,
 D2, D3, as shown by dotted line in Fig. 6(B)
 and (C). In this manner, ink ejection (sputtering)
 can be carried out in two runs for one and same image
 element. According to the second recording mode,
 10 a reproduced image with a substantially equal trans-
 mission density to that of a reproduced image recorded
 on the plane paper can be obtained on a film having
 a defect that image density obtained would be insufficient
 owing to the higher transmittance thereof, if recording
 15 is carried out in an equal recording density to that
 of the plane paper.

 In the foregoing embodiment, two runs of ejection
 are carried out for one and same image element on
 the recording material conveyed at a constant speed
 20 as described above, but it is needless to say that
 the second recording mode can be performed, for example,
 by intermittently conveying the recording material
 or by passing the film twice through the printing
 position of head 216, thereby conducting two runs of
 25 ejection for one and same image element.

 In Fig. 7, a control system in the apparatus
 of Fig. 5 is shown, where numeral 2100 is a controlling

1 circuit for controlling the driving of the respected
sections; numeral 2101 is a read-only memory (ROM) en-
casing a control program, etc.; numeral 2102 is a freely
readable and writable random-access memory (RAM); numeral
5 2103 is an operating section. The operating section
has, together with an operation section switch panel
for designating the normal recording conditions such
as number of recording copies, recording image density,
etc., first and second mode-designating switches 2104-1
10 and 2104-2 for designating the first and second recording
mode, respectively and further has a display 2105 for
displaying recording conditions, etc.

The input signal from the operating section 2103
is supplied to the control section 2100 through a buffer
15 circuit 2106 for data input and output. Furthermore,
a driving circuit 2107 is subjected to driving control
by the control circuit 2100 through the buffer circuit
2106, whereby display is controlled in the display 2105.

Numeral 2111 is motors as driving sources for
20 the respective rollers and numeral 2112 is a driving
circuit for on-off control of the motors 2111. Numerals
2113 through 2116 are motor clutches for transferring
motor revolution power to the pickup roller 25, and pairs
of rollers 27, 28, 29, and 220 and are subjected to on-
25 off control through driving circuits 2118 through 2121,
respectively.

Numeral 2122 is a driving circuit for on-off

1 control of the suction fan 218. In the controlling
circuit 2100, driving signals are supplied to the
respective driving circuits through a buffer circuit
for data output 2124 on the basis of the detection signals
5 supplied from the respective sensors 22, 223 and 224
through a buffer circuit for data input 2123 to control
driving of the conveying system.

Numerals 2130 and 2131 are driving circuits for
driving the first and second ink jet recording heads
10 216 and 217, and an image signal corresponding to the
image information read by the image reading means not
shown in the drawing is supplied to both driving circuits
2130 and 2131 through an image input interface 2132 and
an image memory 2133. Furthermore, a driving signal
15 from the controlling circuit 2100 is supplied to the
driving circuits 2130 and 2131 through an image-controlling
circuit 2134. The respective head 216 or 217 is ener-
gized by the driving circuit 2130 or 2131 on the basis
of these two signals to form an image on the recording
20 paper or film conveyed from the cassette 21.

In Fig. 8 is shown recording operation onto
a sheet of recording material in the apparatus of Fig. 5,
where step S21-2 judges which of mode-designating switches
2104-1 and 2104-2 is on. When switch 2104-1 is on,
25 step S21-2 follows, and the recording mode is set to
the first recording mode, whereas, when switch 2104-2
is on, step S-21-3 follows to set the second recording

1 mode. When the first recording mode is set, step S22
follows to start revolution of pickup roller 25, and
the recording material is conveyed from the cassette
21 toward the pair of timing rollers 27. In that case,
5 recording paper is encased in the cassette 21, and the
recording paper is conveyed. Steps S23 provides a
sufficient conveying time until the leading edge of the
recording paper has been engaged into the pair of timing
rollers 27, and step S24 stops revolution of pickup
10 roller 25. Then, steps S25, S26, S27 and S28 follow
successively to start revolution of the pair of timing
rollers 27, the pair of feed rollers 28 and 29 and the
pair of discharge rollers 220 and to turn the suction
fan 218 on at the same time. As a result, the recording
15 paper can reach the pair of feed rollers 28 through the
pair of timing rollers 27 and can be further conveyed
through the pair of feed rollers 28.

Steps S29 judges whether or not the leading edge
of the conveyed recording paper is detected by the second
20 sensor 223. When the leading edge is detected, signal
"yes" is transmitted, and step S210 follows to stop
revolutions of the pair of timing rollers 27. Then,
in step S211, the first ink jet recording head 216 is
driven to start printing onto the recording paper. The
25 printing operation is continued until the trailing end
of the recording paper has been detected by the second
sensor 223. That is, when the trailing end of the

1 recording paper is detected in step S212, step S213 follows to stop the printing operation.

The recording paper with an image thus formed on its surface is conveyed toward the pair of discharge
5 rollers 220 through the pair of feed rollers 29, and discharged further toward the discharge tray 221 through the pair of discharge rollers 220. When the trailing end of the recording paper is detected by the third sensor 224 in step S214, step S215 follows to provide a suf-
10 ficient conveying time until the recording paper has been discharged into the discharge tray 221. Then, steps S216 through S218 follow successively to stop driving of the pair of feed rollers 28 and 29, the pair of discharge rollers 220 and the suction fan 218. One sequence
15 of recording operation for the recording paper according to the first recording mode is completed in the manner as described above.

Now, the operations when the switch 2104-2 turns on will be described below.

20 In this case, step S21-1 proceeds to step S221 through step S21-3, as described above. Step S221 starts revolution of pickup roller 25 to convey a recording material from the cassette 21 toward the pair of timing rollers 27. A transparent resin film is encased
25 in the cassette 21 and is conveyed. Step S222 provides a sufficient conveying time until the leading edge of the transparent resin film has been engaged into the

1 pair of timing rollers 27, and step 223 stops revolution
of pickup roller 25. Then, steps S224, S225, S226 and
S227 follow successively to start revolutions of the
pair of timing rollers 27, the pair of feed rollers 28
5 and 29, and the pair of discharge rollers 220, and to
turn the suction fan 218 on at the same time. As a
result, the transparent resin film can reach the pair
of feed rollers 28 through the pair of timing rollers
27, and can be further conveyed through the pair of feed
10 rollers 28.

Step S228 judges whether or not the leading
edge of the conveyed transparent resin film is detected
by the first sensor 222. When the leading edge is
detected, signal "yes" is transmitted, and step S229
15 follows to stop revolution of the pair of timing rollers
27. Then, in step S230, the second ink jet recording
head 217 is driven to start printing out the transparent
resin film. The printing operation is continued until
the trailing edge of the transparent resin film has been
20 detected by the first sensor 222. That is, when the
trailing edge of the transparent resin film is detected
in step S231, step S232 follows to stop the printing
operation.

The transparent resin film with an image thus
25 formed on its surface is conveyed toward the pair of
discharge rollers 220 through the pair of feed rollers
29, and discharged further toward the discharge tray

1 221 through the pair of discharge rollers 220. When
the trailing edge of the transparent resin film is
detected by the third sensor 224, step S215 follows to
provide a sufficient conveying time until the transparent
5 resin film has been discharged into the discharge tray
221. Then, steps S216 through S218 follow successively
to stop driving of the pair of feed rollers 28 and 29,
the pair of discharge rollers 220 and the suction fan
218. One sequence of recording operation for the trans-
10 parent resin film according to the second recording mode
is completed in the manner as described above.

As described above, the apparatus for recording
of the present invention has a first recording means
for forming an image according to a first recording mode
15 suitable for a reflective recording material, and a
second recording means for forming an image according
to a second recording mode suitable for a light-trans-
mitting recording material, where a reproduced image
with a practically sufficient transmission density can
20 be obtained particularly even on a light-transmitting
recording material by performing recording by the
respective recording means corresponding to these two
recording materials when a practically equal image
density is designated. Thus, the trouble appearing when
25 a transmitted image is observed, that is, an insufficient
density of image formed on a light-transmitting recording
material due to a large transmittance, can be eliminated.

1 In the foregoing embodiment, the ink droplet
ejection (sputtering) is carried out in two runs for
one and same image element in the second recording mode
suitable for recording on a film, but the run number
5 of the overlapping sputtering is not restricted to two.
That is, when an equal density is designated, a trans-
mission density substantially equal to that of a
reproduced image by plane paper recording must be obtained
in a reproduced image by film recording.

10 In the apparatus for recording of the present
invention, the recording means is not restricted only
to the ink jet recording process, but, for example, a
recording means of heat transfer proces can be also used.

 In Fig. 9 is shown further embodiment of an ink
15 jet printer according to the present inventin, where
numeral 31 is a cassette containing plane recording paper
or transparent resin film; numeral 35 is a pickup roller
for feeding the recording paper or transparent resin
film from the cassette; numeral 37 is a pair of timing
20 rollers; numerals 38 and 39 are pairs of feed rollers;
numerals 311, 312, 313, 314 and 315 are conveying guides
which constitute routes for conveying the recording paper
or film and also ensure its smooth conveying. Numerals
316 and 317 are first and second ink jet recording
25 heads provided in series in the direction of conveying
the recording paper or film.

 In the present embodiment, both heads are so
arranged as to make the mutual distance between the

1 printing positions of these two recording heads smaller
than the minimum width of the recording material to be
conveyed.

An aqueous ink is supplied to both ink jet
5 recording heads 316 and 317 from an ink storage tank
not shown in the drawing, and an image is reproduced
on the recording paper or film conveyed from the cassette
31 according to an image signal transmitted from an image
reading means. These two recording heads are constituted
10 as the so called full multiheads arranged in full line
in the direction vertical to the direction of conveying
the recording paper or film, that is, in the direction
perpendicular to the paper surface in the drawing.

When a first recording mode suitable for recording
15 onto the recording paper is designated, only the first
ink jet recording head 316 is driven to perform recording
onto the recording material, as will be described later,
whereas, when a second recording mode suitable for
recording onto the film is designated the first and second
20 ink jet recording heads 316 and 317 are both driven to
perform recording onto the recording material.

Numeral 318 is a suction fan and numeral 319
is a porous guide plate. The recording paper or film
is attracted to the guide plate 319 through suction by
25 the suction fan 318 to keep the flatness of the recording
paper or film and also to keep the best distance between
the recording material and the recording heads 316 and

1 and 317. Numeral 320 is a pair of discharge rollers
and numeral 321 is a discharge tray. After the
recording by the recording head 316 or 317, the recording
paper or film is conveyed to the pair of discharge
5 rollers 320 through the pair of feed rollers 39 and is
discharged further into the discharge tray 321 through
the pair of discharge rollers 320.

Numerals 322, 323 and 324 are first, second and
third sensors, respectively, for detecting the recording
10 material, which are provided in the conveying route for
the recording material. The first sensor 322 is pro-
vided in the conveying direction just before the recording
position by the second ink jet recording head 317, and
the driving of recording head 317 is controlled by the
15 detection output from the first sensor. Likewise, the
second sensor 323 is provided just before the first ink
jet recording head 316, and the driving of recording
head 316 is controlled by the detection output from the
second sensor. The third sensor 324 is provided in the
20 conveying direction just before the pair of discharge
rollers 320, and driving of the pair of discharge
rollers 320, the pair of feed rollers 39, etc. is
controlled on the basis of the detection output from
the third sensor.

25 Now, the first recording mode and second recording
mode will be described below, referring to Fig. 10.

1 In Fig. 10(A), symbol S shows a recording
material, and symbols D1, D2, and D3 show printing
positions according to both recording modes 316 and
317. In the first recording mode, only the recording
5 head 316 is driven to eject ink droplets onto the
respective printing positions D1 - D3, and the ink
droplets I1 - I3 are deposited on the recording
material S, as shown in Fig. 10(B).

 In the second recording mode, on the other
10 hand, both recording heads 316 and 317 are driven to
eject ink droplets I1 - I3 from the recording head
316 to overlap the ink droplets I11 - I13 ejected
from the recording head 317. As a result, the state
shown in Fig. 10 can be obtained. In this manner,
15 ink ejection (sputtering) can be carried out in two
runs for one and same image element. According to
the second recording mode, a reproduced image with a
substantially equal transmission density to that of
image formed on the plane paper can be obtained on
20 a film having a defect that image density of image
formed thereon would be insufficient, if recording
is performed in an equal recording density to that of
the plane paper, owing to the high transmittance of
the film.

25 In Fig. 11, a control system in the apparatus
of Fig. 9 is shown, where an image is formed according
to the first and second recording mode, and numeral

1 3100 is a controlling circuit for controlling the
driving of the respected sections, numeral 3101
is a read-only memory (ROM) encasing a control
program, etc.; numeral 3102 is a freely readable and
5 writable random-access memory (RAM); numeral 3103
is an operating section. The operating section has,
together with an operation section switch panel for
designating the normal recording conditions such
as number of recording copies, recording image
10 density, etc., first and second mode-designating
switches 3104-1 and 3104-2 for designating the first
and second recording mode, respectively, and further
has a display 3105 for displaying recording conditions,
etc.

15 The input signal from the operating section
3103 is supplied to the controlling section 3100
through a buffer circuit 3106 for data input and
output. Furthermore, a driving circuit 3107 is
subjected to driving control from the controlling
20 circuit 3100 through the buffer circuit 3106, whereby
display is controlled in the display 3105.

Numeral 3111 is motors as driving sources for
the respective rollers and numeral 3112 is a driving
circuit for on-off control of the motors 3111.

25 Numerals 3113 through 3116 are motor clutches for
transferring motor revolution power to the pickup
roller 35, and pairs of rollers 37, 38, 39, and 320

1 and are subjected to on-off control through driving
circuits 3118 through 3121, respectively.

Numeral 3122 is a driving circuit for on-off
control of the suction fan 318. In the controlling
5 circuit 3100, driving signals are supplied to the
respective driving circuits through a buffer circuit
for data output 3124 on the basis of the detection
signals supplied from the respective sensors 322,
323 and 324 through a buffer circuit for data input
10 3123 to control driving of the conveying system.

Numerals 3130 and 3131 are driving circuits
for driving the first and second ink jet recording
heads 316 and 317, and in image signal corresponding
to the image information read by the image reading
15 means not shown in the drawing is supplied to both
driving circuits 3130 and 3131 through an image
input interface 3132 and an image memory 3133.

Furthermore, a driving signal from the controlling
circuit 3100 is supplied to the driving circuits
20 3130 and 3131 through an image-controlling circuit
3134. The respective head 316 or 317 is energized
by the driving circuit 3130 or 3131 on the basis of
these two signals to form an image on the recording
paper or film conveyed from the cassette 21.

25 In Fig. 12 are shown recording operations
onto a sheet of recording material in the apparatus
of Fig. 9, where step S31-1 judges which of the

1 mode-designating switches 3104-1 and 3104-2 is on.
When switch 3104-1 is on, step S31-2 follows, and the
recording mode is set to the first recording mode,
whereas, when the switch 3104-2 is on, step S31-3
5 follows to set the second recording mode.

When the first recording mode is set, step
S32 follows to start revolution of pick-up roller
35, and the recording material is conveyed from the
cassette 31 toward the pair of timing rollers 37.
10 Thereby the recording paper encased in the cassette
31 is conveyed. Step S33 is provided with a
sufficient conveying time until the leading edge of
the recording paper has been engaged into the pair of
timing rollers 37, and step S34 stops revolution of
15 pick-up roller 35. Then, steps S35, S36, S37 and
S38 follow successively to start revolution of the
pair of timing rollers 37, the pair of feed rollers 38
and 39 and the pair of discharge rollers 320 and to
turn the suction fan 318 on at the same time. As a
20 result, the recording paper can reach the pair of
feed rollers 38 through the pair of timing rollers 37
and can be further conveyed through the pair of feed
rollers 38.

Step S 39 judges whether or not the leading
25 edge of the conveyed recording paper is detected by
the second sensor 323. When the leading edge is
detected, signed "yes" is transmitted, and step S310

1 follows to stop revolutions of the pair of timing
rollers 37. Then, in step S311, the first ink jet
recording head 316 is driven to start printing onto
the recording paper. The printing operation is
5 continued until the trailing end of the recording
paper has been detected by the second sensor 323.
That is, when the trailing edge of the recording
paper is detected in step S312, step S313 follows to
stop the printing operation.

10 The recording paper with an image thus formed
on its surface is conveyed toward the pair of
discharge rollers 320 through the pair of feed rollers
39, and discharged further toward the discharge tray
321 through the pair of discharge rollers 320. When
15 the trailing end of the recording paper is detected
by the third sensor 324 in step S314, step S315
follows to provide a sufficient conveying time until
the recording paper has been discharged into the
discharge tray 321. Then, steps S316 through S318
20 follow successively to stop driving of the pair of
feed rollers 38 and 39, the pair of discharge rollers
320 and the suction fan 318. One sequence of
recording operations for the recording paper according
to the first recording mode is completed in the
25 manner as described above.

Now, the operations when the switch 3104-2
turns on will be described below.

1 In this case, step S31-1 proceeds to step
S321 through step S31-3, as described above. Step
S321 starts revolution of pick-up roller 35 to convey
a recording material from the cassette 31 toward the
5 pair of timing rollers 37. A transparent resin film
is encased in the cassette 31 and is fed. Step S322
is provided with a sufficient conveying time until
the leading edge of the transparent resin film has
been engaged into the pair of timing rollers 37, and
10 step S323 stops revolution of pick-up roller 35. Then,
steps S324, S325, S326 and S327 follow successively
to start revolutions of the pair of timing rollers
37, the pair of feed rollers 38 and 39, and the pair
of discharge rollers 320, and to turn the suction fan
15 318 on at the same time. As a result, the transparent
resin film can reach the pair of feed rollers 38
through the pair of timing rollers 37, and can be
further conveyed through the pair of feed rollers 38.

 Step S328 judges whether or not the leading
20 edge of the conveyed transparent resin film is
detected by the first sensor 322. When the leading
edge is detected, signal "yes" is transmitted, and
step S329 follows to stop revolution of the pair of
timing rollers 37. Then, in step S330, the second
25 ink jet recording head 317 is driven to start
printing onto the transparent resin film. The
printing operation is continued until the trailing edge

1 of the transparent resin film has been detected by
the first sensor 322. That is, when the trailing edge
of the transparent resin film is detected in step
S333, step S334 follows to stop the printing operation
5 of the second ink jet recording head 317. On the
other hand, when the leading edge of the film conveyed
toward the first ink jet recording head 316 is detected
by the second sensor 323 during the printing by the
head 317, the step S331 advances into the step S332
10 to make the first ink jet recording head 316 start
printing operation onto the film. In this manner,
two runs of recording-liquid deposition can be
performed onto the film. The printing operation of
the first ink jet recording head 316 is continued
15 until the trailing edge of the transparent resin film
has been detected by the second sensor 323. That is,
when the trailing edge of the film is detected in
step S335, step S336 follows to stop the printing
operation of the second ink jet recording head 316.

20 The transparent resin film with an image thus
formed on its surface is conveyed toward the pair of
discharge rollers 320 through the pair of feed rollers
39, and discharged further toward the discharge
tray 321 through the pair of discharge rollers 320.
25 When the trailing edge of the transparent resin film
is detected by the third sensor 324, step S315
follows to provide a sufficient conveying time until

1 the transparent resin film has been discharged into
the discharge tray 321. Then, steps S315 through S318
follow successively to stop driving of the pair of
feed rollers 38 and 39, the pair of discharge rollers
5 320 and the suction fan 318. One sequence of record-
ing operations for the transparent resin film accord-
ing to the second recording mode is completed in the
manner as described above.

In the foregoing embodiment, two recording
10 heads are provided and the ink droplet ejection
(sputtering) is carried out in two runs for one and
the same image element in the second recording mode
suitable for recording on a film, but the run number
of the recording-liquid deposition is not restricted
15 thereto. That is, when an equal density is designated,
a transmission density substantially equal to that of
a reproduced image by plane paper recording must be
obtained in a reproduced image by film recording.
For example, three recording heads can be provided,
20 and three runs of recording-liquid deposition can
be performed by driving all of the heads in the
recording onto the film, whereas in the recording
onto plane paper, two of these three heads can be
selected to perform two runs of recording-liquid
25 deposition.

As described above, the present apparatus for
recording has a plurality of recording means, where

1 at least two recording means are driven in the case
of a light-transmitting recording material to perform
a plurality of recording-liquid depositon for one and
the same image element, so that a reproduced image
5 with a practically sufficient transmission density
can be obtained even on a light-transmitting recording
material. The trouble appearing when a transmitted
image is observed, that is, an insufficient density
of image formed on a light-transmitting recording
10 material due to a large transmittance, can be
eliminated.

In the present apparatus for recording, the
recording means is not restricted only to the ink
jet recording process, but, for example, a recording
15 means of heat transfer process can be also used.



46

CLAIMS

1. An image recording process comprising the steps of:
 - 5 selecting one of a light-transmitting recording material and a light-reflecting recording material;
determining, for each image element in a regular array of such image elements making up an image field on the selected recording material, whether to deposit liquid
10 on that image element; and
depositing a predetermined number of droplets of recording liquid onto the recording material at each image element so determined in accordance with the selection of recording material such that more
15 droplets are deposited per image element so determined when a light-transmitting recording material is selected than when a light-reflecting recording material is selected.
- 20 2. A process according to claim 1, wherein the droplets of the recording liquid are formed by an ink jet method.
- 25 3. A process according to claim 1 or 2, wherein the droplets of the recording liquid are droplets of aqueous ink.



47 -

4. A processing according to any preceding claim, wherein the light-transmitting recording material is a plastic resin film.

5 5. A process according to any preceding claim, wherein the light-transmitting recording material is acceptable to the droplets of the recording liquid.

6. An image recording process substantially as described in the description with reference to the drawings.

7. An image recording apparatus comprising:
means for selecting one of a recording mode for
15 recording on a light-transmitting recording material
and a recording mode for recording on a
light-reflecting recording material;
means for determining, for each image element in a
regular array of such image elements making up an
20 image field on a recording material, whether to
deposit liquid on that image element; and
means for depositing a predetermined number of
droplets of recording liquid onto the recording
material at each image element so determined in
25 accordance with the selection of recording mode such
that more droplets are deposited per image element so



48

determined when the recording mode for light-transmitting material is selected than when the recording mode for light-reflecting material is selected.

5

8. An apparatus according to claim 7, wherein the depositing means includes an ink jet means for depositing the droplets.

10 9. An apparatus as claimed in claim 7 or 8, wherein the depositing means repeats deposition of a droplet at an image element so determined when in the recording mode for light-transmitting material.

15 10. An apparatus as claimed in any of claims 7 to 9, wherein the depositing means comprises a first recording means for depositing droplets only in the recording mode for light-reflecting material and a second recording means for depositing droplets only in
20 the recording mode for light-transmitting material.

11. An apparatus as claimed in any of claims 7 to 9 wherein the depositing means comprises a first recording means for depositing droplets in both
25 recording modes, and a second recording means for



49 -

depositing droplets only in the recording mode for light-transmitting material.

5 12. An apparatus for recording, which comprises a plurality of recording means for recording by deposition on recording materials, and an actuation-controlling means for controlling the drive of the recording means in accordance with a first recording mode or a second recording mode, M number of
10 the recording means being actuated in the first recording mode to record an image element on a recording material, where $M \geq 1$, and N number of the recording means being actuated in the second recording mode to record the same image element on a recording
15 material, where $N > M$.

13. An apparatus according to claim 12, wherein each recording means is an ink jet means.

20 14. A recording apparatus substantially as described in the description with reference to the drawings.
