

INK AMOUNT DETECTING DEVICE AND RECORDING
APPARATUS PROVIDED WITH SUCH A DEVICE

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to an ink amount detecting device for informing of the shortage of ink remainder in a printing apparatus or the like of an ink jet type, for example.

10 Related Background Art

As means for detecting the shortage of ink remainder in a printing apparatus using a liquid ink as a recording agent, there has hitherto been available, among various others, a method for detecting the
15 surface of an ink liquid utilizing the electrical conductivity of the ink by providing a pair of electrodes in an ink tank; a method for detecting by a pressure sensor the negative pressure which is generated when the ink is exhausted by making an ink
20 container with a flexible bag; or a method for optically detecting the position of a float which floats in the tank using an infrared light which passes the tank wall. Among them, the method for optically detecting the float position is particularly desirable
25 and excellent from the viewpoint of the apparatus maintenance because this method is of a non-contact type and there is no need for embedding any detecting



members in the tank or in the ink guiding passage
unlike other methods.

Nevertheless, since this optical detection method
uses a float, there are some cases that a hitch or the
5 like occurs between the tank wall and the float,
leading to a significant drawback such as lowering the
reliability.

Also, in a case of a printing apparatus of a
serial type which records by allowing the recording
10 head to scan a recording sheet, the ink container is
arranged to move along with the recording head. Thus,
it is necessary to provide a mechanism to detect the
ink remainder in such a movable ink container, which
creates a problem in making the recording head portion
15 small and light, the wiring arrangement simple, or the
like, leading to the complicated structure of the
apparatus after all.

SUMMARY OF THE INVENTION

20 In consideration of the problems encountered in
the related art, the present invention is designed and
achieved by giving thought to the aspects which have
never been predicted.

It is an object of the present invention to
25 provide a highly reliable ink detecting device capable
of detecting the amount of ink contained in ink
reservoiring means, and a recording apparatus provided



with such a device.

It is another object of the present invention to provide an ink detecting device used for a recording apparatus for recording on a recording medium by use of a plurality of recording means for recording on the recording medium while being shifted correlatively with respect to the recording medium corresponding to a plurality of different colors of ink, which is capable of detecting the amount of ink in a plurality of ink reservoiring means shiftable together with the aforesaid recording means correlatively with respect to the recording medium, comprising:

a transparent member provided for the wall of each of the foregoing ink reservoiring means;

light emitting means for emitting light provided in a given position along the shifting passage of the foregoing ink reservoiring means in order to emit light to the foregoing transparent member arriving at the foregoing given position;

light receiving means for receiving the light which is emitted from the foregoing light emitting means and totally reflected at least once on the inner surface of the foregoing transparent member in the ink reservoiring means;

wherein the light emitted from the foregoing light emitting means to the foregoing transparent member reaches the foregoing light receiving means when



totally reflected at least once on the inner surface of the foregoing ink reservoiring means which is not in contact with the ink, and is transmitted without any total reflection through the inner surface of the foregoing ink reservoiring means which is in contact with the ink; and

detecting means for detecting per ink reservoiring means whether the foregoing light receiving means has received the light or not when the foregoing plural ink reservoiring means arrive at foregoing given position.

It is still another object of the present invention to provide a recording apparatus provided with the above-mentioned ink detecting device.

It is a further object of the present invention to provide an ink detecting device used for a recording apparatus for recording on a recording medium by use of recording means for recording on the recording medium while being shifted correlatively with respect to the recording medium, which is capable of detecting the amount of ink in ink reservoiring means shiftable together with the aforesaid recording means correlatively with respect to the recording medium, comprising:

a transparent member provided for the wall of the foregoing ink reservoiring means;

light emitting means for emitting light provided in a given position along the shifting passage of the



foregoing ink reservoiring means in order to emit light to the foregoing transparent member arriving at the foregoing given position;

light receiving means for receiving the light
5 which is emitted from the foregoing light emitting means and totally reflected at least once on the inner surface of the foregoing transparent member in the ink reservoiring means;

wherein the foregoing transparent member is
10 provided with a stepping plane orthogonal to the axis of the incident light which is incident upon the portion where the light emitted from the foregoing light emitting means enters, and a stepping plane orthogonal to the axis of the emitting light is
15 provided on the portion where the light is emitted to the foregoing light receiving means, and the light emitted from the foregoing light emitting means to the foregoing transparent member reaches the foregoing light receiving means when totally reflected at least
20 once on the inner surface of the foregoing ink reservoiring means which is not in contact with the ink, and is transmitted without any total reflection through the inner surface of the foregoing ink reservoiring means which is in contact with the ink;
25 and

detecting means for detecting whether the foregoing light receiving means has received the light



or not when the foregoing ink reservoiring means arrives at the foregoing given position.

It is still a further object of the present invention to provide a recording apparatus provided
5 with the above-mentioned ink detecting device.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view illustrating a way in which an ink detection is made according to the present
10 embodiment (when ink is absent).

Fig. 2 is a view illustrating a way in which an ink detection is made according to the present embodiment (when ink is present).

Fig. 3 is a view showing an example of the
15 application of the device to a serial printer.

Fig. 4 is a view showing an example of an optical passage board.

Fig. 5 is a block diagram of an ink detecting process in a serial printer according to the embodiment
20 1.

Fig. 6 is a flowchart showing the ink detecting process in the serial printer according to the embodiment 1.

Fig. 7 is a view showing an example of the
25 application of the device to a color serial printer.

Fig. 8 is a flowchart showing an ink detection process in a color serial printer according to the



embodiment 2.

Fig. 9 is a block diagram schematically showing the structure wherein a recording apparatus according to the present invention is applied to an information processing apparatus.

Fig. 10 is a view illustrating the external appearance of an information processing apparatus.

Fig. 11 is a view illustrating the external appearance of another example of the information processing apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, with reference to the accompanying drawings, the detailed description will be made of the embodiments according to the present invention.

<Embodiment 1>

As an embodiment of the present invention, the description will be made of an example applicable to an ink remainder detecting unit of an ink jet recording apparatus.

Fig. 1 is a view illustrating an ink tank unit of an ink jet recording apparatus to which the present invention is applied. In Fig. 1, a hole is made at a part of the tank wall 1. An optical passage board 2 is provided for the hole portion and adhesively bonded or welded by ultrasonic to the tank wall face to couple them so that no ink leaks from the inside. An light



emitting element 3 used for this example is an LED emitting an infrared light. Also, a light receiving element 4 used for this example is a phototransistor. The light emitting element 3 and light receiving element 4 are both provided with a collimator lens, respectively, to enhance orientation, and are arranged so that the light emitted from the light emitting element 3 is guided to the light receiving element 4 through the path represented by an arrow B indicating the optical passage. Also, in this example, the ink tank is of a disposable ink cartridge type. Therefore, the light emitting element 3 and light receiving element 4 are fixed on the main body side, and the structure is arranged to implement the above-mentioned positional relationship by the ink tank guiding means which is provided separately.

Now, the description will be made of the operational principle of the above-mentioned embodiment. In the present embodiment, the optical passage board 2 is made of a transparent acrylic resin. The refractive index of the transparent acrylic resin is approximately 1.49. When the tank is empty (that is, the state where the air is filled), the critical angle is approximately 48° where the refractive index of the air is 1. In the present embodiment, since the incident angle A is defined as 37° , the light emitted from the light emitting element 3 is totally reflected



by the inner surface 2a of the optical passage board as shown in Fig. 1, and most of the incident infrared light reaches the light receiving element 4 (light passage indicated by an arrow in Fig. 1). On the contrary, when ink is present in the inside of the tank, the critical angle will be approximately 9° because the refractive index of the ink is 1.47 approximately. Accordingly, there is no reflection. The light emitted from the light emitting element 3 passes the inner surface 2a of the optical passage board and does not reach the light receiving element 4 (passage represented in Fig. 2). Therefore, it is possible to detect the presence and absence of the ink by observing the output of the light receiving element 4; hence enable the use of an ink jet recording apparatus to be informed of the absence of ink.

Also, it is possible to configure the optical passage board as shown in Fig. 4 or to integrally form the tank wall surface in the configuration of the optical passage block. The outer surface of the optical passage board 2 is formed to provide a serrated cross section so that the outer surface is at right angles to the incident light and the exit light in order to prevent the loss caused by the reflection of the incident light and exit light from the light emitting element 3, but not to be extruded from the tank wall surface 1. If the optical passage board 2 is



configured as shown in Fig. 4, this board 2 does not extrude from the tank wall surface 1, which will contribute to implementing a small device.

5 The ink detecting device described above is easily applicable to a serial printer which holds the recording head and ink tank on the carriage as shown in Fig. 3. In this case, the light emitting element 3 and light receiving element 4 are fixed in the home position or the like on the main body side. Thus, the structure is arranged so that a detecting circuit is actuated when the carriage arrives at the detecting position. In this way, an advantage is obtained to eliminate any cables connecting the carriage and the main body for the purpose. The operation of this printer will be described in conjunction with Fig. 5 and Fig. 6. Fig. 5 is a block diagram showing this ink detecting device. A pulse motor 17 which drives the carriage is driven in accordance with the value of a step number counter 71. A control unit 72 causes the carriage to be shifted to a given position. Then, depending on whether the light emitted from a light emitting element 9 is received by a light receiving element 10 or not, an ink absence alarm light illuminating circuit 73 is turned on.

25 Fig. 6 is a flowchart illustrating this control. This flowchart is executed by the control unit 72. At first, the carriage is returned to the home position



(S61). The light emitting element is illuminated
(S62). Then, the carriage is shifted to the ink
detecting position, that is, a given position where the
light from the light emitting element 3 reaches the
5 optical passage board 2 of the ink tank (S63). It is
possible to judge that the carriage is in a given
position according to a value of the step number
counter 71. Thus, when the position is determined, a
test is given to ascertain whether the light receiving
10 element receives light or not (S64). If affirmative,
ink is not in contact with the inner surface of the
optical passage member 2, and it is known that the
total reflection has taken place. Then, the ink
absence alarm is illuminated (S65). Subsequently, the
15 carriage is returned to the home position (S66). The
light emitting element is turned off (S67) to terminate
the process.

With the procedures described above, the ink in
the tank can be detected.

20 Also, the detecting principle of the present
invention utilizes the refractive index of ink.
Fundamentally, therefore, it is not affected by the
color of any ink. Accordingly, it is possible to apply
exactly the same detection circuit to each of the
25 colors of a color printer having a plurality of ink.
Hence, as described earlier, a set of light emitting
element and light receiving element is provided on the



main body side, and by stopping the carriage at the position of each tank having different color, it is possible to detect all kinds of color ink in use.

<Embodiment 2>

5 As a second embodiment according to the present invention, the description will be made of an example in which the invention is applied to an ink remainder detecting unit of a color ink jet recording apparatus.

10 Fig. 7 is a view showing the carriage portion of a color ink jet recording apparatus to which the present invention is applied. In Fig. 7, an image of each color element is recorded by a four-color head having a head 1 for recording in black, head 2 in yellow, head 3 in magenta, and head 4 in cyanogen. Then, a full color
15 recording is executed by superposing the images in four colors appropriately. On the wall surface of ink tank for each head, each of the optical passage members 5 to 8 is provided, respectively.

20 The ink remainder detection for each tank can be made in the same manner as described in the foregoing embodiment. In other words, the optical passage members 5 to 8 correspond to the optical passage member 2 in Fig. 1 and Fig. 2 while the light emitting element 9 corresponds to the light emitting element 3, and the
25 light receiving element 10 to the element 4. To exemplify the head 1, when ink is present in the ink container of the head 1, the light emitted from the



light emitting element 9 is transmitted through the inside of the tank because the refractive index of the optical passage member 5 and that of the ink in the container are substantially the same. If the ink is
5 absent, the total reflection occurs on the inner surface of the optical passage member 5, thus enabling the light to reach the light receiving element 10. This property is utilized for the detection of ink in the tank.

10 Subsequently, the description will be made of an actual ink remainder detecting sequence in conjunction with a flowchart shown in Fig. 8. This flowchart is executed by a control unit which controls the recording apparatus, the block diagram of which is shown in Fig.
15 6.

At first, a pulse motor 17 is driven to shift the carriage 15 to the home position to illuminate the light emitting element 9 (S81). Then, although the carriage 15 is driven by the pulse motor 17 (S82), a
20 step number is counted by a step number counter 71 which is separately arranged, and when the carriage passes the cyanogen detecting position, that is, the position in which the light from the light emitting element 9 is incident upon the optical passage member 8
25 provided for the cyanogen head 4, the carriage refers to the output of the light receiving element 10 (S83). At this juncture, if the ink in the cyanogen head 4 is



sufficient, the light receiving element 10 does not detect any light, but if the remainder of the ink is insufficient, the totally reflected light on the inner surface of the optical passage member 8 is detected by the light receiving element. Then, an alarm lamp (not shown) is illuminated to promote the supply of ink to the cyanogen head 4 (S84).

Further, the same operation will be executed when the carriage passes the detecting position of each of the magenta, yellow, and black heads. Then, lastly, the carriage 15 is returned to the home position to turn off the light emitting element 9, thus terminating the ink remainder detection (S85 to S94).

The carriage speed for executing this operation should desirably be a motion having a constant velocity of 100 mm/s or less in order to avoid inviting any erroneous detection due to waving of the liquid surface in the ink tank. Further, although it may take an extra time, it may be possible to stop the carriage 15 at each of the head detection positions for the execution of this detection.

As described above, the attention is given to the fact that the four color ink tanks are arranged on the carriage 15 in parallel in the traveling direction of the carriage 15 for the color ink jet printer, and the optical passage members 5 to 8 are also arranged in parallel in the traveling direction of the carriage 15.



for each of the four color ink tanks. Thus, by allowing the detecting unit where the light emitting element 9 and light receiving element 10 are arranged to pass each of them sequentially, it is intended to
5 detect each of the four color ink remainders rapidly and without any direct contact. Furthermore, the structure according to the present embodiment enables the entire system of the detecting unit to be formed on the side end of the tank. Therefore, compared to the
10 system using the float position detection which requires the detecting member to be arranged on the lower part of the ink tank due to its structural arrangement, the probability of occurrence of any miscarriage is extremely small in executing the
15 detection which may cause an ink leakage by chance, leading to the ink adhesion to the optical components or the short circuit of electrical circuits. Thus, the device reliability will be significantly improved. Also, for the ink tank which travels with the carriage,
20 it will suffice if only the optical passage member is provided while the other structural components can be fixed to the main body. As result, it is possible to implement making the head portion small and light. There is also no need for connecting any flexible
25 cables and the like to the head for the ink detection, hence making the provision of a simple structure possible.



In this respect, the present invention may be applicable to a system comprising a plurality of equipment or to a system comprising a single equipment. The present invention is also applicable to a system or
5 apparatus which becomes operative when a program is provided as a matter of course.

Also, as ink usable for the present invention, it is possible to employ a plurality of ink having different colors. The plurality of ink having
10 different colors include those having different densities for one kind of color.

The present invention produces an excellent effect on ink jet recording methods, particularly a recording head and a recording apparatus wherein the flying
15 droplets are formed by utilizing thermal energy to perform recording.

Regarding the typical structure and operational principle of such a method, it is preferable to adopt those which can be implemented using the fundamental
20 principle disclosed in the specifications of U.S. Patent Nos. 4,723,129 and 4,740,796. This method is applicable to the so-called on-demand type recording system and a continuous type recording system. Particularly, however, it is suitable for the on-demand
25 type because the principle is such that at least one driving signal, which provides a rapid temperature rise beyond a departure from nucleation boiling point in



response to recording information, is applied to an electrothermal transducer disposed on a liquid (ink) retaining sheet or liquid passage whereby to cause the electrothermal transducer to generate thermal energy to
5 produce film boiling on the thermoactive portion of the recording head; thus effectively leading to the resultant formation of a bubble in the recording liquid (ink) one to one for each of the driving signals. By the development and contraction of the bubble, the
10 liquid (ink) is discharged through a discharging port to produce at least one droplet.

The driving signal is preferably in the form of pulses because the development and contraction of the bubble can be effectuated instantaneously, and,
15 therefore, the liquid (ink) is discharged with quick response. The driving signal in the form of pulses is preferably such as disclosed in the specifications of U.S. Patent Nos. 4,463,359 and 4,345,262. In this respect, the temperature increasing rate of the heating
20 surface is preferably such as disclosed in the specification of U.S. Patent No. 4,313,124 for an excellent recording in a better condition.

The structure of the recording head may be as shown in each of the above-mentioned the specifications
25 wherein the structure is arranged to combine the discharging ports, liquid passages, and the electrothermal transducers as disclosed in the above-mentioned



patents (linear type liquid passage or right angle liquid passage). Besides, the structure such as disclosed in the specifications of U.S. Patent Nos. 4,558,333 and 4,459,600 wherein the thermal activation
5 portions are arranged in a curved area is also included in the present invention.

In addition, the present invention is applicable to the structure disclosed in Japanese Laid-Open Application No. 59-123670 wherein a common slit is used
10 as the discharging ports for plural electrothermal transducers, and to the structure disclosed in Japanese Patent Laid-Open Application No. 59-138461 wherein an opening for absorbing pressure wave of the thermal energy is formed corresponding to the discharging
15 ports.

Moreover, the present invention is effectively applicable to a serial type recording head wherein the recording head is fixed on the main assembly; to a replaceable chip type recording head which is connected
20 electrically with the main apparatus and for which the ink is supplied when it is mounted in the main assemble; or to a cartridge type recording head having an ink container integrally provided for the head itself.

25 Also, as constituents of a recording head according to the present invention, it is preferable to provide recording head recovery means and preliminarily



auxiliary means additionally because these constituents will contribute to making the effectiveness of the present invention more stabilized. To name them specifically, such constituents are capping means for the recording head, cleaning means, compression or suction means, preliminary heating means such as electrothermal transducers or heating elements other than such transducers or the combination of those types of elements, and the preliminary discharge mode besides the regular discharge for recording.

Further, as the recording mode of the apparatus, the present invention is extremely effective in applying it to an apparatus having at least one of a multi-color mode with ink of different colors, a full-color mode using the mixture of the colors, or a mode using the kinds of ink which are of the same color but have different densities, irrespective of whether the recording head is integrally structured or it is structured by a combination of plural recording heads.

Now, in the embodiments according to the present invention set forth above, while the ink has been described as liquid, it may be an ink material which is solidified below the room temperature but liquefied at the room temperature. Since the ink is controlled within the temperature not lower than 30°C and not higher than 70°C to stabilize its viscosity for the provision of the stable ejection in general, the ink



may be such that it can be liquefied when the applicable recording signals are given.

In addition, while positively preventing the temperature rise due to the thermal energy by the use of such energy as an energy consumed for changing states of ink from solid to liquid, or using the ink which will be solidified when left intact for the purpose of preventing ink evaporation, it may be possible to apply to the present invention the use of an ink having a nature of being liquefied only by the application of thermal energy such as an ink capable of being ejected as ink liquid by enabling itself to be liquefied anyway when the thermal energy is given in accordance with recording signals, an ink which will have already begun solidifying itself by the time it reaches a recording medium. For an ink such as this, it may be possible to retain the ink as a liquid or solid material in through holes or recesses formed in a porous sheet as disclosed in Japanese Patent Laid-Open Application No. 54-56847 or Japanese Patent Laid-Open Application No. 60-71260 in order to execute a mode whereby to enable the ink to face the electrothermal transducers in such a state. In the present invention, the most effective method for the respective ink mentioned above is the one which is capable of implementing the film boiling method described above.

Furthermore, as the mode of a recording apparatus



according to the present invention, there are a copying apparatus combined with a reader or the like, and an apparatus executing a mode as a facsimile apparatus having the transmission and reception functions in addition to those which are integrally arranged or separately arranged as an image output terminal of an information processing equipment such as the above-mentioned word processor, computer or the like.

Fig. 9 is a block diagram schematically showing the structure of a recording apparatus according to the present invention when the apparatus is applied to an information processing apparatus having functions as a word processor, a personal computer, a facsimile apparatus, and a copying apparatus. In Fig. 9, a reference numeral 201 designates a control unit provided with a CPU such as a microprocessor, and various I/O ports to control the entire system of the apparatus by outputting control signals, data signals, and others to each unit and inputting control signals and data signals from each unit; 202, a displaying unit, on the screen of which various menus, documentary information, image data read by an image reader 207, and the like are displayed; and 203, a pressure sensitive transparent touch panel arranged on the display unit 202 capable of inputting items, coordinate positions, and the like on the displaying unit 202 by depressing its surface by a finger or the like as



desired.

A reference numeral 204 designates an FM
(Frequency Modulation) sound source which stores the
music information created by a music editor or the like
5 in a memory 210 and/or an external memory device 212 as
digital data, and reads them from the memory and others
to perform an FM modulation. The electrical signals
from the FM sound source 204 are transduced into the
audible sounds by a speaker unit 205. A printer unit
10 206 is the apparatus to which the present invention is
applied as an output terminal for a word processor,
personal computer, facsimile apparatus, and copying
apparatus.

A reference numeral 207 designates an image reader
15 which is arranged in the conveying passage of source
documents in order to photoelectrically read the data
on source documents for facsimile and copying
operations in addition to reading various other source
documents; 208, a facsimile transmission and reception
20 unit which performs the facsimile transmission of the
data on the source document read by the image reader
207, and receives the transmitted facsimile signals for
demodulation, and which also has a function to
interface with the external devices; 209, a telephone
25 unit which has various functions to serve as an
ordinary telephone and as a device to automatically
take and record messages among others; and 210, a



memory unit including the ROM which stores a system program, manager program, and other application programs as well as character fonts, dictionaries, and the like, the RAM which stores the application program and text information load from the external memory device 212, and a video RAM or the like.

A reference numeral 211 designates a keyboard unit which inputs text information and various commands; 212, an external memory device using a floppy disk, hard disk, and the like as its storing medium, and in this external memory device 212, text information, music, or voice information, and user's application program and others are stored.

Fig. 10 is a view illustrating the outer appearance of the information processing apparatus shown in Fig. 9. In Fig. 10, a reference numeral 301 designates a flat panel display utilizing liquid crystal and others to display various menus, graphic information, and text information, and enable the coordinate input and item specifying input to be executed when the surface of the touch panel arranged on this display 301 is depressed by a finger or the like; and 302, a hand set which is used when the apparatus functions as a telephone unit.

The keyboard 303 is detachably connected to the main body through a cord, through which various text information and various data can be inputted. Also,



the keyboard 303 is provided with various function keys 304 and others; and 305, an insertion inlet for a floppy disk.

5 A reference numeral 307 designates a sheet stacker where the source documents are stacked for the image reader 207 to read, and the source document thus read are exhausted from the rear portion of the apparatus. Also, in a case of a facsimile reception, or the like, the recording is made by an ink jet printer 306.

10 In this respect, the above-mentioned display 301 may be a CRT, but it is desirable to use a flat panel such as a liquid crystal display using a ferroelectric liquid crystal because with such a display, it is possible to implement making the apparatus small and
15 light. When the above-mentioned image processing apparatus functions as a word processor, the text information inputted through the keyboard unit 211 in Fig. 9 is processed by the control unit 201 in accordance with a text processing program, and output
20 to the printer unit 206 as images. When the above-mentioned information processing apparatus functions as a personal computer, the various data inputted through the keyboard unit 211 are operationally processed by the control unit 201 in accordance with an application
25 program, and the results of the operation are output to the printer unit 206 as images. When the apparatus functions as a receiver of the facsimile apparatus, the



facsimile information inputted from a facsimile transmission and reception unit 208 is received by the control unit 201 for processing in accordance with a given program and output to the printer unit 206 as reception images. Also, when the apparatus functions as a copying apparatus, a source document is read by the image reader 207, and the data on the source document thus read are transferred to the printer unit 206 through the control unit 201 and output as copied images. In this respect, when the apparatus functions as a transmitter of the facsimile apparatus, the data on the source documents read by the image reader 207 are processed by the control unit 201 for transmitting in accordance with a given provided, and then, transmitted to the communication line through the facsimile transmitter 208. Here, it may be possible to arrange the above-mentioned apparatus as an integrated type where an ink jet printer is incorporated in the main body as shown in Fig. 11. In this case, the portability will be further enhanced. In Fig. 11, the constituents having the same functions as those shown in Fig. 10 are indicated by the corresponding reference marks.

Since a high-quality recording image is obtainable by applying a recording apparatus according to the present invention to the multi-functional information apparatus as described above, a further enhancement of



1 the functions of the above-mentioned information
processing apparatus is possible.

5

10

15

20

25

This Sheet Has Been Replaced





WHAT IS CLAIMED IS:

1. An ink detecting device used for a recording apparatus for recording on a recording medium by use of a plurality of recording means for recording on the recording medium while being shifted correlatively with respect to the recording medium corresponding to a plurality of different colors of ink, which is capable of detecting the amount of ink in a plurality of ink reservoiring means shiftable together with said recording means correlatively with respect to the recording medium, comprising:

a transparent member provided for the wall of each of said ink reservoiring means;

light emitting means for emitting light provided in a given position along the shifting passage of said ink reservoiring means in order to emit light to said transparent member arriving at said given position;

light receiving means for receiving the light which is emitted from said light emitting means and totally reflected at least once on the inner surface of said transparent member in the ink reservoiring means

wherein the light emitted from said light emitting means to said transparent member reaches said light receiving means when totally reflected at least once on the inner surface of said ink reservoiring means which is not in contact with the ink, and is transmitted without any total reflection through the inner surface





of said ink reservoiring means which is in contact with the ink; and

detecting means for detecting per ink reservoiring means whether the foregoing light receiving means has received the light or not when said plural ink reservoiring means arrive at said given position.

2. A recording apparatus for recording on a recording medium by use of a plurality of recording means for recording on the recording medium while being shifted correlatively with respect to the recording medium corresponding to a plurality of different kinds of ink, comprising:

an ink amount detecting device for detecting the amount of ink is a plurality of ink reservoiring means, which correlatively shifts with respect to the recording medium together with said recording means including

a transparent member provided for the wall of each of said ink reservoiring means;

light emitting means for emitting light provided in a given position along the shifting passage of said ink reservoiring means in order to emit light to said transparent member arriving at said given position;

light receiving means for receiving the light which is emitted from said light emitting means and totally reflected at least once on the inner surface of





said transparent member in the ink reservoiring means
wherein the light emitted from said light emitting
means to said transparent member reaches said light
receiving means when totally reflected at least once on
5 the inner surface of said ink reservoiring means which
is not in contact with the ink, and is transmitted
without any total reflection through the inner surface
of said ink reservoiring means which is in contact with
the ink; and

10 detecting means for detecting per ink reservoiring
means whether the foregoing light receiving means has
received the light or not when said plural ink
reservoiring means arrive at said given position.

15 3. A recording apparatus according to Claim 2,
wherein
said recording means is an ink jet recording head
for recording by discharging ink.

20 4. A recording apparatus according to Claim 3,
wherein
said recording head is the ink jet recording head
which is a recording head for discharging ink by
utilizing thermal energy and is provided with the
25 thermal energy transducers generating the thermal
energy given to ink.





5. A recording apparatus according to Claim 4,
wherein

said recording head is the one which causes ink to
change its state by the thermal energy which is applied
5 by said thermal energy transducers to discharge ink
from the discharging ports in accordance with said
change of state.

6. An image forming apparatus for recording on a
10 recording medium by use of a plurality of recording
means for recording on the recording medium while being
shifted correlatively with respect to the recording
medium corresponding to a plurality of different kinds
of ink, comprising:

15 an ink amount detecting device for detecting the
amount of ink is a plurality of ink reservoiring means,
which correlatively shifts with respect to the
recording medium together with said recording means
including

20 a transparent member provided for the wall of each
of said ink reservoiring means;

light emitting means for emitting light provided
in a given position along the shifting passage of said
ink reservoiring means in order to emit light to said
25 transparent member arriving at said given position;

light receiving means for receiving the light
which is emitted from said light emitting means and





totally reflected at least once on the inner surface of said transparent member in the ink reservoiring means

wherein the light emitted from said light emitting means to said transparent member reaches said light

5 receiving means when totally reflected at least once on the inner surface of said ink reservoiring means which is not in contact with the ink, and is transmitted

without any total reflection through the inner surface of said ink reservoiring means which is in contact with

10 the ink;

detecting means for detecting per ink reservoiring means whether the foregoing light receiving means has received the light or not when said plural ink reservoiring means arrive at said given position; and

15 means for reading images on a source document.

7. An image forming apparatus for recording on a recording medium by use of a plurality of recording means for recording on the recording medium while being
20 shifted correlatively with respect to the recording medium corresponding to a plurality of different kinds of ink, comprising:

an ink amount detecting device for detecting the amount of ink is a plurality of ink reservoiring means,
25 which correlatively shifts with respect to the recording medium together with said recording means including





a transparent member provided for the wall of each of said ink reservoiring means;

light emitting means for emitting light provided in a given position along the shifting passage of said ink reservoiring means in order to emit light to said transparent member arriving at said given position;

light receiving means for receiving the light which is emitted from said light emitting means and totally reflected at least once on the inner surface of said transparent member in the ink reservoiring means

wherein the light emitted from said light emitting means to said transparent member reaches said light receiving means when totally reflected at least once on the inner surface of said ink reservoiring means which is not in contact with the ink, and is transmitted without any total reflection through the inner surface of said ink reservoiring means which is in contact with the ink;

detecting means for detecting per ink reservoiring means whether the foregoing light receiving means has received the light or not when said plural ink reservoiring means arrive at said given position; and

means for transmitting and/or receiving image information.

25

8. An image forming apparatus according to Claim 7, further comprising:





means for reading images on a source document.

9. An image forming apparatus for recording on a recording medium by use of a plurality of recording means for recording on the recording medium while being shifted correlatively with respect to the recording medium corresponding to a plurality of different kinds of ink, comprising:

an ink amount detecting device for detecting the amount of ink is a plurality of ink reservoiring means, which correlatively shifts with respect to the recording medium together with said recording means including

a transparent member provided for the wall of each of said ink reservoiring means;

light emitting means for emitting light provided in a given position along the shifting passage of said ink reservoiring means in order to emit light to said transparent member arriving at said given position;

light receiving means for receiving the light which is emitted from said light emitting means and totally reflected at least once on the inner surface of said transparent member in the ink reservoiring means

wherein the light emitted from said light emitting means to said transparent member reaches said light receiving means when totally reflected at least once on the inner surface of said ink reservoiring means which





is not in contact with the ink, and is transmitted without any total reflection through the inner surface of said ink reservoiring means which is in contact with the ink;

5 detecting means for detecting per ink reservoiring means whether the foregoing light receiving means has received the light or not when said plural ink reservoiring means arrive at said given position; and means for inputting recording signals.

10

10. An image forming apparatus according to Claim 9, wherein

said means for inputting recording signals is a keyboard.

15

11. An ink detecting device used for a recording apparatus for recording on a recording medium by use of recording means for recording on the recording medium while being shifted correlatively with respect to the recording medium, which is capable of detecting the amount of ink in ink reservoiring means shiftable together with the aforesaid recording means correlatively with respect to the recording medium, comprising:

20

a transparent member provided for the wall of said ink reservoiring means;

light emitting means for emitting light provided





in a given position along the shifting passage of said ink reservoiring means in order to emit light to said transparent member arriving at said given position;

light receiving means for receiving the light
5 which is emitted from said light emitting means and totally reflected at least once on the inner surface of said transparent member in the ink reservoiring means

wherein said transparent member is provided with a stepping plane orthogonal to the axis of the incident
10 light which is incident upon the portion where the light emitted from said light emitting means enters, and a stepping plane orthogonal to the axis of the emitting light is provided on the portion where the light is emitted to said light receiving means, and the
15 light emitted from said light emitting means to said transparent member reaches said light receiving means when totally reflected at least once on the inner surface of said ink reservoiring means which is not in contact with the ink, and is transmitted without any
20 total reflection through the inner surface of said ink reservoiring means which is in contact with the ink; and

detecting means for detecting whether said light receiving means has received the light or not
25 when said ink reservoiring means arrives at said given position.

12. A recording apparatus for recording by use of



recording means which records on a recording medium while correlatively shifting with respect to the recording medium, comprising:

an ink amount detecting device for detecting ink
5 amount in ink reservoiring means which correlatively shifting with respect to the recording medium together with said recording means including

a transparent member provided for the wall of said ink reservoiring means;

10 light emitting means for emitting light provided in a given position along the shifting passage of said ink reservoiring means in order to emit light to said transparent member arriving at said given position;

light receiving means for receiving the light
15 which is emitted from said light emitting means and totally reflected at least once on the inner surface of said transparent member in the ink reservoiring means

wherein said transparent member is provided with a stepping plane orthogonal to the axis of the incident
20 light which is incident upon the portion where the light emitted from said light emitting means enters, and a stepping plane orthogonal to the axis of the emitting light is provided on the portion where the light is emitted to said light receiving means, and the
25 light emitted from said light emitting means to said transparent member reaches said light receiving means when totally reflected at least once on the inner





surface of said ink reservoiring means which is not in contact with the ink, and is transmitted without any total reflection through the inner surface of said ink reservoiring means which is in contact with the ink;
5 and

detecting means for detecting whether the said light receiving means has received the light or not when said ink reservoiring means arrives at said given position.

10

13. A method for detecting the ink amount in a plurality of ink reservoiring means which correlatively shift with respect to the recording medium together with a plurality of recording means for recording on
15 the recording medium corresponding a plurality of different colors of ink, comprising the following step of:

providing a transparent member for the wall of each of said ink reservoiring means;

20 emitting light from a given position along the shifting passage of said ink reservoiring means to said transparent member which arrives at said given position; and

detecting per ink reservoiring means whether there
25 is among said emitting light any light which is totally reflected at least once in the inner surface of said transparent member in ink reservoiring means or not





when said plurality of ink reservoiring means arrive at said given position by utilizing the fact that the light emitted to said transparent member is totally reflected at least once on the inner surface of said ink reservoiring means which is not in contact with ink, and is transmitted without any total reflection through the inner surface of said ink reservoiring means which is in contact with ink.

10 14. A method for detecting the ink amount in an ink reservoiring means which correlatively shifts with respect to the recording medium together with a recording means for recording on the recording medium, comprising the following step of:

15 providing for the wall of said ink reservoiring means a transparent member having a stepping plane orthogonal to the axis of the incident light in the portion where the light enters, and a stepping plane orthogonal to the axis of the exit light in the portion
20 where the light exits;

 emitting light from a given position along the shifting passage of said ink reservoiring means to said transparent member which arrives at said given position; and

25 detecting whether there is among said emitting light any light which is totally reflected at least once in the inner surface of said transparent member in





- 39 -

ink reservoiring means or not when said ink reservoiring means arrives at said given position by utilizing the fact that the light emitted to said transparent member is totally reflected at least once on the inner surface of said ink reservoiring means which is not in contact with ink, and is transmitted without any total reflection through the inner surface of said ink reservoiring means which is in contact with ink.

10 15. A liquid level detection arrangement which comprises:

- a) a liquid container having a transparent window in a wall thereof;
- b) means for directing a beam of light at said wall from outside the container at such an angle that the presence or absence of liquid on the other side of the window causes the light beam to be transmitted through or deflected by the window; and
- c) a light detector positioned to collect the reflected light beam and generate a signal.

This Sheet Has Been Replaced

