(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 803 358 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.10.1997 Bulletin 1997/44

(51) Int Cl.[6]: **B41J 2/015**

(21) Application number: **97302780.8**

(22) Date of filing: **23.04.1997**

(84) Designated Contracting States:
DE FR GB

(30) Priority: **23.04.1996 JP 101596/96**
10.01.1997 JP 3280/97

(71) Applicant: **SEIKO INSTRUMENTS INC.**
Chiba-shi, Chiba 261 (JP)

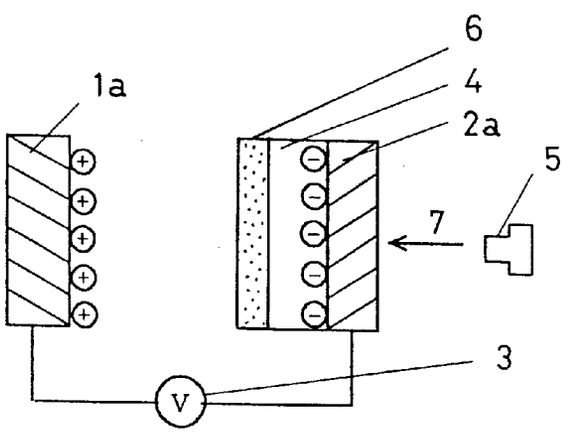
(72) Inventors:
- **Ohhama, Satoshi**
  Chiba-shi, Chiba (JP)
- **Iwaki, Tadao**
  Chiba-shi, Chiba (JP)
- **Kawawada, Naoki**
  Chiba-shi, Chiba (JP)
- **Kawaguchi, Kouji**
  Chiba-shi, Chiba (JP)
- **Kuwahara, Seiji**
  Chiba-shi, Chiba (JP)
- **Okano, Hiroshi**
  Chiba-shi, Chiba (JP)
- **Sato, Tatsuru**
  Chiba-shi, Chiba (JP)

(74) Representative: **Sturt, Clifford Mark et al**
J. MILLER & CO.
34 Bedford Row,
Holborn
London WC1R 4JH (GB)

(54) Recording apparatus as well as recording unit and recording head for using same apparatus

(57) In ink jet recording methods, the continuous type is high in recording speed but difficult to simplify the device due to restoration of unnecessary ink or the like, while the on-demand type is simplified in device structure but difficult to speed up recording rate. An recording apparatus employing a recording head structured by: having a head section formed by a transparent electrode 2a formed on a substrate, a photoconductive layer 4 formed on the transparent electrode 2a, and a means for supplying ink 6 onto the photoconductive layer 4, and an opposing electrode la, in this order; the means for supplying ink 6 and the opposing electrode la being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply 3 for applying voltage to between the transparent electrode 2a and the opposing electrode la, and a light irradiating means 5 for supplying light corresponding to a desired image pixel to the potoconductive layer, enabling high-precision and high-quality output printing of characters.

FIG. 1



EP 0 803 358 A2

Description

Background of the Invention

This invention relates to a recording apparatus as well as a recording unit and a recording head used for the recording apparatus, adapted to obtain on a medium to be recorded output images coping with broad needs of ranging from a printing industry demanding high-speed outputs of high-quality images, a printer industry based on in-office or personal demands, to a civil-use appliance industry requiring low-priced general-purpose output apparatuses and devices using various kinds and purposes of mediums to be recorded.

In a slit jet method (Susumu Ichinose and others: "Slit Jet Recording Method", the First Non-impact Printing Technology Symposium Thesis, P119 - 124, 1984) as one kind of static-electricity attraction methods in the conventional ink-jet recording, a recording head has as shown in Fig. 20 an ink ejecting port 101 formed in a slit form, an upper plate 102 and a lower plate forming the ink ejecting port 101, a recording electrode 104 arranged per unit of recording pixel on the lower plate 103, an opposing electrode 105 arranged opposite to the ink ejecting port 101, a medium to be recorded 110 to be moved along the opposing electrode 105, and a driving power supply 106 for supplying a voltage to a selected electrode of the recording electrode 104, wherein ink 108 is filled within the ink ejecting port 101 and a voltage pulse is applied to between the recording electrode 104 and the opposing electrode 105 to cause the ink 108 to eject so that a flying ink 109 adheres onto the medium to be recorded 110 and infiltrates thereinto, resulting in obtaining desired output printed characters or images.

The conventional slit jet method like this is free from restriction of resolving power by nozzles and can facilitate cleaning of the ink ejecting port 101, by replacing the nozzles used in ink jet recording with the aforesaid ink ejecting port 101 in an elongate slit form.

Furthermore, the slit jet method employs a plurality of the ink ejecting ports 101 to fill the ink 108 within each of the ink ejecting ports 101, thereby easily obtaining color output printed characters.

In the conventional ink jet recording method there have been problems described below.

(1) The improvement of resolving power is difficult because of using nozzles for ink ejection.
(2) In ink jet recording methods there are divided as a continuous type and an on-demand type. The continuous type is high in recording speed but difficult to simplify the device due to restoration of unnecessary ink or the like, while the on-demand type is simplified in device structure but difficult to speed up recording rate.

In the conventional slit jet method for solving the above problems on the abovestated ink jet recording method, there have been problems described below.

(1) The improvement on resolving power is difficult because of the arrangement of recording electrodes corresponding to recording pixel unit for causing ink flying.
(2) Upon applying voltage to a recording electrode, when a selected recording electrode and a non-selected recording electrode are adjacent to, there occurs discharge phenomenon between the both electrodes, making difficult to optimize ink characteristics and control of applying voltage and timing thereof.

Summary of the Invention

Therefore in the present invention, it is the subject to provide a recording apparatus as well as a recording unit and a recording head for use in the recording apparatus, which perform high-precision and high-quality printing at high speed and are capable of output printing freely from selecting a record medium form.

In order to solve the abovestated problems, a recording head of the present invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having at least a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying light corresponding to a desired image pixel to the potoconductive layer.

Furthermore, in order to solve the abovestated problem, a recording unit of this invention is provided with a paper feeding means for supplying a medium to be recorded between the ink supplying mans and the opposing electrode of the abovestated recording head, and structured such that the medium to be printed is transferred by a predetermined amount in synchronism with ending of printing of one line or a predetermined lines or one screen by the above recording head.

Furthermore, in order to solve the abovestated problem, a recording apparatus of this invention is a recording apparatus which controls adhesion of ink to the medium to be recorded to record image pixels on the medium to be recorded, and structured by being provided with the abovestated recording head and recording unit.

Brief Description of the Drawings

Fig. 1 is an explanatory diagram showing a first structure of a recording head in a first example of the present invention.

Fig. 2 is an explanatory diagram showing a second structure of a recording head in a second example of the present invention.

Fig. 3 is an explanatory diagram showing a third structure of a recording head in a third example of the present invention.

Fig. 4 is an explanatory diagram showing a slit cross-section fabrication shape in the third example of the present invention.

Fig. 5 is an explanatory diagram showing a fourth structure of a recording head in a fourth example of the present invention.

Fig. 6 is an explanatory diagram showing a fifth structure of a recording head in a fifth example of the present invention.

Fig. 7 is an explanatory diagram showing a sixth structure of a recording head in a sixth example of the present invention.

Fig. 8 is other explanatory diagram showing a sixth structure of a recording head in a sixth example of the present invention.

Fig. 9 is other explanatory diagram showing a sixth structure of a recording head in a sixth example of the present invention.

Fig. 10 is an explanatory diagram showing a first structure of a recording unit using the first-structure recording head of the present invention.

Fig. 11 is an explanatory diagram showing a second structure of a recording unit using the second-structure recording head of the present invention.

Fig. 12 is an explanatory diagram showing a seventh structure of a recording unit using the seventh-structure recording head of the present invention.

Fig. 13 is an explanatory diagram showing a ninth structure of a recording unit using the ninth-structure recording head of the present invention.

Fig. 14 is an explanatory diagram showing the shape of an opposing electrode in a tenth example of the present invention.

Fig. 15 is an explanatory diagram showing a tenth structure of a recording unit using the tenth-structure recording head of the present invention.

Fig. 16 is an explanatory diagram of transferring to a medium to be recorded by an eleventh structure of the recording unit of the present invention.

Fig. 17 is an explanatory diagram showing a twelfth structure of the recording unit using the eleventh-structure recording head of the present invention.

Fig. 18 is an explanatory diagram of transferring to a medium to be recorded by an eleventh structure of the recording unit of the present invention.

Fig. 19 is an explanatory diagram showing a recording apparatus using the recording unit described in the first to thirteenth examples of the present invention.

Fig. 20 is an explanatory diagram showing a structure of a recording apparatus of a conventional slit-jet method.

Detailed Description of the Preferred Embodiments

A first structure of a recording head of this invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording head of the first structure operates as follows.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value at irradiated region, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer so that the ink receives Coulomb's force to fly toward the opposing electrode.

A first structure of a recording unit of the present invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having, between the ink supplying means and the opposing electrode, a paper feeding means for supplying a medium to be recorded without contact with the ink supplying means, a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording unit of the first structure operates as follows.

In a state that voltage is applied to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for the irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer

and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer so that the ink receives Coulomb's force to fly toward the opposing electrode side. This flown ink moves onto the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired image pixels on the medium to be recorded.

The paper feeding means, after the recording head completes predetermined main-scanning direction printing, conveys the medium to be recorded by a predetermined amount in a sub-scanning direction to prepare the next main-scanning direction printing. And, the main-scanning direction printing is carried out, and, if this ends, the medium to be recorded is paper-fed by a predetermined amount in the sub-scanning direction. This is repeated and one image of recording ends.

A second structure of a recording head of the present invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, a means for supplying ink onto the photoconductive layer, and a slit plate provided with a slit for controlling ejection of ink, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording head of the second structure operates as follows.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer so that the ink is controlled in ink amount and directionality and receives Coulomb's force to fly toward the opposing electrode side.

Also, a second structure of a recording unit of the present invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, a means for supplying ink onto the photoconductive layer, and a slit plate provided with a slit for controlling ejection of ink, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having, between the slit plate and the opposing electrode, a paper feeding means for supplying a medium to be recorded, a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording unit of the second structure operates as follows.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer so that the ink is controlled in ink amount and directionality and receives Coulomb's force to fly toward the opposing electrode side. The flown ink moves to the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired image pixels on the medium to be recorded. The aforesaid paper feeding means is the same as one already explained, and the explanation will be hereinafter omitted.

Furthermore, a third structure of a reading head of this invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, a means for supplying ink onto the photoconductive layer, and a slit plate having a slit for controlling ejection of ink whose cross section is fabricated in a taper shape, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording unit of the third structure operates as follows.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer. At this time, the ink has electric

charges easy to concentrate to the inside of the ink because the slit cross section of the slit plate is in the taper form, and is controlled in ink amount and directionality and receives Coulomb's force to fly toward the opposing electrode side.

Also, a third structure of a recording unit of the present invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, a means for supplying ink onto the photoconductive layer, and a slit plate having a slit for controlling ejection of ink whose cross section is fabricated in a taper shape, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having, between the slit plate and the opposing electrode, a paper feeding means for supplying a medium to be recorded, a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording unit of the third structure operates as follows.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer. At this time, the ink has electric charges easy to concentrate to the inside of the ink because the slit cross section of the slit plate is in the taper form, and is controlled in ink amount and directionality and receives Coulomb's force to fly toward the opposing electrode side. And, the flown ink moves to the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired image pixels on the medium to be recorded.

Furthermore, a fourth structure of a recording head of this invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer having a projection for controlling ejection of ink formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording head of the fourth structure operates as follows.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to a position corresponding to the projection of the photoconductive layer having the projection reduces the resistance value for irradiated region of the photoconductive layer having the projection, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer having the projection and the transparent electrode, to charge electric charges to the inside of the ink within the projection on the photoconductive layer having the projection, and the ink is controlled in ink amount and directionality by the projection on the photoconductive layer and receives Coulomb's force to fly toward the opposing electrode side.

Furthermore, a fourth structure of a recording unit of this invention is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer having a projection for controlling ejection of ink formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode, in this order; the means for supplying ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a paper feeding means for supplying a medium to be recorded between the projection formed on the photoconductive layer and the opposing electrode, a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to desired image pixels to the potoconductive layer.

The above recording unit of the fourth structure operates as follows.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to a position corresponding to the projection of the photoconductive layer having the projection reduces the resistance value for irradiated region of the photoconductive layer having the projection, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer having the projection and the transparent electrode, to charge electric charges to the inside of the ink within the projection on the photoconductive layer having the projection, and the ink is controlled in ink amount and directionality by the projection on the photoconductive lay-

er and receives Coulomb's force to fly toward the opposing electrode side. The flown ink moves to the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired image pixels on the medium to be recorded.

Furthermore, a fifth structure of a recording head of this invention is structured by integrating the substrate and the transparent electrode formed on the substrate for the recording heads of the recording-head first to fourth structures. Also, a fifth structure of a recording unit of this invention lies in a structure that the recording head of the recording unit for the recording-unit first to fourth structures is rendered as the recording head of the fifth structure.

The above recording head of the fifth structure and the recording unit of the fifth structure operate as below.

In a state that voltage is applied with using a power supply to between the substrate-integrated type transparent electrode having the integrated substrate and transparent electrode, and the opposing electrode, the irradiation of light with using the light irradiating means from the substrate-integrated type transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the substrate-integrated type transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode side. The flown ink moves to the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded.

Furthermore, a sixth structure of a recording head of this invention has a structure that the opposing electrode and the head section of the recording head for the recording-head first to fifth structures are in one body or almost in one body.

Also, a sixth structure of a recording unit of this invention lies in a structure that the recording head of the recording unit for the recording-unit first to fifth structures is rendered as the recording head of the sixth structure.

The above recording head of the sixth structure and the recording unit of the sixth structure operate as below.

In a state that voltage is applied with using a power supply to between the transparent electrode and the acceleration-type opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode side. Further, this ink passes through the acceleration-type opposing electrode and moves to the medium to be recorded on the paper feeding means to be infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded.

Furthermore, a seventh structure of a recording head of this invention lies in that the recording head of the present structure has further an ink-accelerating means for accelerating flown ink in the recording head for the record-head first to fifth structures. Also, a seventh structure of a recording unit of this invention lies in a structure that the recording head of the recording unit for the recording-unit first to fifth structures is rendered as the recording head of the seventh structure.

The above recording head of the seventh structure and the recording unit of the seventh structure operate as below.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode side. The flown ink is further accelerated by the accelerating means and the flown ink, by inserting a medium to be recorded from the paper feeding means to between the opposing electrode and the accelerating means, moves to the medium to be recorded to be infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded.

Furthermore, an eighth structure of a recording head of this invention is the recording head for the record-head first to seventh structures, and the recording head is further in a line form corresponding to a printing width on the medium to be recorded. Also, an eighth structure of a recording unit of this invention lies in a structure that the recording head of the recording unit for the recording-unit first to seventh structures is rendered as the recording head of the eighth structure.

The above recording head of the eighth structure and the recording unit of the eighth structure operate as below.

In a state that voltage is applied with using a power supply to between the individual transparent electrode and the opposing electrode, the irradiation of light in a line form manner by the light irradiating means from the transparent electrode side to the photoconductive layer

reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode side. The flown ink moves to the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired image pixels on a one-line region of the medium to be recorded.

Furthermore, a ninth structure of a recording head of this invention is the recording head for the record-head first, second, third, fourth, fifth, seventh, and eighth structures, wherein the recording head is further in a line form, as the opposing electrode, corresponding to a medium to be recorded, and the opposing electrode has rising in a projection form at an ink-adhesion portion. Also, a ninth structure of a recording unit of this invention lies in a structure that the recording head of the recording unit for the recording-head first, second, third, fourth, fifth, seventh, and eighth structures is rendered as the recording head of the ninth structure.

The above recording head of the ninth structure and the recording unit of the ninth structure operate as below.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the rising portion in the projection form of the opposing electrode side. By inserting a medium to be recorded into a place where the ink-adhesion portion is projectingly rising from the paper feeding means, the flown ink moves to the medium to be recorded to be infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on a one-line region medium to be recorded.

Furthermore, a tenth structure of a recording head of this invention is the recording head of the recording-unit first to ninth structures, wherein the recording head is structured to have as a light irradiating means a recording sheet having a negative image printed on a transparent sheet.

Also, a tenth structure of a recording unit of this invention lies in a structure that the recording head of the recording unit for the recording unit first to ninth structures is rendered as the recording head of the tenth structure.

The above recording head of the tenth structure and the recording unit of the tenth structure operate as below.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light with using the light irradiating means from the transparent electrode side to the entire surface of the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode side. By inserting a medium to be recorded from the paper feeding means to between the opposing electrode and the ink, this flown ink moves to the medium to be recorded to be infiltrated and adhered thereto, resulting in obtaining desired printed characters or images by one image on the medium to be recorded.

Furthermore, an eleventh structure of a recording unit of this invention lies in a structure that a plurality of recording heads for the recording-head first to tenth structures are employed to have a means for supplying different color of ink to each recording head.

The above recording unit of the eleventh structure operates as below.

In a state that voltage is applied with using a power supply to between the transparent electrode and the opposing electrode, the irradiation of light by the light irradiating means from the transparent electrode side to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode side. This flown ink moves to the medium to be recorded to be infiltrated and adhered thereto, resulting in obtaining desired image pixels by one dot or one line or on one display region of the medium to be recorded. By repeating the abovestated process on each color of the recording head, desired color printed characters or color images are obtained on the medium to be recorded.

Furthermore, an eleventh structure of a recording head of this invention lies in a structure being a recording head of the recording-head first to tenth structures, wherein the recording head is further of a serial shape and has a means for supplying different colors of ink onto a divided transparent electrode. Also, a twelfth structure of a recording unit of this invention lies in a structure being the recording head of the recording unit for the

recording-unit first to tenth structures is rendered as the recording head of the eleventh structure.

The above recording head of the eleventh structure and the recording unit of the eleventh structure operate as below.

In a state that voltage is applied with using a power supply to between individual transparent electrodes and the opposing electrode, the irradiation of light by the light irradiating means from the side of a transparent electrode of each ink-color region to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current to flow in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode side. This flown ink moves to the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired image pixels on the medium to be recorded. By repeating the abovestated process on each color of the divided region, desired color printed characters or color images are obtained on the medium to be recorded.

Furthermore, a thirteen structure of a recording unit of this invention lies in a structure being the recording unit for the recording-unit first to twelfth structures, wherein the recording unit has an opposing electrode divided to have individual switching means.

The above recording unit of the thirteenth structure operates as below.

In a state that voltage is applied with using a power supply to between the transparent electrode and the switching means for the opposing electrode while the switching means on this side relative to the printing direction being in an ON state, the irradiation of light by the light irradiating means from the transparent electrode to the photoconductive layer reduces the resistance value for irradiated region of the photoconductive layer, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink on the photoconductive layer, and the ink receives Coulomb's force to fly toward the opposing electrode of which switching means is in the ON state. This flown ink moves to the medium to be recorded on the opposing electrode to be infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded. Thereafter, by sequentially turning the switching means ON in the printing direction and turning the switching means on this side relative to the printing direction in synchronism with irradiation of light by the light irradiating means onto the photoconductive layer, desired image pixels of one-line region are obtained on the medium to be recorded.

Furthermore, the recording apparatus of the present invention is structured to be provided with any of the above-described recording heads or recording units.

[Example]

Examples of the present invention will be explained hereinbelow based on the drawings.

(Example 1)

Fig. 1 is an explanatory diagram showing a first example of the first structure of the recording head of the present invention. In Fig. 1, in a state that voltage is applied to between the transparent electrode 2a (substrate not shown) and the opposing electrode la using the power supply 3, the irradiation of light, from the direction of the arrow 7, from the side of the transparent electrode 2a to the photoconductive layer 4, using the irradiating means 5 causes the reduction of resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 4 so that the ink receives Coulomb's force to fly toward the opposing electrode 1a.

As the photoconductive layer 4 of the present invention, there can be used an inorganic photoconductor such as an Se-base, CdS-base, ZnO-base, and BSO ($Bi_{12}SiO_{20}$) -base photoconductive single-crystal materials or amorphous silicon hydrides of such as i-type, pi-type, or pin-type, or a stack-type organic photoconductor such as CTM (Charge Carrier Transport Material)/ CGM (Charge Carrier Generation Material). As for the photoconductive layer 4, photoconductivity is important and it is preferred that the difference of potential in surface potential is great. The dark resistance of the above inorganic photoconductor or the organic photoconductor lies in 10^9 - 10^{14} Ω.cm, and the irradiation of light to the photoconductive layer 4 reduces the resistance value down to 10^4 -10^{11} Ω.cm, which brings the irradiated region into a state of photoelectric current flow. Naturally, it is needless to say that the resistance value and change thereof due to irradiation of light are different depending on the material or the structure thereof. Also, although the layer thickness of the photoconductive layer 4 is 10 - 50 μm, while its electric characteristics require great resistance values, high sensitivity, and quick optical responsibility, which are possible by the aforesaid photoconductors.

Further, where an amorphous silicon hydride is used as the photoconductive layer 4, the dark resistance is 10^9 - 10^{11} Ω.cm, and the resistance value can be reduced down to 10^4 - 10^6 Ω.cm by light irradiation and secure the difference of surface potential great. Also,

although it is needless to say that the dark resistance value increases as the layer thickness of the photoconductive layer 4 is greater, it is desired that the layer thickness is 50 μm or less, preferably about 20 - 30 μm, because the resolution power deteriorates at 20 - 100 μm or greater.

Also, in order to raise the dark resistance value and simultaneously suppress the spreading of electric charges to a minimal limit so as to realize ink flying with high resolution, it is preferable to use an i-type amorphous silicon hydride with impurity elements removed therefrom.

Semiconductor laser can be employed as the light irradiation means 5, wherein a laser light is irradiated in the direction of the arrow 7 from the light irradiating means 5 to a position corresponding to a desired image pixel on the photoconductive layer 4. On the photoconductive layer 4, the resistance value is lowered in a desired image pixel region irradiated. Here, it is possible to improve the optical sensitivity by improving the light attenuation rate through matching the oscillating wavelength of laser light and the sensitivity coefficient of the photoconductive layer 4 for the oscillating wavelength. Also as for the laser light 7, the laser light irradiated from the laser oscillating device such as semiconductor laser is optimized as to irradiation light intensity, image-forming light spot shape, etc. by an optical lens in the light irradiating means 5, and it can be structured by a laser light scanning mechanism constituted by a polygon miller, etc. In the recording head of the present invention, since the laser light is irradiated from the light irradiating means 5, images can be formed in non-contact and at high speed on the photoconductive layer 4 at a position corresponding to a desired image pixel. In the present example, although semiconductor laser is used as a light emitting source of the light irradiating means 5, there is no limitation to this and He-Ne laser or semiconductor laser array or LED array or halogen lamp can be fully used as a light emitting source. Also, it is needless to say that optical shutter array or a liquid crystal display television may be used, instead of the aforesaid laser scanning optical system.

In the present example, although the ink 6 is charged with electric charges by irradiating light to the photoconductive layer 4, the charging amount of electric charges is determined by the diameter of light irradiation by the light irradiating means 5 and the irradiation light intensity and the irradiation pulse width. As the irradiation diameter is larger, the irradiated area of the photoconductive layer 4 becomes larger, increasing the amount of charging. Also, the increase of irradiation light intensity increases the reduction in resistance value in the phtoconductive layer 4 so that photoelectric currents are easy to flow and the charging amount to the ink 6 increases. Further, where the irradiation pulse width is increased, the charging amount can be increased in a similar manner. In the recording head of the present invention, by controlling the amount of electric charges to be charged to the ink 6, the ink flying speed can be raised to a high speed. Also, the ink flying speed can be varied corresponding to a medium to be recorded.

As the transparent electrode 2a of the present invention, ITO (Indium-Tin-Oxide) or conductive polymer materials, metal films sufficiently thin for transmission of light (e.g., Al film with a film thickness of 0.03 μm, etc.) or further ZnO or SnO2 or a compound thereof can be used. Also as the opposing electrode la of the present invention, highly-conductive metallic materials, such as aluminum, copper, and gold, can be used.

The power supply voltage value to be applied to between the transparent electrode 2a and the opposing electrode la of the present invention is at 500 V - 4 KV, wherein the appropriate applying voltage varies by the electric conductivity of the ink 6 or the material of the photoconductive layer 6 or the distance between the head section and the opposing electrode la or the like. Although it is needless to say that there is on principle no influence if the polarity of this power supply 3 is reversed of positive/negative, it is preferred that the opposing electrode la is given of positive polarity because most ink is apt to be charged in negative polarity.

Also, there is a possibility that the power supply voltage value becomes 500 V or lower by the improvement in the future on materials for each constituent component. Accordingly, the power supply voltage value used for this recording head is not limited to 500 V - 4 KV.

The influencing factors of the ink 6 of the present invention on ink flying involve surface tension, viscosity, electric conductivity, and so on. The relation between the surface tension and the maximum spacing (the maximum spacing of ink 6 flying is hereinafter determined as the maximum spacing) of ink 6 flown to the opposing electrode la is that, where electric conductivity and viscosity are thought of as constant, the maximum record spacing increases with decrease of surface tension in a range of surface tension of 20 - 50 dyn/cm. Accordingly, as the surface tension is smaller, the resisting force in the ink ejection process becomes small and ejection of ink is possible with weak electric field, so that the maximum record spacing can be increased large. The surface tension is generally high for aqueous ink which is 72.8 dyn/cm for pure water while organic solvent ranges from 200 dyn/cm to 35 dyn/cm, so that as the ink 6 of the present invention it is possible to use an ink dissolving with dyestuffs in an organic solvent. Also, it is possible to increase the maximum record spacing by dissolving in the ink 6, as a surfactant, anion surfactant, cation surfactant, non-ionic surfactant, or the like, to improve the surface tension.

Although the viscosity of the above ink solvents can be selected over a wide range, a solvent with low viscosity is high in volatility and worse in preservability for the ink 6, so that a solvent with a boiling point of, in a range of, about 200 °C or higher is selected in order to secure the preservability. The relation of the viscosity and the maximum record spacing is that, where the sur-

face tension and the electric conductivity are considered constant, the maximum record spacing increases with decrease in viscosity. Accordingly, similarly to the case of the surface tension, when the viscosity is low, the resisting force in the process of ink ejection becomes small and the maximum record spacing can be increased.

For ejection of the ink 6, there is necessity of charging of electric charges from the phtoconductive layer 4 to the ink 6 so that it is desired that the electric conductivity is low. Where the electric conductivity is too low, the electric charges are diffused within the ink 6 before the electric charges charged to the ink 6 reaches a tip of an ink meniscus, and there becomes no occurrence of ink ejection. Accordingly, the appropriate range of electric conductivity for the ink of the present invention is taken as 2×10^{-7} or below.

Incidentally, as to the above setting values for ink characteristics, since there are dependencies of ink flying on light source conditions of the light illuminating means 5, and voltage value supplied to between the transparent electrode 2a and opposing electrode la, and distance to the opposing electrode la, it is needles to say that the characteristic ranges for optimal surface tension, viscosity, electric conductivity, etc. are not limited to the above values.

(Example 2)

Fig. 2 is an explanatory diagram showing one example of the second structure of the recording head of the present invention. In Fig. 2, in a state that voltage is applied using the power supply 3 to between the transparent electrode 2a and the opposing electrode la, the irradiation of light, from the direction of the arrow 7, using the light irradiating means 5 from the transparent electrode 2a side to the photoconductive layer 4 causes the reduction of resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 4, and further the ink is controlled in ink amount and directionality by the slit plate 8 and receives Coulomb's force to fly toward the opposing electrode la. At this time, the width of the slit provided in the slit plate 8 determines the maximum value of ink static pressure at the ink ejection port, and the ink 6 received with static pressure forms a semilunar projection in the ink ejection port, i.e. a meniscus, to determine an ink supply amount. Further, as the slit width is smaller, the radius of ink meniscus can be reduced small and the Coulomb's force for ejecting the ink 6 can be increased large, so that the recording characteristics are improved as the slit width is smaller. Accordingly, it is preferred that the width of the slit provided in the slit plate 8 is about 100 μm, at which no hindrance is given to the supply of ink 6, or less. Also, where the ink 6 is flow out onto the slit plate 8, the ink 6 will fly toward the opposing electrode la, making difficult continuing desirable image pixel. Consequently, the material of the slit plate 8 requires the use of a material having a large contact angle for the ink 6 and insulating properties, and the contact angle is secured by using fluorocarbon polymers or treating the surface of the slit plate 8 fabricated of an insulating material of glass or ceramics or the like with using a silan coupling agent. If the static pressure of the ink 6 is proper, the above unstable phenomenon can be removed. Furthermore, the use of the slit plate 8 serves to control the direction of ink 6 fly to stabilize the amount and speed of ink ejection, and further the control of the ink meniscus curve enhances the efficiency of collecting the ink 6 to reduce the energy for ink flying.

(Example 3)

Fig. 3 is an explanatory diagram showing one example of the third structure of the recording head of the present invention. In Fig. 3, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and the opposing electrode 1a, the irradiation of light using light irradiating means 5, from the direction of the arrow 7, from the side of the transparent electrode 2a to the photoconductive layer 4 causes the reduction of resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 4. At this time, the taper shape made in slit cross section of the slit plate 8 facilitates electric charges to be collected. Accordingly, the ink 6 is effectively charged with electric charges so that it is controlled of ink amount and directionality and receives Coulomb's force to be flown toward the opposing electrode 1a.

The fabrication shape in slit cross section of the slit plate 8 is in the present example a taper shape but it is not limited to this, and there are considerable fabrication shapes as in Fig. 4 (a) - (j) . This fabrication shape in the slit cross section determines the maximum value of static pressure required for flying of the ink 6 to the opposing electrode la side. This is that the ink 6 receives static pressure to form a semilunar-formed projecting surface, i.e. a meniscus, in the slit cross section. The curvature of the meniscus at this time determines supply amount of ink 6. Also, as the fabrication width of this slit cross section is smaller the curvature of ink meniscus can be reduced smaller, and accordingly since the Coulomb's force for flying the ink 6 can be increased larger, the recording characteristics are improved as the fabrication width in the slit cross section is smaller. Also, by altering the slit cross-sectional fabrication shape, the ink

6 is prevented from flowing out of the slit plate 8. Furthermore, the enhancement in efficiency of collecting electric charges to be charged to the ink 6 can reduce the energy for ink flying.

(Example 4)

Fig. 5 is an explanatory diagram showing one example of the fourth structure of the recording head of the present invention. In Fig. 5, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and the opposing electrode la, light is irradiated using light irradiating means 5, from the direction of the arrow 7, from the transparent electrode 2a side onto a projection of the photoconductive layer 9 having the projection causes the reduction of resistance value for the irradiated region of the photoconductive layer 9 having the projection, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 9 having the projection and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 contained in the projection of the photoconductive layer 9 having the projection, and the ink is controlled in ink amount and directionality by the projection on the photoconductive layer 9 and receives Coulomb's force to fly toward the opposing electrode la. At this time, the role of the projection on the photoconductive layer 9 having the projection is similar to the recording head of the abovestated second structure, wherein the function of a slit plate is provided by integrally forming the projection on the photoconductive layer 9, reducing cost and making in compact. Incidentally, it is preferred that the projection on the photoconductive layer is formed of an insulating material, similarly to the slit plate.

(Example 5)

Fig. 6 is an explanatory diagram showing one example of the fifth structure of the recording head of the present invention. In Fig. 6, in a state that voltage is applied using power supply 3 to between a substrate-integrated type transparent electrode 2b and the opposing electrode la, the irradiation of light using light irradiating means 5, from the direction of the arrow 7, from the substrate-integrated type transparent electrode 2b side to the photoconductive layer 4 causes the reduction of resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the substrate-integrated type transparent electrode 2b, to charge electric charges to the inside of the ink 6 on the irradiated region of the photoconductive layer 9, and the ink receives Coulomb's force to fly toward the opposing electrode la side. As the substrate-integrated type transparent electrode 2b, there is used an inorganic photoconductor such as an Se-base, CdS-base, ZnO-base, and BSO($Bi_{12}SiO_{20}$)-base photoconductive single-crystal materials or an amorphous silicon hydride of such as i-type, pi-type, or pin-type, or a stack-type organic photoconductor such as CTM (Charge Carrier Transport Material)/CGM (Charge Carrier Generation Material), by which the substrate and the transparent electrode 2a and photoconductive layer 4 can be formed in a stack form wherein the substrate is not necessarily required.

(Example 6)

Figs. 7, 8 and 9 are explanatory diagrams showing examples of the sixth structure of the recording head of the present invention. In Fig. 7, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and an acceleration-type opposing electrode 1b, the irradiation of light using light irradiating means 5, from the direction of the arrow 7, from the transparent electrode 2a side to the photoconductive layer 4 causes the reduction of resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 9, and the ink receives Coulomb's force to pass through a cavity of the acceleration-type opposing electrode 1b and fly toward the direction of the arrow 13. The shape of the accretion-type opposing electrode 1b is structured by an upper plate and a lower plate separated therebetween as shown in Fig. 7, wherein the upper plate and the lower plate are applied by voltages of the same potential from the power supply 3 so that the ink 6 receives Coulomb's force to fly passing between the upper plate and the lower plate in the direction of the arrow 13. By the abovestated structure, the acceleration-type opposing electrode and the head section are made integral, and flying of ink is possible only by the head section. Also, by providing no opposing electrode function to the paper feeding means 11 side, the phenomenon that the medium to be recorded 10 is attracted by static electricity due to an applied voltage is removed to enable reduction in torque value for the paper feeding means 11. Furthermore, as the shape of the acceleration-type opposing electrode 1b there can be considered of a core-type shape structured by integration with the head section as shown in Fig. 8. Furthermore, as shown in Fig. 9, the upper plate and the lower plate of the acceleration-type opposing electrode 1b are formed in parallel and in a line form on the slit plate 8 of the head section, wherein the upper plate and the lower plate are applied by voltages of the same potential from the power supply 3 so that the ink 6 receives Coulomb's force to fly toward the direction of the arrow 13. At this time, the spacing between the upper plate

and the lower plate of the acceleration-type opposing electrode 1b is to be spacing which is greater than a slit width of the slit plate 8 to secure a distance required for the ink 6 to be pulled off upon being flown from the meniscus state. Furthermore, the above structure provides the formation of the acceleration-type opposing electrode 1b on the head section, making the structure compact.

(Example 7)

Fig. 10 is an explanatory diagram showing one example of the first structure of the recording head of the present invention. In Fig. 10, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and the opposing electrode la, the irradiation of light using light irradiating means 5, from the direction of the arrow 7, from the side of the transparent electrode 2a to the photoconductive layer 4 causes the reduction in resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a to charge electric charges to the inside of the ink 6 on the photoconductive layer 9, and the ink receives Coulomb's force to fly in the direction of the arrow 13 toward the opposing electrode la side. By inserting a medium to be recorded 10 between the opposing electrode la and the ink 6 from the paper feeding means 10, the flying ink 12 moves to the medium to be recorded 10 to be infiltrated and adhered thereto so that desired printed characters or images are obtained on the medium to be recorded 10. At this time, size of the dot transferred to the medium to be recorded 10 is determined by the distance between the medium to be recorded 10 and the recording head and the voltage value applied between the transparent electrode 2a and the opposing electrode la and the amount of ink 12. The amount of flying ink 12 is determined by the quantity of optical energy given to the photoconductive layer 4 from the light irradiating means 5.

As for the distance between the medium to be recorded 10 and the head section, if too short, there are cases that the insertion of a medium to be recorded is not smoothly done and possibilities of contact through rumples. Also, if too long, the ink 12 flown will fall due to gravity, making difficult the formation of desired image pixels. Therefore, it is preferred that the distance between the medium to be recorded 10 and the head section is about 0.2 to 1 mm, and it is proper that a desired distance is taken about 0.5 mm.

(Example 8)

Fig. 11 is an explanatory diagram showing one example of the second structure of the recording unit using the second structure of the recording head of the present invention. In Fig. 11, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and the opposing electrode la, the irradiation of light using light irradiating means 5, from the direction of the arrow 7, from the transparent electrode 2a side to the photoconductive layer 4 causes the reduction in resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 9, so that the ink 6 is controlled in ink amount and directionality by the slit plate and receives Coulomb's force to fly in the direction of the arrow 13 toward the opposing electrode la. By inserting a medium to be recorded 10 between the opposing electrode 1a and the slit plate 8 by the paper feeding means 10, the flying ink 12 moves to the medium to be recorded 10 to be infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded 10. At this time, size of the dot transferred to the medium to be recorded 10 is determined by the distance between the medium to be recorded 10 and the recording head and the voltage value applied between the transparent electrode 2a and the opposing electrode la and the amount of flying ink 12. The amount of flying ink 12 is determined by the optical energy amount given to the photoconductive layer 4 from the light irradiating means 5 and the slit plate 8 shape. As for the distance between the medium to be recorded 10 and the head section in the present example, if too short, there are cases that the insertion of a medium to be recorded 10 is not smoothly done and possibilities of contact through rumples. Also, if too long, the flown ink 12 will fall due to gravity, making difficult the formation of desired image pixels. Therefore, it is preferred that the distance between the medium to be recorded 10 and the head section is about 0.2 to 1 mm, and it is proper that the desired distance is about 0.5 mm.

Besides the recording heads as were shown in the example 7 and 8, recording units of the third to the sixth structures can be constituted with using a recording head for the third to the sixth structures.

(Example 9)

Fig. 12 is an explanatory diagram showing one example of the seventh structure of the recording unit using the seventh structure of the recording head of the present invention. In Fig. 12, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and the opposing electrode la, the irradiation of light using light irradiating means 5, from the direction of the arrow 7, from the transparent electrode 2a side to the photoconductive layer 4 causes the reduction in resistance value for the irradiated region of

the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 9, and the ink 6 receives Coulomb's force to fly in the direction of the arrow 13 toward the opposing electrode la side and the flying ink 12 is accelerated by an accelerating means 14. By inserting a medium to be recorded 10 between the opposing electrode la and the accelerating means 14 from the paper feeding means 11, the flying ink 12 moves to the medium to be recorded 10 and infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded 10. At this time, size of the dot transferred to the medium to be recorded 10 is determined by the distance between the medium to be recorded 10 and the recording unit and also the voltage value applied between the transparent electrode 2a and the opposing electrode la and the amount of flying ink 12. The amount of flying ink 12 is determined by the optical energy amount given to the photoconductive layer 4 from the light irradiating means 5.

Therefore, it is preferred that the distance between the medium to be recorded 10 and the accelerating means 14 in the present example is about 0.2 to 1 mm, and it is proper that the desired distance is about 0.5 mm.

By the accelerating means 14 of the present example the speed of the flying ink 12 is raised high, and it is possible to reduce the energy amount supplied to the photoconductive layer 4 by controlling the applying voltage value for ink 6 flying and the optical energy given from the light irradiating means 5.

Also, the accelerating means 14 is fabricated of a material having good conductivity such as by aluminum, copper, and gold, which also may be of a capacitor made up by one set of flat plates, and also a matter being of a shape of a closed tube such as a cylinder.

In the present example, the accelerating means 14 is given of voltage through a resistance from an electrode on an opposing electrode la side of the power supply 3. However, the application of voltage to the accelerating means 14 is not limited to this, and it is possible, for example, to provide a greater potential difference between the transparent electrode 2a and the accelerating means 14 than the potential difference between the transparent electrode 2a and the opposing electrode la. This is determined by the amount of the flown ink 12 or the distance between the accelerating means 14 and the surface of the ink 6, or the like.

Also, as shown in Fig. 12, it is possible to cause the ink 6 to fly only with the accelerating means by using a switch function in the opposing electrode la. By this, the recording unit of the present example is made integral and compact. Furthermore, removal is made for the phenomenon that the medium to be recorded 10 is attracted by static electricity force due to the absence of voltage applied to the opposing electrode 1a side, reducing the torque value for the paper feeding means 11.

Also, an eighth recording head can be structured wherein the abovestated recording head for the first to seventh structures is made in a line form corresponding to a printing width on a medium to be recorded 10. Also, a eighth structure of a recording unit using this eighth structure of the recording head can be structured.

(Example 10)

Fig. 13 is an explanatory diagram showing one example of the ninth structure of the recording unit using the ninth structure of the recording head of the present invention. In Fig. 13, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and the opposing electrode la, the irradiation of light using light irradiating means 5, from the direction of the arrow 7, from the transparent electrode 2a side to the photoconductive layer 4 causes the reduction in resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 4, and the ink 6 receives Coulomb's force to fly in the direction of the arrow 13 toward an projectingly rising portion of the opposing electrode la. By inserting a medium to be recorded 10 between the opposing electrode la and the accelerating means 14 from the paper feeding means 11, the flying ink 12 moves to the medium to be recorded 10 and infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded 10. At this time, size of the dot transferred to the medium to be recorded 10 is determined by the distance between the medium to be recorded 10 and the recording unit and also the voltage value applied between the transparent electrode 2a and the opposing electrode la and the amount of flying ink 12. The amount of flying ink 12 is determined by the optical energy amount given to the photoconductive layer 4 from the light irradiating means 5.

In the present example, the shape of the opposing electrode la is in the line form corresponding to the medium to be recorded 10 and of the shape of projectingly rising at the ink-adhesion portion, but is not limited to this, and there can be considered of shapes shown in Fig. 14. In Fig. 14, (a) - (d) are adapted such that electric field is readily collected at a portion of a rising shape in the opposite electrode la, while (e) - (h) are made of a conductive metal only at a hatched portion, having an effect of collecting electric field with higher efficiency. Accordingly, by altering the shape of the opposing electrode 1a as in Fig. 14, electric field becomes easy to be collected at an ink flying portion between the head and

the opposing electrode 1a, resulting in stabilization in ink flying direction.

(Example 11)

Fig. 15 is an explanatory diagram showing one example of the tenth structure of the recording unit using the tenth structure of the recording head of the present invention. In Fig. 15, in a state that voltage is applied using power supply 3 to between the transparent electrode 2a and the opposing electrode la, the irradiation of light using light irradiating means 5, from the direction of the arrow 15, from the transparent electrode 2a side through a record sheet 16 to the photoconductive layer 4 causes the reduction in resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer and the transparent electrode, to charge electric charges to the inside of the ink 6 on the photoconductive layer 4, and the ink 6 receives Coulomb's force to fly in the direction of the arrow 13 toward the opposing electrode la side. By inserting a medium to be recorded 10 between the opposing electrode la and the ink 6 from the paper feeding means 11, the flying ink 12 moves to the medium to be recorded 10 and infiltrated and adhered thereto, resulting in obtaining desired printed characters or images on the medium to be recorded 10. At this time, size of the dot transferred to the medium to be recorded 10 is determined by the distance between the medium to be recorded 10 and the recording unit and also the voltage value applied to between the transparent electrode 2a and the opposing electrode la and the amount of flying ink 12. As for the flying ink 12 amount, it is determined by the amount of optical energy given to the photoconductive layer 4 from the light irradiating means 5. As for the distance between the medium to be recorded 10 and the ink 6, if too short, there is difficulty in inserting method for the medium to be recorded 10 and the medium to be recorded 10 contacts with the recording head due to rumples of the medium, while, if too long, the flying ink 12 will drop due to gravity, making difficult to form desired image pixels.

Therefore, it is preferred that the distance between the medium to be recorded 10 and the ink 6 in the present example is about 0.2 to 1 mm, and it is proper that the desired distance is about 0.5 mm.

As for a recording sheet 16 of the present example, an transparent sheet of an OHP or the like can be used, which is a recorded matter having negative image information written on a transparent sheet. It is also possible for a record sheet 16 to use a recorded matter having desired image pixels written by the light irradiating means 5. As a means for irradiating the entire surface of the record sheet 16 of the present example, a halogen lamp, etc. capable of entire-surface exposure can be used.

Owing to the preset example, by irradiating light to the photoconductive layer 4 through the record sheet 16, printing speed is greatly improved to implement high-speed printing. Also the use of the record sheet 16 enables continuous printing with repeatedly using a negative image, performing high-speed printing.

(Example 12)

Fig. 16 is an explanatory diagram of one example of the eleventh structure of the recording unit of the present invention. The recording unit of the present invention shown in Fig. 16 is structured by vertically superposing four line-form recording heads corresponding to a printing width of a medium to be printed 10, wherein the individual recording heads are supplied with ink 6, from the top, of yellow (y), magenta (M), cyan (c), and black (Bk). Hereinafter, these individual recording heads are referred to as a yellow-ink recording head, a magenta-ink recording head, a cyan-ink recording head, and a black-ink recording head. As a recording procedure, in a state that voltage is applied using power supply 3 to between the individual transparent electrodes 2a and the opposing electrode la, the irradiation of light by the light irradiating means 5, from the direction of the arrow 7, from the side of the transparent electrode 2a of the yellow-ink recording head to the photoconductive layer 4 causes the reduction in resistance value for an irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the yellow ink on the photoconductive layer 4, and the ink 6 receives Coulomb's force to fly toward the opposing electrode la side. The flown yellow ink moves to the medium to be recorded 10 on the opposing electrode la to be infiltrated and adhered thereto, resulting in obtaining desired image pixels of yellow ink by one line on the medium to be recorded 10. Then, the yellow-ink recording head is driven in the direction of the arrow 17, to obtain desired image pixels of magenta ink by one line on the medium to be recorded 10 by the recording procedure with the magenta-ink recording procedure. Then, the magenta-ink recording head is driven in the direction of the arrow 17, to obtain desired image pixels of cyan ink by one line on the medium to be recorded 10 by the recording procedure with the cyan-ink recording head. Then, the cyan-ink recording head is driven in the direction of the arrow 17, to obtained desired image pixels of black ink by one line on the medium to be recorded 10 by the recording procedure with the black-ink recording head. Thereafter, the medium to be recorded 10 is driven in the direction of the arrow 19 by one line by means of a paper feeding means, not shown, and four recording heads are driven in the direction of the arrow 18 back to the home position. The above process is repeated to obtain desired

color image pixels for each image on the medium to be recorded 10.

In the present example, although the ink 6 configuration is of four kinds, full-color of high-precision output printed characters or images with limitless printing colors are to be obtained by increasing the number of recording heads and supplying multi-colors of ink 6 individually.

Furthermore, in the present example, although explanation was made on the method that the recording heads of the present invention are driven each time each color of Y, M, C, and Bk is transferred to the medium to be recorded 10, it is needless to say that it is possible, by providing a structure of simultaneously accessing each of pixel information Y, M, C, and Bk, to simultaneously irradiate recording pixel information of each color of Y, M, C, and Bk onto the photoconductive layer 4.

(Example 13)

Fig. 17 is an explanatory diagram of one example of the twelfth structure of the recording unit using the eleventh structure of the recording head of the present invention. In Fig. 17, the recording head is structured by four-division, and four-divided transparent electrodes 2a has a photoconductive layer 4 formed thereon, wherein yellow (y), magenta (M), cyan (c), and black (Bk) of ink 6, are supplied onto the photoconductive layer 4 respectively as shown in Fig. 17. Hereinafter, these are referred to as a yellow-ink recording region, a magenta-ink recording region, a cyan-ink recording region, and a black-ink recording region. As a recording procedure, in a state that a voltage is applied using power supply 3 to between the transparent electrodes 2a and the opposing electrode la, the irradiation of light by the light irradiating means 5, from the direction of the arrow 7, from the side of the transparent electrode 2a of the yellow-ink recording region to the photoconductive layer 4 causes the reduction in resistance value for the irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the yellow ink on the photoconductive layer 4, and the yellow ink receives Coulomb's force to fly toward the opposing electrode la side. The yellow ink moves to the medium to be recorded 10 on the opposing electrode la to be infiltrated and adhered thereto, resulting in obtaining desired image pixels in yellow ink are obtained on the medium to be recorded 10. Then, the recording head is driven in the direction of the arrow 20b from the yellow ink recording region, to obtain desired image pixels of magenta ink on the medium to be recorded 10 by the recording procedure in a magenta-ink recording region. Then, the recording head is driven in the direction of the arrow 21a and the direction of the arrow 20a from the magenta-ink recording region, to obtain desired image pixels of cyan ink on the medium to be recorded 10 by the recording procedure in a cyan-ink recording region. Then, the recording head is driven in the direction of the arrow 20b from the cyan-ink recording region, to obtained desired image pixels of black ink on the medium to be recorded 10 by the recording procedure in a black-ink recording region. Thereafter, the recording head is driven in the direction of the arrow 20a and the above process is repeated, resulting in obtaining desired color image pixels in one-line region on the medium to be recorded 10.

Thereafter, the medium to be recorded is driven by one line in the direction of the arrow 21b by the paper feeding means 11, and further the recording head is driven in the direction of the arrow 21b to be returned to the home position where the above process is repeated, thereby obtaining desired color image pixels by one image on the medium to be recorded 10.

In the present example, although the ink 6 configuration is of four kinds, full-color of high-precision output printed characters or an image is to be obtained by increasing the number of division of the above recording head and supplying multi-colors of ink 6 individually. Also it is needless to say that, where a type using a slit plate 8 is employed as the record head of the present invention, the slit plate 8 is in a state of four-division. Furthermore, according to the example of the present invention, the recording head of the present invention in serial form enables full-color printing of characters, making possible the size compact.

(Example 14)

Fig. 18 is an explanatory diagram wherein transfer is made onto the medium to be recorded with using the one example shown in the thirteenth structure of the recording unit of the present invention. In Fig. 18, in a state that a voltage is applied using power supply 3 to between a switching means 22 connected to the opposing electrode la and the transparent electrodes 2a, and in a state that the switch of the switching means 22 on this side relative to the arrow 23 direction is turned ON, the irradiation of light by the light irradiating means 5, from the direction of the arrow 7, from the side of the transparent electrode 2a to the photoconductive layer 4 causes the reduction in resistance value for an irradiated region of the photoconductive layer 4, giving flow of photoelectric current in the irradiated region. As a result, a conducting state is brought between the ink 6 contacting with the irradiated region of the photoconductive layer 4 and the transparent electrode 2a, to charge electric charges to the inside of the ink 6 on the photoconductive layer 4, and the ink receives Coulomb's force to fly toward the opposing electrode la whose switch of the switching means is in the ON state. The ink 12 moves to the medium to be recorded 10 on the opposing electrode la to be infiltrated and adhered thereto, resulting

in obtaining desired printed characters or images on the medium to be recorded 10. Thereafter, the switch of the switching means 22 is sequentially turned ON in the direction of the arrow 23 and the switch of the switching means 22 on this side relative to the recording direction is turned OFF in synchronism with irradiation of light from the direction of the arrow 7 onto the photoconductive layer 4 by the light irradiating means 5, resulting in desired image pixels by one line region on the medium to be recorded 10.

In the present example, although the switching of the opposing electrode la is done by using the switching means 22, it is also possible to drive the opposing electrode la in synchronism with the light irradiating means 5. Also, the use of the switching means 22 of the present example can reduce power consumption for ink 6 flying.

(Example 15)

Fig. 19 is an explanatory diagram of one example of the first structure of the recording apparatus using the recording unit described in the first to thirteen examples of the present invention. In Fig. 19, the recording apparatus 30 inputs from an external apparatus 28 an image data, which performs image correction treatment and pattern recognition in an image correcting circuit 25 to convert the data by pixel for outputting an image pixel data 31. The image pixel data 31 is transferred to the inside of a recording unit 24 in synchronism with a triggering signal 36 from a controller 26, and a flying ink 32 corresponding to the image pixel data 31 is adhered and transferred to a medium to be recorded 10. At this time, by outputting a control signal 33 from the controller 26 to a paper feeding means 11, synchronization is made for the flying ink 32 and the medium to be recorded 10. Also, the voltage value 34 within the recording unit 24 is set from the controller to the power supply unit 27, and a voltage 35 is supplied from the power supply unit 24 to the recording unit 24. Furthermore, the output of a light control signal 37 for light-source irradiating light intensity and irradiating pulse width within the recording unit 24 is controlled by the controller 26, controlling dots to be formed on the medium to be recorded 10. By carrying out the above process, the recording unit 24 of the present invention as the recording apparatus 30 can perform high-precision high-quality printing at high speed, provide output printed characters in a manner of non-contact and free from selecting record medium shapes.

In the descriptions given hereinbefore, various combinations were not referred to in order to avoid troublesomeness. However, it is needless to say that a structure of a recording head, in a recording unit using a plurality of recording heads, may appropriately adopt various recording heads of the present invention. The same is also true for a structure having an accelerating means, a structure having an opposing electrode with a projection shape, a structure of irradiating the entire surface of a photoconductive layer, and other structures or recording apparatuses.

This invention is structured, as the structure of the recording head as explained hereinbefore, by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode, in this order; the means for supplying the ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to a desired image pixel to the potoconductive layer, thereby providing the following effects.

(1) Since light is irradiated from the light irradiating means, the recording process is in non-contact and treatment is at high speed.
(2) By controlling optical energy of the light irradiating means to charge electric charges to the inside of ink, the ink flying speed can become high and varied by medium to be recorded.

Next, the structure of the recording head is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, a means for supplying ink onto the photoconductive layer, and slit plate provided with a slit for controlling ejection of ink, and an opposing electrode, in this order; the means for supplying the ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to a desired image pixel to the potoconductive layer, thereby providing the following effects.
(3) There is no necessity of nozzles per image pixel within the recording head, and a slit structure by a slit plate makes possible increase of resolving power, reduction of cost, and further cleaning after ink ejection.
(4) The provision of the slit plate controls the direction of ink flying, and further the control on ink meniscus curves enhances the efficiency of collecting ink, reducing energy for ink flying.

Next, as the structure of the recording head is structured wherein the cross section of the slit provided in the slit plate is cut in a taper form, providing the following effects.
(5) By varying the cut shape of the slit cross section, the ink is prevented from flowing out of the slit plate.
(6) The energy for ink flying can be reduced by the

enhancement in efficiency of collecting electric charges to be charged to the ink.

Next, as the structure of the recording head is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode, in this order; the means for supplying the ink and the opposing electrode being arranged to have a gap sufficient for inserting a medium to be recorded therethrough; having a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying in pulsing manner light corresponding to a desired image pixel to the potoconductive layer, thereby providing the following effects.

(7) The resolving power enhancement and cost reduction is feasible, by providing a wall as a projection in the photoconductive layer to give a function of the slit plate for controlling the amount of ink ejection.

Next, the structure of the recording head is structured by integrating the substrate and the transparent electrode formed on the substrate, providing the following effect.

(8) The recording head section becomes possible to be formed with the substrate and the transparent electrode and photoconductive layer rendered in a stacked state, making possible compacting.

Next, as the structure of the recording head, the opposing electrode and the head section is structured by integral formation.

(9) The opposing electrode and the head section are integrated and ink flying is possible only by the head section, making the apparatus structure compact.

Next, as the structure of the recording head, the ink accelerating means for accelerating the flown ink is provided in the recording head, providing the following effects.

(10) The flying ink speed is sped up by the accelerating means, enabling high-quality and high-speed printing.

(11) Ink flying is also possible only by the head section and the accelerating means, making the apparatus structure compact.

(12) The absence of applying voltage to the opposing electrode side eliminates the phenomenon of poor delivery of the medium to be recorded, reducing the torque value for the paper feeding means.

Next, as the structure of the recording head, the formation in a line form corresponding to the printing width on the medium to be recorded, providing the following effects.

(13) The structure of vertical stacking of the recording heads makes possible the use of a plurality recording units, that is, there is no limitation in printing color and high-precision output printing can be obtained in full colors.

(14) The structure of the recording head in the line form enables the printable range corresponding to a manuscript character width of a medium to be recorded, enabling largely shortening in recording speed and high-speed printing.

Next, as the structure of the recording head, the opposing electrode is structured in a line form corresponding to a medium to be recorded and the ink-adhesion portion is raised in a projection form, providing the following effect.

(15) The shape of the opposing electrode is in rising in a projection form at the ink-adhesion portion facilitates collection in electric field for the head section and the opposing electrode, stabilizing the ink flying direction.

Next, as the structure of the recording head, the light irradiating means is structured to have a record sheet recorded with negative image information on a transparent sheet, providing the following effects.

(16) As the light irradiating means, the entire-surface irradiation to the photoconductive layer through the record sheet greatly shorten the printing speed, performing high-speed printing.

(17) The repeated use of the record sheet as a negative image makes possible continuos printing, performing high-speed printing.

Next, as the structure of the recording head, the formation in a serial shape provides the following effects.

(18) The increase of the number of division for the recording head to supply multicolor inks to the divided parts of the recording head makes possible obtaining of full-color and high-precision output printing.

(19) The serial shape structure of the recording head makes possible the recording head structure compact.

Next, the structure of the recording apparatus is structured by: having a head section formed by a transparent electrode formed on a substrate, a photoconductive layer formed on the transparent electrode, and a means for supplying ink onto the photoconductive layer, and an opposing electrode having an ink-droplet accelerating means and formed integral with or almost integral with the head section, in this order; having at least a power supply for applying voltage to between the transparent electrode and the opposing electrode, and a light irradiating means for supplying light corresponding to a desired image pixel to the potoconductive layer, providing the following effects.

(20) It is possible to handle as nearly an on-demand type, because the ink supply amount can be controlled by the photoconductive layer while keeping high speed of the continuous type.

(21) It is possible to enhance, as compared with the ink-jet method, the resolving power at a level of electronic photography because the resolving power can be restricted by controlling the spot diameter of the light supplying means.
(22) The structure of the apparatus is simple and low in cost, as compared with the electronic photography method.

The aforegoing description has been given by way of example only and it will be appreciated by a person skilled in the art that modifications can be made without departing from the scope of the present invention.

Claims

1. A recording head for an ink jet recording apparatus characterised by:

   a head section comprising a transparent electrode (2a), a photoconductive layer (4) formed on the transparent electrode, and a means for supplying ink (6) onto the photoconductive layer;
   an opposing electrode (1a) with a gap between said ink layer and the opposing electrode sufficient for inserting a medium to be recorded therethrough; means for applying a voltage to between said transparent electrode and said opposing electrode, and a light irradiating means for supplying light corresponding to a desired image pixel or pixel array to said photoconductive layer.

2. A recording head according to claim 1, characterised by a slit plate (8) provided with a slit for controlling ejection of ink from said ink layer.

3. A recording head according to claim 2, characterised in that the cross section of the slit provided in said slit plate has a tapering shape.

4. A recording head according to any preceding claim, wherein the ink supplying means is arranged to supply a layer of ink over said photoconductive layer.

5. A recording head according to claim 1, wherein said photoconductive layer has a projection for controlling ejection of ink on said transparent electrode.

6. A recording head according to any preceding claim, wherein said transparent electrode is formed integrally with a substrate.

7. A recording head according to any preceding claim, characterised in that said opposing electrode and said head section are integrally formed.

8. A recording head according to any preceding claim, including a paper feeding means (11) for supplying a medium (10) to be recorded between ink disposed on said photoconductive layer and said opposing electrode, or between said slit plate and said opposing electrode, or between the projection formed on said photoconductive layer and said opposing electrode.

9. A recording head according to any preceding claim, including an accelerating means (14) for accelerating said ink between said ink supplying means and said opposing electrode, said slit plate and said opposing electrode, or the projection formed on said photoconductive layer and said opposing electrode.

10. A recording head according to any preceding claim, wherein said recording head is arranged to print the width of a print line on said medium to be recorded.

11. A recording head according to claim 10, wherein said opposing electrode has a projecting portion shaped as a line form.

12. A recording head according to any preceding claim, wherein said light irradiating means has a record sheet having negative image information recorded thereon.

13. A recording unit employing a plurality of recording heads according to any preceding claim, wherein each recording head has a different-colour ink supplying means to adhere and infiltrate colour image pixels onto said medium to be recorded.

14. A recording apparatus, adapted to control ink adherence adapted to control ink adherence to a medium to be recorded depending on a recording signal to record image pixels on the medium to be recorded, characterised by being provided with a recording head or heads according to any preceding claim.

FIG. 1

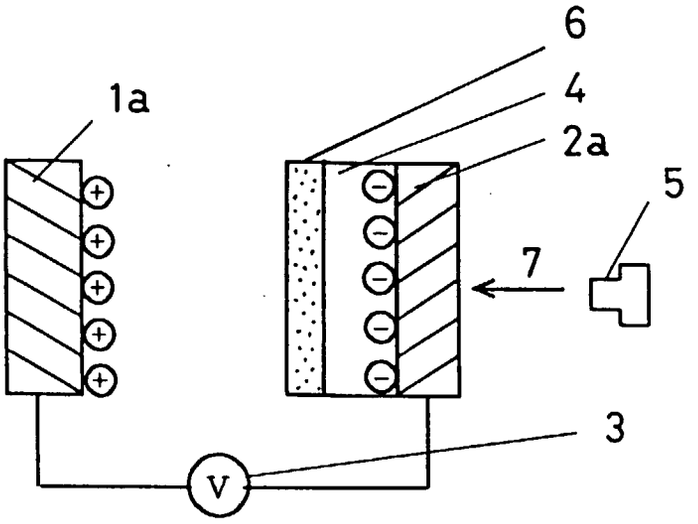


FIG. 2

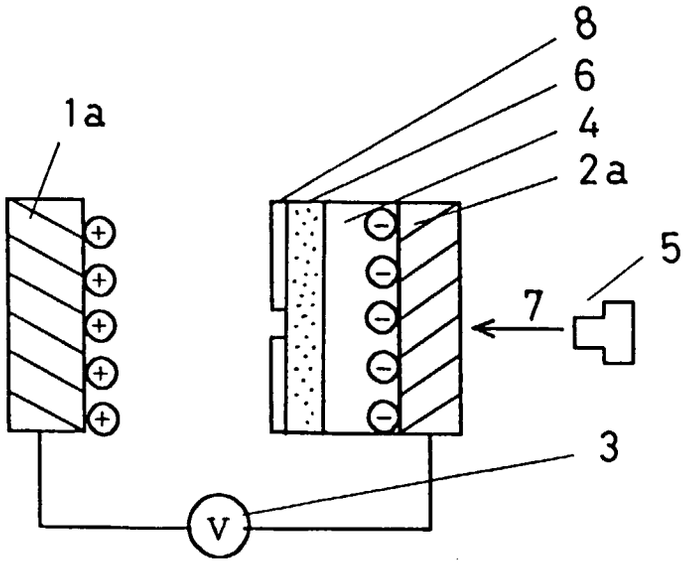


FIG. 3

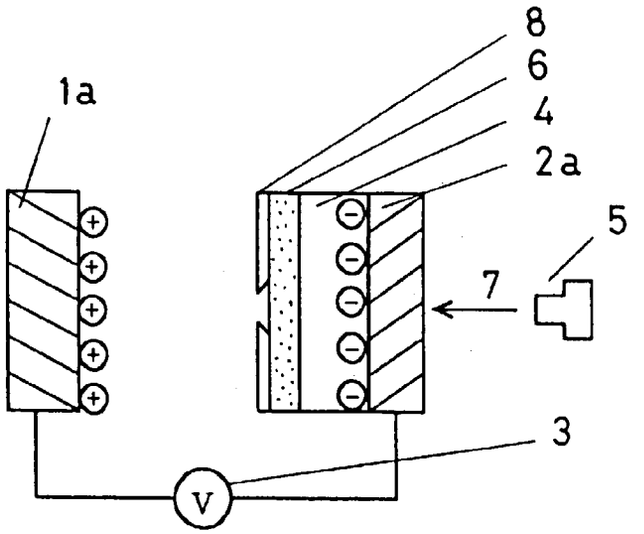


FIG. 4

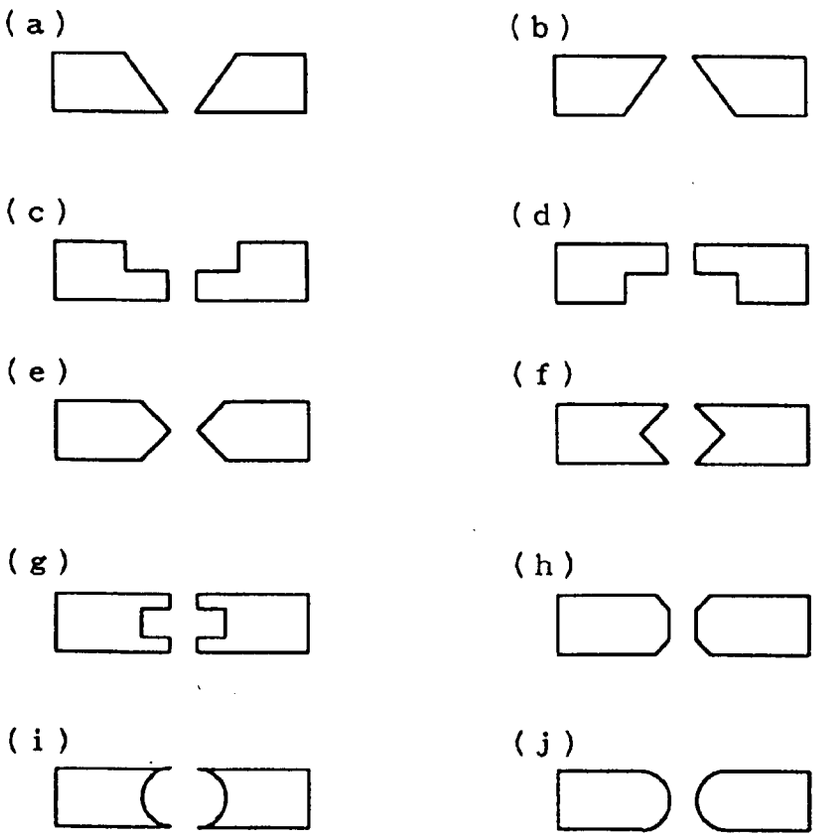


FIG. 5

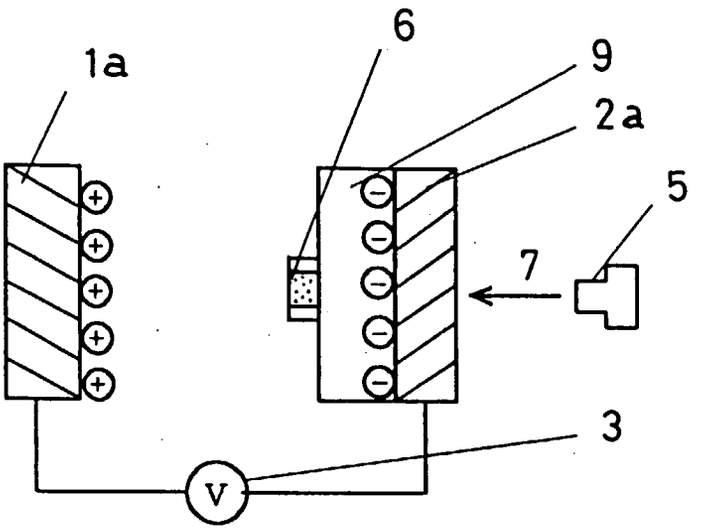


FIG. 6

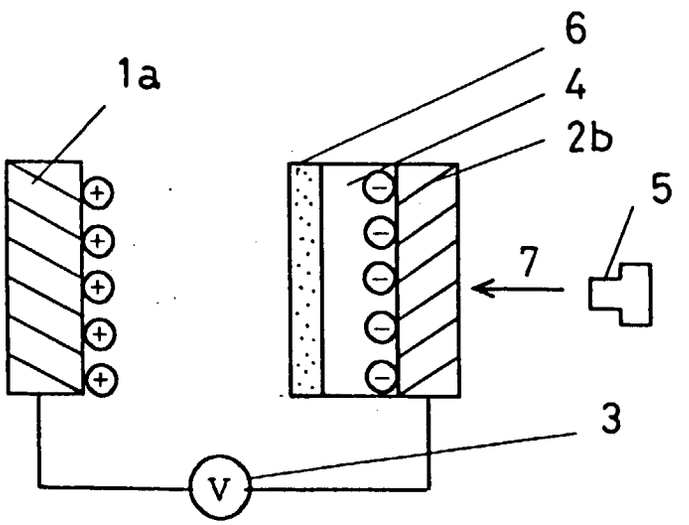


FIG. 7

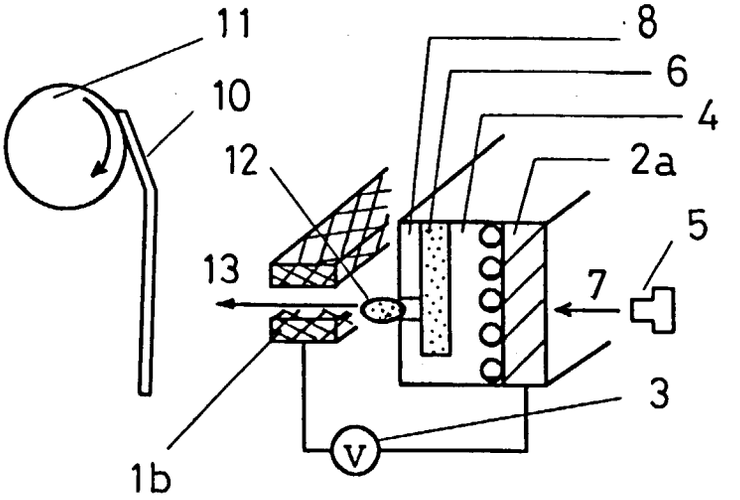


FIG. 8

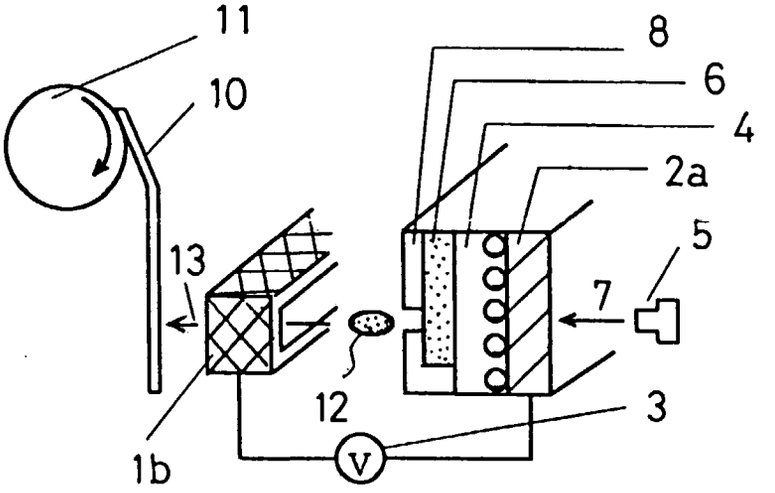


FIG. 9

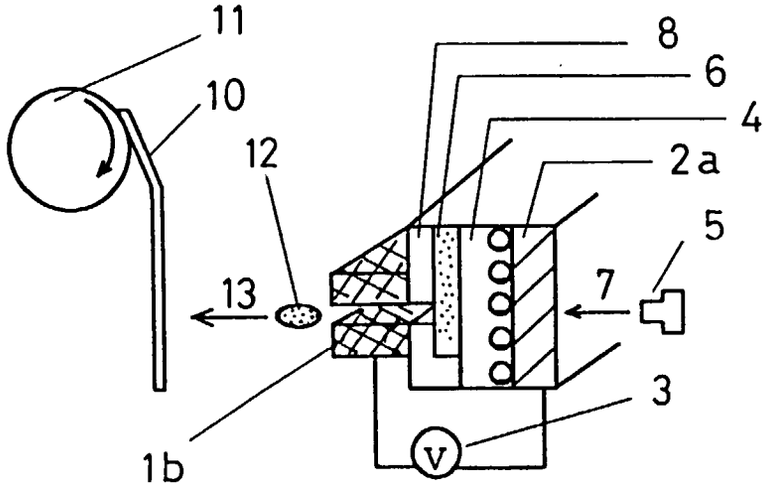


FIG. 10

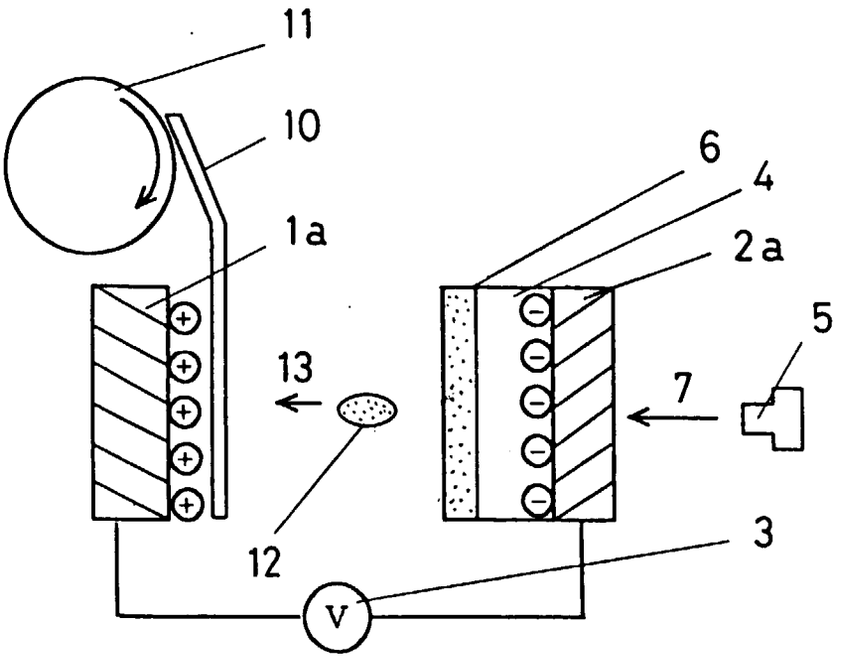


FIG. 11

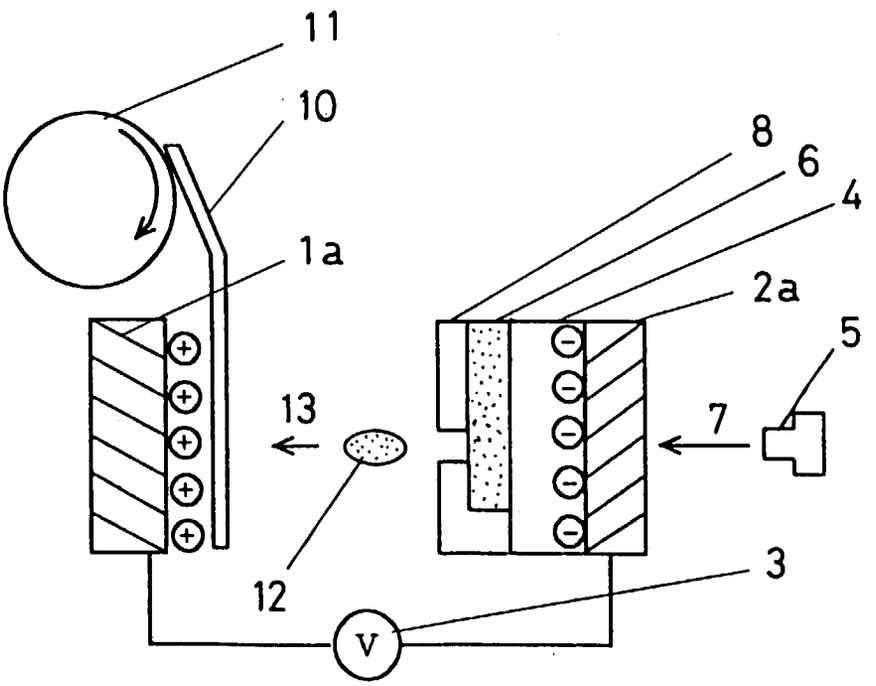


FIG. 12

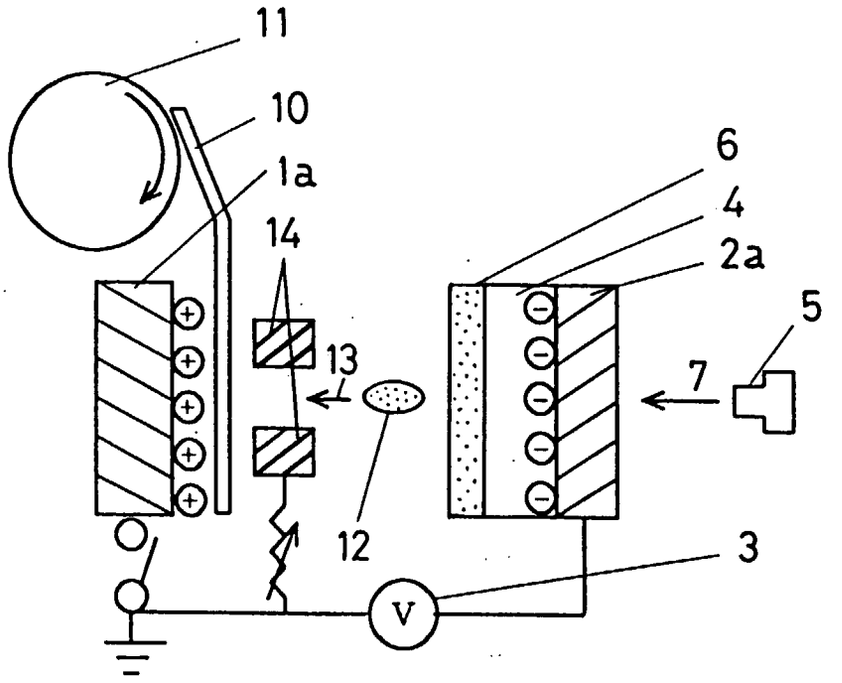


FIG. 13

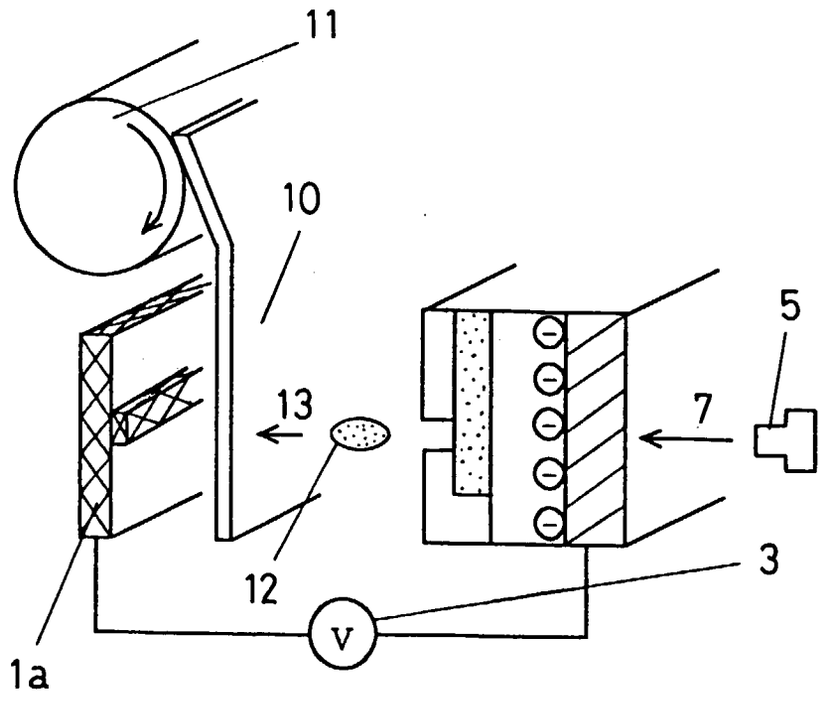


FIG. 14

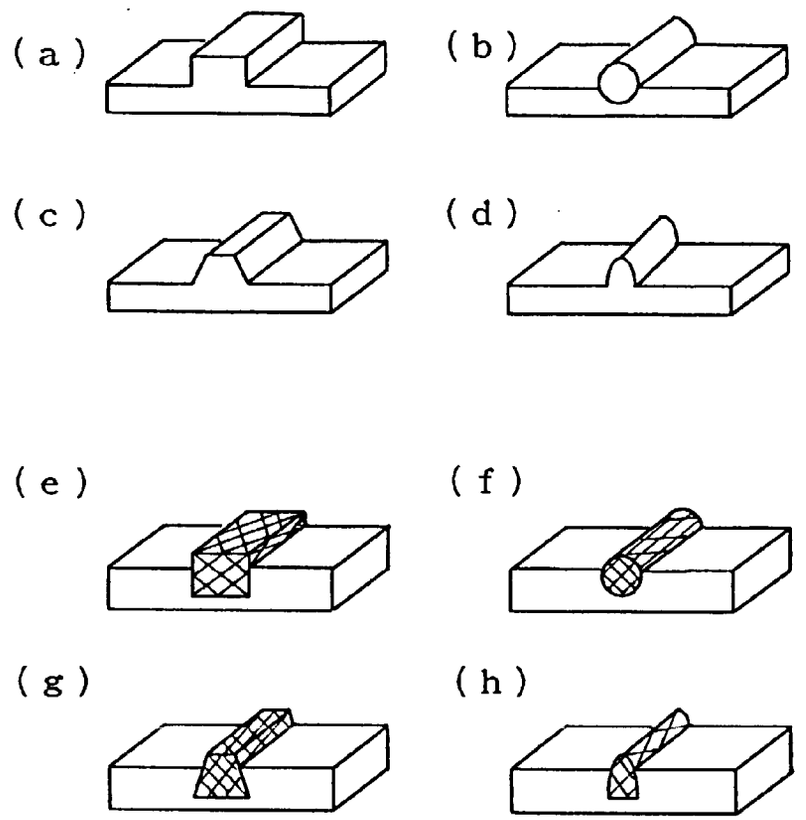


FIG. 15

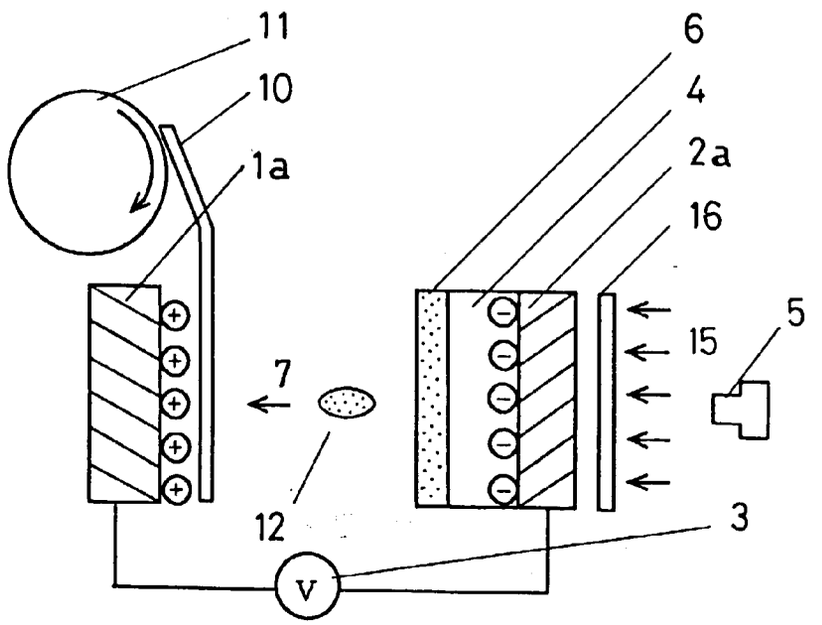


FIG. 16

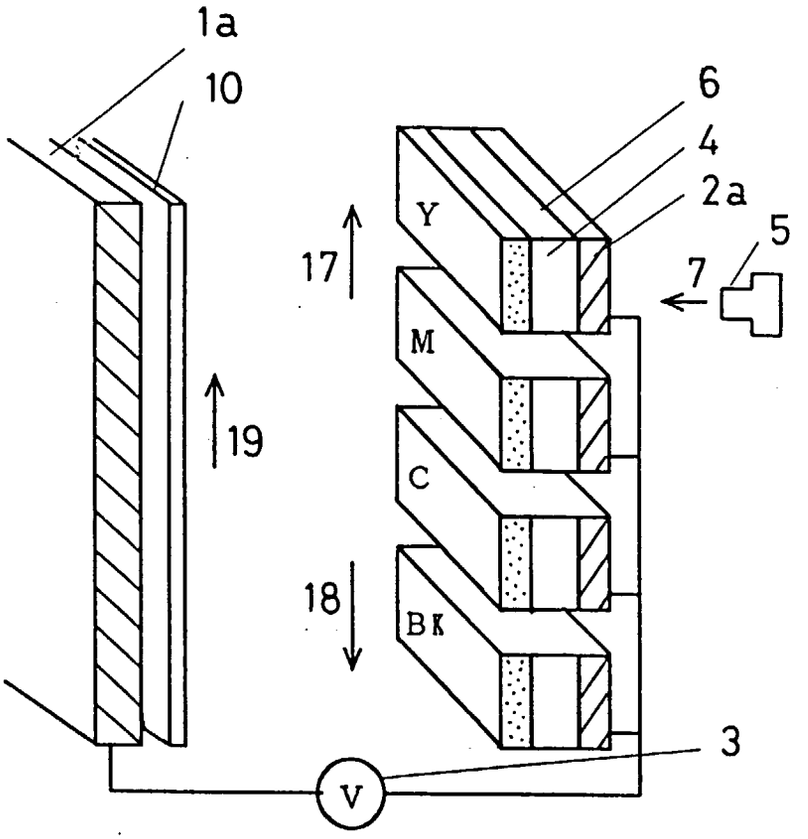

1a
10
6
4
2a
Y
17
5
7
M
19
C
18
BK
3
V

FIG. 17

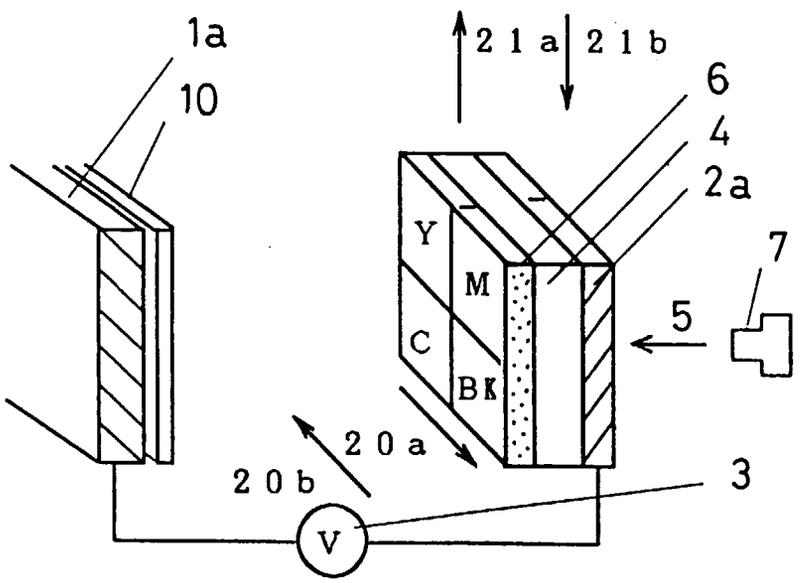

1a
10
21a
21b
6
4
2a
Y
M
7
C
5
BK
20a
20b
3
V

FIG. 18

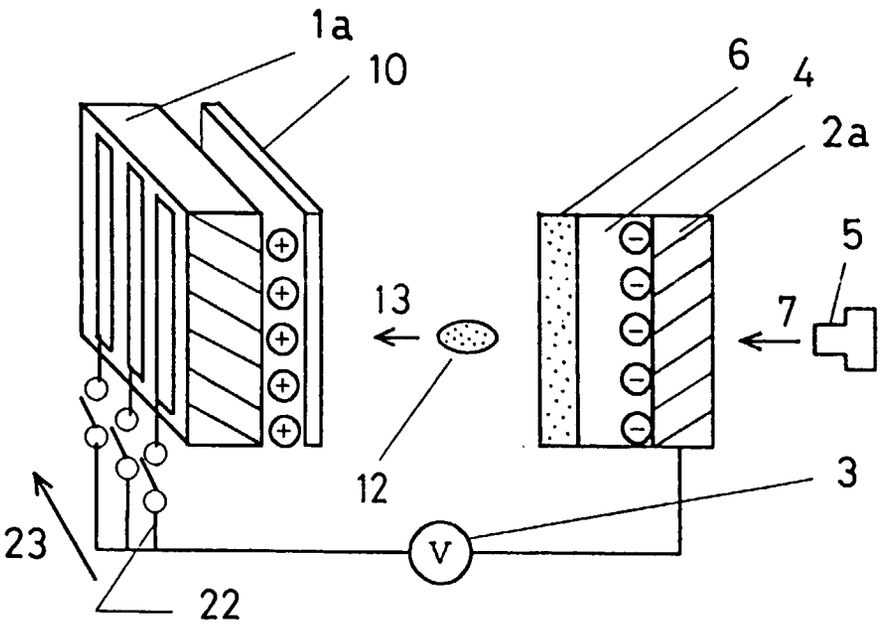


FIG. 19

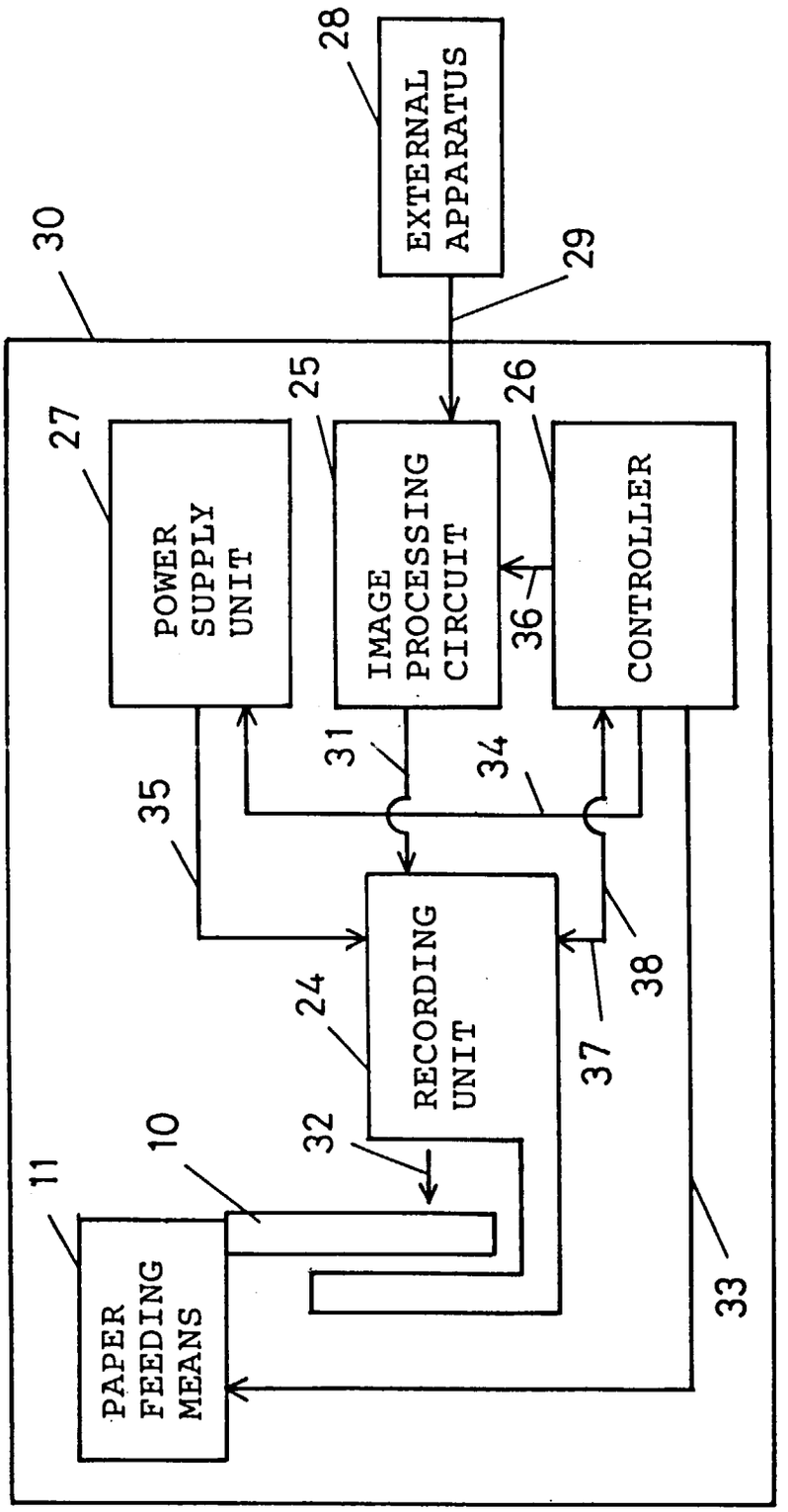

28
EXTERNAL APPARATUS
29
30
25
26
27
POWER SUPPLY UNIT
IMAGE PROCESSING CIRCUIT
CONTROLLER
36
31
34
35
RECORDING UNIT
24
38
37
32
10
11
PAPER FEEDING MEANS
33

FIG. 20
PRIOR ART