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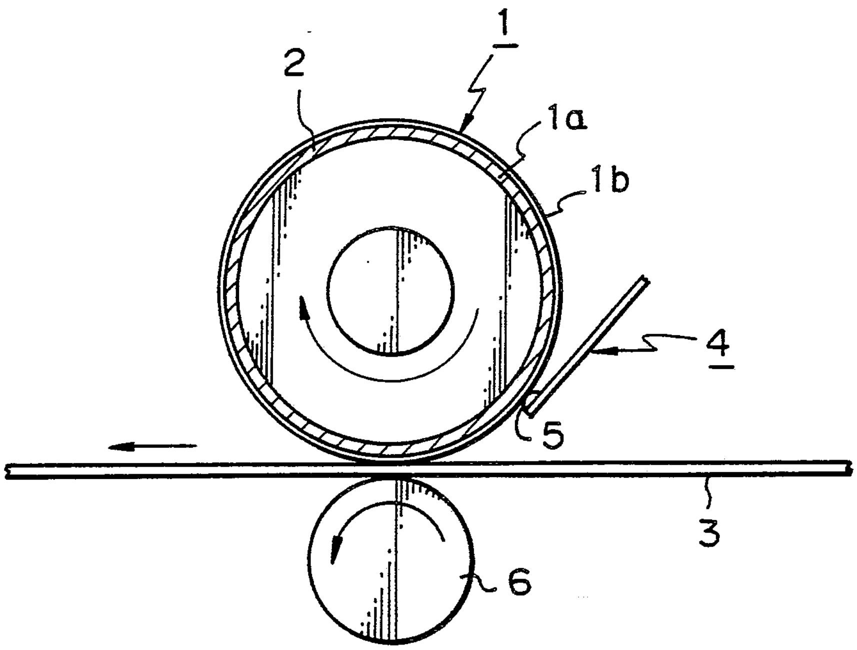
(54) Method of and apparatus for recording.

(57) Disclosed is a method of recording images on a recording medium (3), comprising the steps of: heating a recording member (1) having ink (2) for effecting recording of an image on the recording medium (3) and a porous material allowing the ink to permeate therethrough in response to an image signal; conveying the recording medium to the recording member after heating; and transferring the ink onto the recording medium via the porous material. Also disclosed is an apparatus for recording images on a recording medium, comprising: a recording member (1) having ink (2) for effecting recording of an image on the recording medium (3); a heater (5) for heating the recording member in response to an image signal; and a conveyor for conveying the recording medium in such a manner as to bring the recording medium into contact with the recording member which has been heated by the heater.

EP 0 254 420 A1

Fig. 2



Method of and Apparatus for Recording

BACKGROUND OF THE INVENTION:

Field of the Invention

The present invention relates to a method of and apparatus for recording images (e.g., characters, numerals, codes, and graphic figures) on a recording medium. More particularly, the present invention relates to a method of and apparatus for recording which may be suitably used for such apparatus as image processors, electronic typewriters, copying machines, printers, facsimile equipment, and various types of notice board.

Description of the Related Art

Nowadays, the thermal transfer recording method has become the main type of recording method employed in information processing. In this recording method, using an ink film formed by applying a heat fusible ink on a substrate, the ink film is heated into the pattern of an image by a recording head, and the molten ink is transferred onto a recording sheet. This method is characterized by the fact that the apparatus used can be made compact and lightweight and that recording can be effected on plain paper.

With the above-described thermal transfer recording method, however, there are certain drawbacks in that, since an ink film used one must then be disposed of, the running costs become high, and in that the disposal of ink films is troublesome.

SUMMARY OF THE INVENTION:

Accordingly, a primary object of the present invention is to provide a method of and an apparatus for recording which are capable of effecting the recording of an image on a recording medium without using a so-called ink film.

Another object of the present invention is to provide a method of and an apparatus for recording which afford low running costs.

Still another object of the present invention is to provide a method of and an apparatus for recording which allow a clear recorded image to be obtained.

A further object of the present invention is to provide a method of and an apparatus for recording which allow continuous recording (i.e., recording on a plurality of sheets) to be effected.

To this end, according to one aspect of the present invention, there is provided a method of recording images on a recording medium, comprising the steps of: heating a recording medium having ink for effecting recording of an image on the recording medium and a porous material allowing the ink to permeate therethrough in response to an image signal; conveying the recording medium to the recording member after heating; and transferring the ink onto the recording medium via the porous material.

According to another aspect of the present invention, there is provided an apparatus for recording images on a recording medium, comprising: a recording member having ink for effecting recording of an image on the recording medium; heating means for heating the recording member in response to an image signal; and conveying means for conveying the recording medium in such a manner as to bring the recording medium into contact with the recording member which has been heated by the heating means.

According to still another aspect of the present invention, there is provided an apparatus for recording images on a recording medium, comprising: ink for effecting recording images on the recording medium; a recording medium having a plurality of porous materials allowing the ink to permeate therethrough, the pore diameter of the porous material constituting the surface layer of the recording member among the plurality of recording materials being identical with or smaller than the pore diameter of the porous material constituting the inner layer of the recording member; heating means for heating the recording member in response to an image signal, and conveying means for conveying the recording medium in such a manner as to bring the recording medium into contact with the recording member which has been heated by the heating means.

BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. I is a perspective view of a recording apparatus to which the present invention is applied;

Fig. 2 is a schematic cross-sectional view of the apparatus;

Fig. 3 is a schematic cross-sectional view of another embodiment;

Fig. 4 is a perspective view of a recording apparatus in accordance with an embodiment of the present invention;

Fig. 5 is an explanatory cross-sectional view;

Fig. 6 is an explanatory top plan view of a recording head;

Fig. 7 is an explanatory cross-sectional view of the recording head;

Fig. 8 is an explanatory enlarged view illustrating pressure-contacting portions of a recording member and a pressure-contacting member;

Fig. 9 is a block diagram illustrating a control circuit;

Fig. 10 is a flowchart of a recording operation;

Fig. 11 is a diagram illustrating an embodiment for positioning heat generating elements at pressure contacting portions;

Fig. 12 is a diagram illustrating an embodiment in which a recording head having ink permeating holes is used;

Figs. 13, 14 and 15 are diagrams illustrating an embodiment in which the recording head is constituted by a rigid member;

Fig. 16 is a diagram of an embodiment which is arranged such that a pressure-contacting member is rotatively driven;

Fig. 17 is a diagram illustrating an embodiment in which the pressure-contacting member does not rotate;

Fig. 18 is a diagram illustrating an embodiment which is not provided with a pressure-contacting member;

Fig. 19 is a diagram illustrating an embodiment in which a roll of paper is used as a recording medium;

Fig. 20 is a side elevational view of a recording apparatus provided with a dispersing means;

Fig. 21 is a diagram illustrating a state in which ink in a recording member is dispersed by heat suppled by a heating roller;

Fig. 22 is a diagram of an embodiment which is not provided with a pressure-contacting member;

Figs. 23 and 24 are diagrams illustrating other examples of the dispersing means;

Fig. 25 is a perspective view of a recording apparatus provided with an ink replenishing means;

Fig. 26 is a side elevational view thereof;

Fig. 27 is a diagram illustrating an embodiment which is not provided with a pressure-contacting member;

Figs. 28 and 29 are diagrams illustrating other examples of the ink-replenishing means;

Fig. 30 is a diagram illustrating an embodiment which is provided with a cooling means;

Fig. 31 is a side elevational view of a recording apparatus in which the recording member has a single-layer structure;

Fig. 32 is a perspective view of a recording apparatus to which a still further embodiment is applied;

Fig. 33 is a side cross-sectional view thereof;

Fig. 34 is a perspective view of a blade member;

Fig. 35 is a perspective view of a recording apparatus to which a yet further embodiment is applied;

Fig. 36 is a cross-sectional view of a porous material constituting the recording member;

Fig. 37 is a schematic cross-sectional view of a recording member which is employed in yet another embodiment of the present invention;

Fig. 38 is a side elevational view of a recording apparatus thereof;

Fig. 39 is a perspective view of a further embodiment;

Fig. 40 is a side elevational view thereof;

Fig. 41 is a perspective view of a further embodiment;

Fig. 42 is a side elevational view thereof;

Fig. 43 is a perspective view of a further embodiment;

Fig. 44 is a side elevational view thereof;

Figs. 45, 46, and 47 are side elevational views of recording apparatus each provided with a cleaner;

Fig. 48 is a side cross-sectional view of a further embodiment;

Fig. 49 is a perspective view of a further embodiment;

Fig. 50 is a side cross-sectional view thereof;

Fig. 51 is a side cross-sectional view of a further embodiment;

Figs. 52 and 53 are side elevational views of further embodiments;

Figs. 54, 55, and 56 are side elevational views of further embodiments; and

Figs. 57 to 61 are side cross-sectional views of other embodiments.

DETAILED DESCRIPTION OF THE INVENTION:

Referring now to the accompanying drawings, detailed description will be given of embodiments to which the present invention is applied.

An embodiment which will be described below relates to an apparatus for and a method of recording comprising: a recording member having a first porous layer impregnated with a heat fusible ink and a second porous layer disposed on the first porous layer; and a means for applying heat to the surface of the recording member in a pattern. According to this embodiment, since the arrangement is such that a recording member having a first porous layer impregnated with a heat fusible ink and a second porous layer disposed on the first porous layer as well as a means for applying heat to the surface of the recording member are provided, there is no need to employ an ink film. Hence, it is possible to eliminate such troublesome tasks as disposal of used ink films as well as the high running costs that result from the use of disposable ink films.

Referring to the accompanying drawings, detailed description will now be given of this embodiment.

Fig. I is a schematic diagram of a recording apparatus in accordance with the present invention, while Fig. 2 is an explanatory cross-sectional view of the recording apparatus. In the drawings, a recording member I is formed in a cylindrical shape, and is arranged such that a porous membrane layer Ib is laminated on the outer surface of a porous base Ia formed of various types of alloy fiber including stainless steel in mesh. This porous membrane layer Ib is constituted by porous ethylene tetrafluoride resin (e.g., "Fluoropore" (brandname) manufactured by Sumitomo Electric Industries Ltd.) formed with a thickness of I00 μ and an average pore diameter of I0 μ. A heat fusible ink 2 is impregnated over the entire surface of the porous base Ia. A recording medium 3 is formed of paper or the like, and is brought into contact with the recording member I.

A heat generating section 4 disposed upstream of the recording medium 3 is constituted by a multiplicity of heating elements 5 which are juxtaposed in an array and capable of selectively generating heat in response to image information signals from the outside. This heat generating section 4 is arranged such as to be in contact with the recording member I and to be capable of lowering the viscosity of ink inside the recording member I by heat supplied by the heating elements 5, and of allowing the ink of lowered viscosity to be permeated through the porous membrane layer Ib. A platen roller 6 presses the recording medium 3 against the recording member I at a position corresponding to the recording member I.

Next, description will be made of a method of recording which is performed by employing the apparatus of this embodiment.

First, signals from a controlling section (not shown) are sent to the heat generating section 4 to cause the plurality of heating elements 5 juxtaposed in an array in this heat generating section 4 to selectively generate heat. Subsequently, by allowing the heat to be conducted to the porous membrane layer Ib contacted by the heat generating section 4 and to the porous base Ia, the viscosity of ink 2 impregnated in this portion is made low. Meanwhile, ink 2 with its viscosity lowered permeates the porous membrane layer Ib, and an ink image having a predetermined configuration corresponding to the heating portion of the heat generating section 4 is formed on this porous membrane layer Ib.

The ink image formed on the porous membrane layer Ib, as described above, moves as the recording member I rotates in the direction of the arrow. Subsequently, before the ink solidifies downstream, the ink image is transferred onto the recording medium 3 which is pressed by a platen roller 6 at a position where the platen roller is in contact with and opposed to the recording member I, thereby forming an image on the recording medium 3.

In the above-described embodiment, in cases where use is made of a pressurizing means, such as an external air compressor, which is capable of applying pressure on the inside of the recording member I, it is possible to facilitate the permeation through the porous membrane layer Ib of the ink 2 which is located inside the recording member I and whose viscosity has been lowered by heat. In addition, the above-described porous membrane layer Ib is provided with properties which allow the ink 2 to permeate only when the vicosity of the ink 2 has been lowered by heat.

Although, in the above-described embodiment, the porous membrane layer Ib is constituted by an ethylene tetrafluoride resin, it is also possible to use, for instance, a porous resin of such as other fluorine-based resin or a silicon-based resin, or a porous metallic membrane.

As described, in cases where a material having small surface tension, such as ethylene tetrafluoride resin, is used as the porous membrane layer Ib, the ink on the porous membrane layer Ib can be transferred smoothly onto the recording medium 3 since the ink has good repellency.

In the above-described embodiment, although the recording member I is arranged such that, by using the porous base Ia in which alloy fibers are formed in mesh, the porous membrane layer Ib is laminated on the outer surface thereof. As shown in Fig. 3, a recording member IC may be arranged such that, by using a sponge base 7 made of silicone rubber impregnated with the ink 2, the porous membrane layer Ib similar to the one used in the above-described embodiment is laminated on the outer surface thereof. When using this recording member IC, the other arrangements and the recording method are entirely the same as those of the above-described embodiment.

Since its inside is formed by a sponge, the recording member IC itself has resiliency. Accordingly, since its adhesion to the recording medium 3 is improved, it is possible to effect the transfer of an ink image with a better efficiency.

To describe the ink accommodated in the recording member lC, a heat fusible (including softening and sublimation characteristics) ink can typically be used. Furthermore, as for the ink, it is preferable to use one which is capable of maintaining a state in which the ink is always filled in the porous base, e.g., a semisolid ink or the like.

The heat fusible ink is obtained by causing a colorant to be dispersed or dissolved in a heat fusible binder, and its melting viscosity, adhesiveness, etc. are adjusted by adding elastomer or the like to the heat fusible binder.

The heat fusible binder may be composed of a single component or two or more components selected from the group consisting of various kinds of known binder such as natural and synthetic wax resins.

More specifically, the heat fusible binder constituting the ink 3 is selected from: the group consisting of natural wax such as whale wax, beeswax, lanolin, carnauba wax, candellilla wax, montan wax and ceresin wax; the group consisting of petroleum was such as paraffin wax, microcrystalline wax; the group consisting of synthetic wax such as oxidized wax, ester wax, lower molecular polyethylene, Fischertrophsch wax; the group consisting of higher fatty acid such as raulin acid, myrystic acid, palmitic acid, stearic acid, behenic acid; the group consisting of higher alcohol such as steryl alcohol, behnil alcohol; the group consisting of esters such as fatty acid ester of cane sugar, fatty acid ester of sorbitan; the group consisting of amides such as oleyl amide and the like; the group consisting of elastomers such as polyamide resin, polyester resin, epoxy resin, polyurethane resin, polyacrylic resin, polyvinyl chloride resin, cellulose resin, polyvinyl alcohol resin, petroleum resin, phenol resin, polystyrene resin, natural rubber, styrene butadiene rubber, isoprene rubber, chloroprene rubber; the group consisting of oily substances such as mineral oil and vegetable oil; and the group consisting of various plasticizers. The materials selected from the above noted groups are suitably combined, thereby controlling the melt temperature and melting viscosity of the heat fusible binder.

The coloring agent constituting the heat fusible ink 3 in combination with the heat fusible binder is selected from the groups consisting of dyeing materials and pigments such as carbon black which are generally used in printing or other recording methods. The dyeing materials and pigments may be used individually or in the form of a two or more component mixture. It is preferred that the content of the coloring agent is l to 40 percent by weight of the aforesaid ink 3.

Selection of the recording medium 3 is not confined solely to paper, but it is possible to use one which is generally used as an electronic blackboard sheet and in which a high molecular film of Teflon, polypropylene, or the like is coated or laminated on its surface. Therefore, according to this recording apparatus, recording can be effected on a blackboard and the like in an electronic blackboard.

As described above, since this embodiment is arranged such that there are provided a recording member constituted by a first porous layer impregnated with a heat fusible ink and a second porous layer disposed on this first porous layer as well as a means for applying heat on the surface of this recording member in a pattern, and since recording is carried out by using this arrangement, it is possible to provide a recording apparatus and a recording method which afford low running costs without using ink films, which constitute drawbacks of the conventional thermal transfer recording method.

Referring now to Figs. 4 to l9, other embodiments will be described.

This embodiment comprises: a rotatable recording member having a heat-transferable ink and constituted by a plurality of layers; a recording head for heating the surface of the recording member in response to image signals; and a conveying means for conveying a recording medium in such a manner that the recording medium will come into contact with the surface of the recording member heated by the recording head. According to this embodiment, by heating the surface of the rotating recording member by means of the recording head in response to image signals, an image of the ink which has melted or whose viscosity has been lowered is formed on the surface of the recording member, and the image is transfer-recorded by transferring this ink image onto the recording medium being conveyed.

In addition, according to this embodiment, the recording member is constituted by a plurality of porous layers, and the pore diameter of a porous layer forming the surface layer of the recording member is made identical to or smaller than the pore diameter of each of the porous layers constituting inner layers. Therefore, according to this embodiment, the ink is capable of smoothly permeating smoothly from the inside to the outside of the recording member.

Furthermore, according to this embodiment, since, at the time of heating the recording member by the recording head, pressure-contacting portions of the recording member and a pressure-contacting member, or the vicinity thereof, is heated, there are advantages in that the transfer distance becomes short, and in that it is possible to obtain a transfer recorded image having a good transfer efficiency and image quality.

Description will now be made of this embodiment with reference to the accompanying drawings.

Fig. 4 is a perspective view of a recording apparatus in accordance with a first embodiment, while Fig. 5 is an explanatory cross-sectional view thereof.

First, an outline of the overall arrangement will be described. A recording member l2 impregnated with a heat transferable ink ll is arranged such as to be rotatable in the direction of the arrow 'a' by means of a motor l3. A pressure-contacting portion l4 is provided to the recording member l2 at a pressure-contacting portion 'A' in such manner as to be capable of being brought into pressure contact with and separating away from the same.

A recording head l5 which is capable of generating heat in response to image signals is brought into contact with the surface of the recording member l2. When the surface of the rotating recording member l2 is heated by the recording head l5, the ink ll impregnated in the recording member l2 melts in a pattern or its viscosity is lowered, thereby allowing a recorded image to be formed on the surface of the recording member l2.

If a recording medium (e.g., a recording sheet, or a plastic sheet which will be described later; hereafter referred to as the "recording sheet") l7 is conveyed to the pressure-contacting portion 'A' by means of a conveying means l6 in such a manner as to be in synchronization with the formation of the aforementioned recording image, the recording image is pressed against the recording sheet l7, and the melted ink or the ink of lowered viscosity is transferred onto the recording sheet l7. Subsequently, the recording sheet l7 on which the required recording has been effected is discharged onto a discharge tray l8.

Description will now be given of the arrangement of each of the sections of the above-described recording apparatus consecutively.

First of all, the recording member l2 is formed in a cylindrical shape with an axial width substantially identical to or longer than the width of the recording sheet l7, and is composed of an inner layer l2a and an outer layer l2b laminated on the outer periphery of the inner layer l2a. The inner layer l2a is arranged such that a member capable of being impregnated with ink ll which will be described later, such as a porous material formed of a silicone sponge having an average pore diameter of 0.2 - 0.5 mm (No. of cells: approx. 50 - l00 pieces/25 mm), is formed into a cylindrical shape with a diameter of about 20 - l00 mm. In addition, the outer layer l2b constituting a surface layer is composed of a membrane which allows the ink ll to permeate therethrough and is formed with a thickness of about l0 - l00 µm by, for example, porous ethylene tetrafluoride resin having an average pore diameter of about 3 - l0 µm.

The aforementioned recording member l2 is arranged such that a belt l9c is trained between a pulley l9a installed on a rotary shaft l2c and a pulley l9b of the motor l3, and the recording member l2 is rotatable in the direction of the arrow 'a' by means of the drive of the motor l3.

Description will now be given of the ink ll which is impregnated in the recording member l2. This ink has thermal transfer characteristics allowing the ink to be transferred onto the recording sheet l7 as the ink is melted or its viscosity is lowered by heating. Typically, a heat fusible ink is used. Incidentally, the heat fusible ink may be solid, semisolid, or in other similar state insofar as a state in which the ink is impregnated in the inner layer l2a is maintained. However, in view of the thermal efficiency for melting the ink ll, it is preferred that the ink is a semisolid ink.

The heat fusible ink ll is arranged such that a colorant is dispersed or melted in a heat fusible binder, and its melting viscosity and adhesiveness are adjusted by adding elastomer or the like to the heat fusible binder. In addition, the heat fusible binder may be composed of a single component or two or more components selected from the group consisting of various kinds of known binder such as natural and synthetic wax resins.

Furthermore, if a heat fusible binder having supercooling characteristics and a lubricant are prepared and added to the heat fusible binder, it is possible to obtain a good recorded image even if there is some distance between a position of heating by the recording head l5 and a position of transferring ink onto the recording sheet l7. The binder having supercooling characteristics mentioned above refers to one which is capable of retaining a melted state or a state of low viscosity for a fixed time duration even at a temperature below its original melting point or softening point at a time when the binder is once heated above the melting point (softening point) and is then cooled from a melted state or the state of low viscosity. Such a binder itself is already known.

More specifically, the heat fusible binder constituting the ink is, as described above, selected from: the group consisting of natural wax such as whale wax, beeswax, lanolin, carnauba wax, candellilla wax, montan wax and ceresin wax; the group consisting of petroleum wax such as paraffin wax, microcrystalline wax; the group consisting of synthetic wax such as oxidized wax, ester wax, lower molecular polyethylene, Fischertrophsch wax; the group consisting of higher fatty acid such as raulin acid, myrystic acid, palmitic acid, stearic acid, behenic acid; the group consisting of higher alcohol such as steryl alcohol, behnil alcohol; the group consisting of esters such as fatty acid ester of cane sugar, fatty acid ester of sorbitan; the group consisting of amides such as oleyl amide and the like; the group consisting of elastomers such as polyamide resin, polyester resin, epoxy resin, polyurethane resin, polyacrylic resin, polyvinyl chloride resin, cellulose resin, polyvinyl alcohol resin, petroleum resin, phenol resin, polystyrene resin, natural rubber, styrene butadiene rubber, isoprene rubber, chloroprene rubber, the group consisting of oily substances such as mineral oil and vegetable oil; and the group consisting of various plasticizers. The materials selected from the above noted groups are suitably combined, thereby controlling the melt temperature and melting viscosity of the heat fusible binder.

The coloring agent constituting the heat fusible ink 3 in combination with the heat fusible binder is selected from the groups consisting of dyeing materials and pigments such as carbon black which are generally used in printing or other recording methods. The dyeing materials and pigments may be used individually or in the form of a two or more component mixture. It is preferred that the content of the coloring agent is l-to 40 percent by weight of the aforesaid ink.

The pressure-contacting member l4 is constituted by a roller which is composed of a metal such as iron, copper, aluminum, or the like, rubber based on silicone, fluoride, urethane, or the like, a resin based on fluoride, polyacetal, polyamide, or the like having the same length as that of the recording member l2, e.g., one in which polyvinyl chloride is coated on the surface of a urethane foam, on one which is formed of glass or the like. A shaft l4a thereof is rotatably fixed to one end 20a of an arm 20 bent in the shape of a chevron. This arm 20 is arranged such that a bent portion is rotatably journaled by a shaft 20b, and the pressure-contacting member l4 is brought into pressure contact with the surface of the recording member l2 with the linear pressure of 5 - l50 g/cm or thereabout by means of a tensile spring 2l retained at the arm 20. Accordingly, when the recording member l2 rotates in the aforementioned state of pressure contact, the pressure-contacting member l4 is driven to rotate.

Furthermore, an eccentric cam 22 abuts against the other end 20c of the arm 20. If the cam 22 is rotated, the arm 20 rotates with the shaft 20b as a center, thereby allowing the pressure-contacting member l4 to separate from the surface of the recording member l2.

Next, description of the recording head l5 will be made. As shown in a top plan view of Fig. 6 and a cross-sectional view of Fig. 7, this recording head l5 is arranged such that a plurality of heat generating heads are juxtaposed in a row at an upper end portion of a substrate l5a having substantially the same length as the axial length of the recording member l2. This heat generating element l5b is composed of a metallic compound such as carbon, silver, palladium, platinum, ruthenium, or the like, and is capable of generating heat when energized.

A common electrode l5c, an intermediate substrate l5d, and a signal electrode l5e are formed consecutively on the substrate l5a. The common electrode l5c is connected commonly to all the heat generating elements l5b, while each of the signal electrodes l5 is connected to each of the heat generating elements l5b. The substrates l5a and l5d are composed of an insulating material consisting of plastics or mainly consisting of plastics, e.g., polyester, polyimide, or the like. The electrodes l5c and l5e are composed of copper, or a conductive material in which copper or silver is plated with nickel.

In this arrangement, if the signal electrodes l5e are energized in response to image signals, the heat generating elements l5b selectively generate heat correspondingly.

Furthermore, the above-described recording head l5 is formed in the shape of a flexible film having a thickness of dozens of microns to several hundred microns. The recording head l5 per se is elastic and can be adhered to the surface of the recording member l2. The heat generating elements l5b of the recording head l5 abut against the surface of the recording member l2 at the pressure-contacting portion 'A' between the recording member l2 and the pressure-contacting member l4, or the vicinity thereof (upstream of the pressure-contacting portion 'A' in the rotational direction of the recording member l2).

In this embodiment, as shown in Fig. 8, a contacting portion 'B' between the heat generating elements l5b and the recording member l2 is located such as to be situated in the vicinity of the pressure-contacting portion 'A'. The positional relationship between this pressure-contacting portion 'A' and the contacting portion 'B' is such that the ink ll which has melted or whose viscosity has been lowered at the contacting portion 'B' is capable of maintaining the above-described state until it reaches the pressure contacting portion 'A' by the rotation of the recording member l2. In addition, the positional relationship is also such that, when the heat generating elements l5b have generated heat, the heat is transmitted to some extent to the recording sheet l7 being conveyed to the pressure-contacting portion 'A', and that good recording can be effected in terms of the fixing properties and the like. Incidentally, in this embodiment, the distance between the pressure-contacting portion 'A' and the contacting portion 'B' is set to 0.8 to I0 mm.

Next, the conveying means I6 is arranged in such a manner as to convey the recording sheet I7 to the pressure-contacting portion 'A' by means of a feed roller I6a and a pair of conveying rollers I6b, I6c which are driven by a motor (not shown). In other words, the recording sheets stacked and accommodated in a cassette 23 are withdrawn one by one by means of the feed roller I6a, and are then conveyed by means of the pair of conveying rollers I6b, I6c such as to effect a U-turn in synchronization with a recording operation. At the pressure-contacting portion 'A', the recording sheet I7 conveyed by this conveying means I6 is conveyed by the rotation of the recording member I2.

In addition, a feed tray 24 is provided in the vicinity of an inlet of the pair of conveying rollers I6b, I6c so that the recording sheet I7 placed on the tray 24 can also be fed manually.

Sheet guides 25a, 25b for guiding the sides of the recording sheets I7 are disposed between the pair of conveying rollers I6b, I6c. Also, sheet guides 25c, 25d are provided between the pressure-contacting portion 'A' and the discharge tray I8 so as to separate the recording sheets I7 from the recording member I2 and the pressure-contacting member I4 and to guide the same to the discharge tray I8. In addition, a lower guide 25e for the recording sheet 7 is provided between the pair of conveying rollers I6b, I6c and the pressure-contacting member I4, and the recording head I5 also serves as an upper guide.

Furthermore, a jamming (jamming of a sheet in the apparatus) detection means 26 constituted by a photo-interrupter, photo-diode, or a limit switch, etc. is provided at the lower guide 25e.

Next, description will be given of a control circuit for the above-described arrangement. As shown in a block diagram of Fig. 9, recording signals supplied from an external device 27 such as a computer, a word processor, and a reader are transmitted to a CPU 29 via an interface 28. The drive of the conveying means I6, the motor I3, and the eccentric cam 22 is controlled by signals from the CPU 29. In addition, recording signals are sent from the CPU 29 to a driver 30 for driving the recording head I5 in synchronization with the aforementioned controlling of the drive, and the drive of the heat generating elements I5b of the recording head I5 is controlled in response to the recording signals. Consequently, the heat generating elements I5b generate heat in synchronization with the conveyance of the recording sheet I7, and the arrangement is such that the heating temperature of the heat generating elements I5b is controlled by a thermistor or the like. When a jamming detection signal is sent from the jamming detection means 26 to the CPU 29, the CPU 29 stops each of the aforementioned drives, and the occurrence of jamming is displayed on a display unit 3I. This display unit 3I is arranged such that, in addition to the occurrence of jamming, the presence or absence of the recording sheets I7, the turning ON and OFF of a power source, the amount of ink in the recording member I2, and the like can be displayed thereon by means of a detection means (not shown).

With reference to a flowchart shown in Fig. I0, description will now be made of a recording method using the recording apparatus having the above-described arrangement.

As shown in the flowchart, detection of the amount of the ink II in the recording member I2, the presence or absence of the recording sheets I7, and jamming is first carried out in step SI, so as to determine whether the apparatus is on standby for recording. If not on standby, the operation jumps to step S8, and the detection result is displayed on the display unit 3I, while if on standby, the operation proceeds to step S2 to determine whether or not to start recording. Subsequently in step S2, the presence or absence of a recording start signal from a host such as an external device 27 is detected, and, if the start signal is not present, the operation returns to Step SI, while, if present, it proceeds to step S3 to commence recording.

In recording, in step S3, the feed roller I6a rotates in the direction of the arrow 'c' shown in Fig. 5 to feed out the recording sheets I7 one by one from the cassette 23. In step S4, the pair of conveying rollers I6b, I6c rotate in the direction of the arrow 'd' in synchronization with a recording operation to feed the recording sheet I7 to between the recording member I2 and the pressure-contacting portion I4.

Next, in Step S5, the eccentric cam 22 is driven to rotate the arm 20, and brings the pressure-contacting member I4 and the heat generating elements I5b of the recording head I5 into contact with the surface of the recording member I2. Subsequently, specified recording is carried out in step S6.

Description will be made specifically of this recording process. The recording member I2 is rotated in the direction of the arrow 'a' at a peripheral speed of about I - I0 cm/sec in synchronization with the conveyance of the recording sheet I7, and a recording image signal is set to the recording head I5 in synchronization with this rotation. The heat generating elements I5b then generate heat in response to the signal, and the surface of the recording member I2 is selectively heated. This heat is transmitted from the outer layer I2b of the recording member 12 to the inner layer 12a, and the ink impregnated in the heated portion melts or its viscosity is lowered. The ink which has melted or whose viscosity has been lowered permeates the outer layer 12b. At that time, since the pores of the outer layer 12b have diameters finer than those of the inner layer 12a, the ink image 32 constituted by fine ink dots corresponding with the above-described heating is formed on the outer layer 12b. Alternatively, the ink 11 solidified in the outer layer 12b melts or its viscosity is lowered, and the ink image corresponding to the heating by the recording head 15 is formed.

Furthermore, the ink image 32 moves in conjunction with the rotation of the recording member 12, and the ink image 32 reaches the pressure-contacting portion 'A' before it solidifies or permeates the outer layer 12b again to be impregnated in the inner layer 12a. In the pressure-contacting portion 'A', the ink image 32 is pressed against the recording sheet 17 conveyed in synchronization therewith and is thereby transferred onto the recording sheet 17.

The recording sheet 17 on which the image has been recorded, as described above, is discharged onto the discharge tray 18 in conjunction with the rotation of the recording member 12.

Continuous recording can be effected by repeating the above-described process. Incidentally, in cases where jamming occurs during the above-described recording operation, or such as when the recording sheets are absent, such state is detected in step S7, and that state is displayed on the display unit 31 in step S8. In step S9, determination is made as to whether or not all the recording is to be completed, and, when recording is to be effected further, the operation returns to step S1, while, when recording is to be completed, the operation proceeds to step S10.

When the recording operation has been completed, in step S10, the eccentric cam 22 is driven to rotate the arm 20 in the opposite direction to that described above, and separates the pressure-contacting member 14 from the surface of the recording member 12, thereby preventing the deformation of the recording member 12 when recording is not carried out.

As described above, it is possible to transfer an ink image onto the recording sheet 17 without using an ink film. In the above-described arrangement, at the time of the transfer of the ink image, since the heat generating elements 15b are located in the vicinity of the pressure-contacting portion 'A', the heat generated by the elements 15b is also applied to the recording sheet 17 with the same pattern as that of the recording member 12, thereby forming an image on the recording sheet 17. Accordingly, the transfer of the ink image 31 onto the recording sheet 17 can be effected smoothly and efficiently at the pressure-contacting portion 'A'.

Moreover, in the above-described arrangement, since the pore diameter of the outer layer 12b is smaller than that of the inner layer 12a, the ink permeating the outer layer 12b is made into fine dots. Since the ink image is formed by the fine dots, a clear image is recorded on the recording sheet 17.

To the contrary, since the pore diameter of the inner layer 12a is made greater than that of the outer layer 12b, it is possible to cause the inner layer 12a to be sufficiently impregnated with the ink 11.

[Other Embodiments]

Incidentally, although, in the foregoing embodiment, the heat generating 15b are located in the vicinity of the pressure-contacting portion 'A', it is also possible to locate the heat generating elements 15b inside the pressure-contacting portion 'A', as shown in Fig. 11.

For instance, if, in the foregoing embodiment, the linear pressure between the recording member 12 and the pressure-contacting member 14 is increased to about 100 - 150 g/cm, the range of the pressure-contacting portion 'A' expands, so that the heat generating elements 15b adhere to the surface of the recording member 12 within the pressure-contacting portion 'A', as shown in Fig. 11. Even if the recording head 15 is thus located inside the pressure-contacting portion 'A' no hindrance is caused to the rotation of the recording member 12 since the recording head 15 is extremely thin.

In the aforesaid arrangement, when the heat generating elements 15b generates heat in response to a recording image signal, the heat is transmitted positively to both the recording head 12 and the recording sheet 17. Accordingly, since an image corresponding to the image pattern is formed more clearly on the recording sheet 17, and since the melted ink or the ink with its viscosity lowered is transferred onto the image portion immediately after permeating the outer layer 12b, the transfer characteristics improve, so that fogging or the like becomes difficult to occur, and, at the same time, the thermal efficiency also improves.

In cases where the heat generating elements 15b are located in the pressure-contacting portion 'A', the recording head 15 may be arranged as shown in Fig. 12.

In other words, the heat generating elements I5b are arranged in a row at a desired position of the substrate I5a, and the common electrode I5c and the signal electrodes I5e are connected to both ends of the heat generating elements I5b. Furthermore, ink passage holes I5f are formed in the substrate I5a and the heat generating elements I5b.

The portion of the heat generating elements I5b of the recording head I5 is arranged such as to be located in the pressure-contacting portion 'A', and if the heat generating elements I5b are caused to generate heat in response to an image signal, the ink of the recording member I2 which has melted or whose viscosity has been lowered by the heating passes through the ink passage holes I5f and is transferred on to the recording sheet I7. Thus, it is possible to obtain the same effect as that of the embodiment shown in Fig. II.

Since it is unnecessary for the heat generating elements I5b of the above-described recording head I5 to be located at the side portion of the substrate I5a, there is an advantage in that the production of the recording heads I5 can be facilitated.

Although, in the foregoing embodiment, a case is shown in which the recording head I5 is made flexible and extremely thin, the recording head I5 may be arranged to be rigid.

For instance, as shown in Figs. I3, I4, and I5, an arrangement may be provided as follows: A substrate is formed by providing an insulating layer I5h obtained by baking enamel or the like onto the surface of a metallic core I5g constituted by a very low carbon steel plate, a copper plate, a stainless steel plate or the like. The heat gener ating elements I5b are arranged in a row on the substrate, and the common electrode I5c and the signal electrodes I5e are connected to the heat generating elements I5b.

If the arrangement is provided as described above, since the mechanical strength of the recording head I5 is large, it is possible to correct the deformation of the recording member I2 by means of the recording head I5.

In addition, although, in the first embodiment, the arrangement is made such that the pressure-contacting member I4 is driven by the rotation of the recording member II, the pressure-contacting member I4 may be rotatively driven separately, as shown in Fig. I6.

In Fig. I6, the roller constituting the pressure-contacting member I4 is arranged such as to be driven by a motor 33, and the recording member I2 is installed at one end of the arm 20 such as to be rotatable. In this arrangement, the recording member I2 rotates as it is driven by the rotation of the pressure-contacting member I4. In this case, since the mechanical strength of the pressure-contacting member I4 is greater than that of the recording member I2, the pressure-contacting member I4 is less susceptible to deformation. As a result, it is possible to stabilize the conveying speed of the recording sheet I7 in comparison with a case where the recording member I2 is rotatively driven as in the case of the first embodiment.

In Fig. I6, the tensile spring 2I is retained at the arm 20 as in the case of the first embodiment, and causes the recording member I2 to be brought into pressure contact with the pressure-contacting member I4 with a predetermined pressure. At the same time, when the eccentric cam 22 abutting against the arm 20 rotates, the arm 20 rotates with the shaft 20b as the center, thereby separating the recording member I2 from the pressure-contacting member I4.

Furthermore, although, in the above-described embodiment, the arrangement is such that either the recording member I2 or the pressure-contacting member I4 is rotatively driven, an arrangement be also provided such that both of the recording member I2 and the pressure-contacting member I4 are rotatively driven at the same peripheral speed. In this arrangement, the conveying speed of the recording sheet I7 can be further stabilized. In particular, in cases where the recording member I2 and the presure-contacting member I4 are held in pressure contact with each other via the recording head I5, as in the case of the embodiment shown in Fig. I2, it is necessary to rotatively drive both the recording member I2 and the pressure-contacting member I4.

Description of other examples of the recording member I2 will now be described. Although, in the first embodiment, a sponge base made of silicone rubber is used by way of example as a member constituting the inner layer I2a, it is also possible to use a porous material formed of synthetic fiber in mesh or a porous material formed by winding cellulose in a spiral shape. In this case, it is possible to obtain a greater mechanical strength than that of the sponge illustrated in the first embodiment.

With respect to the outer layer I2b, it is also possible to use a porous resin such as a fluoride-based resin and a silicon-based resin other than those illustrated in the first embodiment, or a porous metallic membrane, a metallic mesh, various types of fibrous mesh, and the like.

Although, in the first embodiment, the pore diameter of the outer layer I2b of the recoding member I2 is made smaller than the pore diameter of the inner layer I2a, the pore diameter of the inner layer I2a may be made as the same as that of the outer layer I2b. In this case as well, it is also possible to cause the inner layer I2a to be impregnated sufficiently with the ink.

In addition, although, in the first embodiment, the pore diameter of the outer layer l2b of the recording member l2 is made smaller than that of the inner layer l2a, the pore diameter of the outer layer l2b may be made greater than that of the inner layer l2a.

If the arrangement is made as described above, in cases where the ink ll impregnating the inner layer l2a is melted or its viscosity is lowered by heating of the heat generating elements l5b, the ink ll passes the outer layer l2b smoothly, so that a recorded image with a darker density can be transferred onto the recording sheet l7.

Furthermore, although, in the above-described first embodiment, an example is shown in which the recording layer l2 is formed as a two-layer structure constituted by the inner layer l2a and the outer layer l2b, this recording member l2 may be arranged with a multi-layer structure of three more layers.

When adopting the multi-layer structure of three or more layers, if the pore diameters of the porous layers from the innermost layer to the outermost layer are made consecutively smaller, the permeation of the melted ink or the ink with its viscosity lowered can be effected smoothly.

Next, other examples of the pressure-contacting member l4 will be described. Although, in the first embodiment, the pressure-contacting member l4 is constituted by a rotatable roller-shaped member, the pressure-contacting member l4 may be constituted by an unrotatable member, as shown in Fig. l7.

The pressure-contacting member shown in Fig. l7 is arranged such that a metallic member such as stainless steel or iron, or such a member as hard rubber or hard plastics is installed such as to be capable of being brought into pressure contact with the surface of the recording member l2 at a linear pressure of about 5 - l50 g/cm by means of pressing springs 34.

In the above-described arrangement, the recording sheet l7 is conveyed by cooperative action of the rotating recording member l2 and the pressure-contacting member l4 held in pressure contact therewith, and an ink image 32 is transferred onto the recording sheet l7 by a pressing force of the pressure-contacting member l4 at that time.

It should be noted that the arrangement for bringing the pressure-contacting member l4 into pressure contact with or separating the same from the surface of the recording member l2 is the same as that of the first embodiment.

With respect to the arrangement of separating the pressure-contacting member l4 and the recording member l2 from each other, although, in the first embodiment, the separation is effected by the rotation of the arm 20 through the rotation of the eccentric cam 22, as another example apart from using the eccentric cam, the separation may be effected by the use of, for instance, a solenoid or the like.

In addition, as shown in Fig. l8, an arrangement may be provided such that, without providing the pressure-contacting member l4, the recording head l5 is brought into pressure contact with the surface of the recording member l2, and the recording sheet l7 is conveyed to the pressure-contacting portion, the heating of the recording member l2 by means of the recording head l5 being effected via the recording sheet l7.

As for the recording medium used, in each of the aforesaid embodiments, an example in which cut sheets are used is shown, but the recording medium need not be restricted to cut sheets. As shown in Fig. l9, an arrangement may be provided such that the recording sheet l7 wound in the form of a roll is set inside the apparatus, and the recording sheet l7 is conveyed in correspondence with the recording operation by means of the pair of conveying rollers l6b, l6c, and is cut by an automatic cutter 35 at a point where the recording sheet l7 has been conveyed by a recording length.

Furthermore, the recording medium need not be restricted to the type of paper described with reference to the first embodiment, and any material which allows the ink ll to be transferred may naturally be used, such as a plastic sheet for an overhead projector (OHP), or one in which a high-molecular film of such as Teflon (brandname) or polypropylene is coated or laminated on its surface and which is generally used as a sheet for an electronic blackboard.

Accordingly, it is possible to effect recording on the surface of an electronic blackboard.

As described above, since the arrangement is such that a recording member constituted by a plurality of layers impregnated with ink is rotated, and is heated by a recording head in response to image signals to effect required recording, the waste can be eliminated in comparison with a conventional method of thermal transfer recording in which ink films are used, and, at the same time, the running costs can be lowered as a result. In addition, since a semisolid ink can be used, it is possible to reduce the amount of energy used for heating by the recording head in comparison with a case where a solid ink is used.

Furthermore, if the recording member is formed by a plurality of porous layers, and the pore diameter of the surface layer is made smaller than those of the inner layers, there is an advantage in that an ink image permeating the surface layer is formed by fine ink dots, so that it is possible to obtain a transfer recorded image with good image quality. In addition, in this embodiment, in heating the recording member by the recording head, since the pressure-contacting portions of the recording member and the pressure-contacting member or the vicinity thereof are heated, the transferring distance becomes short, so that there is an advantage in that it is possible to obtain a transfer recorded image with good transfer efficiency and image quality.

Another embodiment will be described with reference to Figs. 20 - 24.

This embodiment is provided with a dispersing means for dispersing in the recording member the ink contained in the recording member. According to this embodiment, since the ink contained in the recording member is dispersed uniformly by the dispersing means, stable ink images are formed on the surface of the recording member at the time when the recording member is heated by the recording head, thereby allowing high-quality images to be obtained.

First, description will be given with reference to Fig. 20. In this embodiment, a dispersing means is added to the recording apparatus shown in Fig. I5, and those members that are similar to those shown in Fig. I5 are denoted by the same reference numerals. In addition, a dispersing means may also be provided to the recording apparatus shown in Figs. I6, I7, and I9 in the same way as with Fig. 20.

A dispersing means 36 for the ink II is constituted a heating roller 36a having the same length as the axial length of the recording member I2, and is installed in such as to be brought into contact with the surface of the recording member I2 downstream of the rotating direction of the recording member I2 and to be rotated by the rotation of the recording member I2.

The aforementioned heating roller 36a is constituted by a metal such as aluminum or copper, and a nichrome heater, an infrared heater, or the like is provided in the inside or outside thereof, and the surface of the recording member I2 with which it is in contact with can be heated thereby.

Incidentally, the drive of this heater is controlled by signals supplied from the aforementioned CPU 29.

In this recording apparatus, it can be estimated that if recording is continued as described above, the amount of the ink impregnated in the surface of the inner layer I2a will be reduced depending on the material of the ink, the recording speed, or the like, and the density of the image may become light should the recording be continued in that state. Therefore, before the density of the image becomes light, the heater 36b of the heating roller 36a is caused to generate heat to heat the surface of the recording member I2. The ink II impregnated in the inner layer I2a is melted by this heating, and the ink II is caused to permeate the surface side of the inner layer in which the content of the ink has become small, as shown in Fig. 2I.

Since the ink II melted in the inner layer I2a by means of the heating roller 36a tends to flow from a dense portion to a less dense portion, even if there is a partial variation in the ink content in the inner layer I2a due to the transfer of the ink image, the melted ink II uniformly permeates the surface side of the inner layer. Accordingly, the surface side of the inner layer assumes a state in which it is constantly impregnated uniformly with the ink II, with the result that the density of the recording images is constantly maintained at a fixed level.

It should be noted that the heating of the recording member I2 by the heating roller 36a may be effected in conjunction with the recording operation, or may be effected upon every time a fixed amount of transfer recording is completed. Incidentally, Fig. 22 is an explanatory diagram of an embodiment in which the pressure-contacting member is not provided.

Description will now be made of another example of the ink dispersing means 36.

In the first embodiment, an arrangement may be provided such that the heating roller 36a is installed such as to be capable of being brought into contact with and separate from the surface of the recording member I2 in the same way as the pressure-contacting member I4, and the heating roller 36a is separated from the surface of the recording member when the recording member I2 is not heated by the heating roller 36a.

In addition, although, in the first embodiment, the arrangement is such that the surface of the recording member I2 is heated by the heating roller 36a rotatively driven by the rotation of the recording member I2, an arrangement may be provided such that the surface of the recording member I2 is heated by a nonrotational heating member 36c, as shown in Fig. 23. In this case, the heating member 36c may either contact or not contact the recording member I2.

In the above-described embodiment, the area of the recording member to be heated can be varied by changing the area of the heating member 36c.

Furthermore, as shown in Fig. 24, an arrangement may be provided such that a heating member 36d constituted by a nichrome wire heater or the like is installed inside the inner layer I2a, and heating may be effected from the inside of the recording member I2.

In the arrangement described above, it is possible to positively supply the ink impregnated in the inner layer I2a to the surface side.

In addition, if the heating roller 36 is made to press the recording member I2 at a predetermined pressure, the ink II impregnated in the inner layer I2a can be supplied to the surface side more effectively.

In addition, if an arrangement is provided such that the heating member cleans the surface of the recording member simultaneously as the recording member I2 is heated by the heating member, it is possible to effect recording with better image quality.

If a means for cooling the recording member I2 is provided downstream of the heating member 36a or the heating members 36c, 36d in the rotating direction of the recording aparatus I2, since the ink uniformly dispersed in the surface side of the inner layer by heating is cooled positively while it reaches the position of the recording head I5, it becomes possible to eliminate fogging and the like, thereby allowing higher image-quality recording to be effected.

Still another embodiment will be described with reference to Figs. 25 to 30.

This embodiment comprises: a rotatable recording member having an ink with heat-transfer characteristics; a recording head for heating the surface of the recording head in response to image signals; a conveying means for conveying the recording medium in such a manner that the recording medium comes into contact with the surface of the recording member heated by the recording head; and an ink replenishing means for replenishing the ink to the recording member. According to this embodiment, when the amount of ink in the recording member has become small due to recording, the ink can be replenished by the ink replenishing means, so that continuous recording can be effected without replacing the recording member.

First, description will be made with reference to Figs. 25 and 26. It should be noted that this embodiment is such an ink replenishing means is added to the recording apparatus shown in Figs. 4 and 5, and those members that are similar to those shown in Figs. 4 and 5 are denoted by the same reference numerals. In addition, the ink replenishing means may also be provided to the recording apparatus shown in Figs. I6, I7, and I9 in the same way as with that shown in Figs. 25 and 26.

An ink replenishing means 40 is arranged such as to have the same length as the axial length of the recording member I2 and is integrally composed of an ink roller 40a incorporating a heating means such as a nichrome wire heater as well as an ink reservoir 40b capable of supplying the ink II to the surface of the roller 40a. The ink roller 40a is installed by a moving means (not shown) such as to be brought into contact with or separate from the surface of the recording member I2, and is arranged such as to rotate in the direction of the arrow shown in Fig. 26 in a state in which it is in contact with the recording member I2. Incidentally, the drive of an abutting and separating means, the heating means, etc., of the ink replenishing means 40 are controlled by signals supplied from the CPU 29. In addition, the ink replenishing means 40 is adapted to be driven automatically by signals from the CPU 29 as an amount of recording is detected by a counter or the like and each time the recording of a predetermined number of sheets is completed. In other words, when a predetermined number of sheets has been recorded, the ink roller 40a of the ink replenishing means 40 is brought into contact with the surface of the recording member I2, and the heating means 'H' inside the ink roller 40a is driven to heat the ink roller 40a, and, at the same time, rotates in the direction of the arrow shown in Fig. 26.

The ink II in the ink reservoir 40b melts, and the ink II is coated on the surface of the ink roller 40a rotatively driven by the rotation of the recording member I2. When the ink layer is brought into contact with the surface of the recording layer I2 in conjunction with the rotation of the ink roller 40a, the ink permeates the outer layer I2b and is impregnated in the inner layer I2a.

It should be noted that, since the heat of the ink II is lost and its viscosity becomes large while the ink II is being impregnated in the inner layer I2a, the ink II does not permeate the outer layer I2b to come out of it.

After thus replenishing the ink II in the recording member I2, the ink roller 40a may be separated from the recording member I2.

The replenishment of the ink II may be effected simultaneously with recording, or may be effected after counting the number of recorded sheets and by interrupting the recording each time a fixed amount of recording is carried out, or upon completion of a fixed amount of recording. Incidentally, Fig. 27 is a side-elevational view of an embodiment which is not provided with a pressure-contacting member.

Next, description will be made of another example of the ink replenishing means 40.

Although, in the first embodiment, the arrangement is such that the ink is supplied from the ink reservoir 40b in the form of a case to the ink roller 40a, as shown in Fig. 28, an arrangement may be provided such that by disposing the ink roller 40a and the ink roller 40c adjacent to each other in such a manner as to form a gap therebetween, an ink reservoir 40d is formed between the rollers 40a, 40c, and the rollers 40a, 40c are rotated in the direction of the arrow shown in Fig. 28, so as to replenish the ink II from the ink reservoir 40d to the recording member I2 via the ink roller 40a.

Alternatively, as shown in Fig. 29, an arrangement may be provided such that a porous layer 40f composed of polyurethane, silicone rubber or the like is formed at the tip of the ink reservoir 40e having the same length as the axial length of the recording member I2, the porous layer 40f being adapted to be capable of being brought into contact with and separating from the surface of the recording member I2. When replenishing the ink II in the above-described arrangement, if the porous layer 40f is brought into contact with the surface of the recording member I2, and if the recording member is rotated and, at the same time, the ink II in the ink reservoir 40e is caused to melt by heating by the heating means 'H', the melted ink II which has permeated the porous layer 40f is replenished to the recording member I2.

Furthermore, as shown in Fig. 30, a cooling means 4I may be provided downstream of the ink replenishing means 40 in the rotational direction of the recording member I2 and upstream of a contacting portion 'B' of the recording head I5.

The aforementioned cooling means 4I may, for example, be arranged in such a manner that a roller which is composed of aluminum, copper or the like and capable of coming into contact with the axial peripheral surface of the recording member I2 is rotatively driven by the rotation of the recording member I2.

By providing the aforementioned cooling means 4I, it becomes possible to deprive the recording member 2 with heat accumulated therein of the heat when the melted ink is replenished by the ink replenishing means 26. Accordingly, even when recording is effected immediately after replenishing the ink, fogging or the like due to accumulated heat can be reduced, thereby allowing large-contrast, high image-quality recording to be effected.

Incidentally, the cooling means 40 need not be restricted to a roller-shaped member which comes into contact with the recording member I2, and if it is arranged with a non-contacting type such as a cooling fan or the like, the possibility of imparting unnecessary deformation to the recording member I2 can be eliminated.

Furthermore, the rotational direction of the ink roller 40a should not be restricted to the direction shown in the embodiment, and the ink roller 40a may be adapted to rotate in the opposite direction, or may be adapted to be rotatively driven by the rotation of the recording member I2.

Although, in the first embodiment, the ink replenishing means 40 is adapted to be driven after each fixed amount of recording, an arrangement may alternatively be provided such that, by detecting the amount of ink impregnated in the inner layer I2a by means of a concentration sensor, the ink replenishing means 40 is driven in correspondence with the detected value.

Thus, according to this embodiment, since a means for replenishing ink to the recording member is provided, it is possible to use the same recording member for extended periods of time, so that the running costs become low. At the same time, since the recording member per se impregnated with ink can be formed thinly, so that the recording member can be made compact in size. Furthermore, it is possible to prevent the deterioration of the image quality caused by a shortage of ink.

In addition, there is another advantage in that, if the cooling means is provided for the recording member, it becomes possible to replenish the ink even during recording.

A further embodiment will now be described. This embodiment is arranged such that, in the recording apparatus shown in Figs. 4 to I9, the pore diameter of a porous layer constituting the surface layer of the recording member is made greater than that of the porous layer constituting an inner layer which is disposed adjacent to the surface layer.

More specifically, the recording member I2 is formed in a tubular shape whose axial length is substantially identical with or longer than the width of the recording sheet I7. Further, the recording member I2 is constituted by a plurality of layers including the inner layer I2a and the outer layer I2b serving as a surface layer laminated on the outer periphery of the inner layer I2a. The inner layer I2a is arranged such that a porous member composed of a member which is capable of being impregnated with the ink II, e.g., a sponge made of silicone rubber of an average pore diameter of about 80 - 300 μm (the number of cells: approx. 80 - 200 pcs/25cm), is formed in a tubular shape with a diameter of about 20 - 200 mm. Meanwhile, the outer layer I2b is arranged such that a porous member which allows the ink II to permeate therethrough and has a pore diameter greater than that of the inner layer I2a. For instance, a plurality of pores with an average pore diameter of about I00 - 500 μm are formed on such as a membrane of polyimide-based plastics formed with a thickness of about 50 - I00 μm.

Thus, according to this embodiment, since the recording member is formed by a plurality of porous layers, and the pore diameter of the surface layer is made greater than that of the inner layer, there are advantages such as that the passage of the ink through the surface layer is facilitated, that it is possible to obtain high-density recorded images at high speed with a smaller amount of energy, and that it is possible to obtain high-quality recorded images with clear contrast.

A further embodiment will be described with reference to Fig. 3l.

Although, in each of the above-described embodiments, an example is shown in which the recording member l2 is provided with a two-layer structure constituted by the inner layer l2a and the outer layer l2b, this recording member l2 may be formed in a multi-layer structure having three or more layers. Alternatively, the recording member l2 may be formed as a single-layer structure as shown in Fig. 3l.

In Fig. 3l, the recording member l2 is arranged such that a material which is capable of being impregnated with the ink ll, e.g., a sponge base made of silicone rubber, porous ethylene tegrafluoride resin or the like, is formed in the shape of a roller having a thickness of 5 - 20 mm or thereabout, and a roller 42 is impregnated with the ink ll.

If the recording member 42 is formed as a single-layer structure as described above, the ink which has melted or whose viscosity has been lowered by the heat generating elements l5b is transferred directly onto the recording sheet l7, with the result that it is possible to obtain recorded images with sufficiently high density.

Furthermore, description another embodiment will be made with reference to Figs. 32 - 35.

This embodiment is further provided with an ink replenishing means for replenishing the ink having heat transfer characteristics from the inside of the recording member to the recording member.

As shown in the drawings, an ink replenishing means 226 is provided inside the recording member l2, and the arrangement is such that the ink ll can be replenished from the ink replenishing means 26 to the recording member l2.

The recording member l2 is formed in a cylindrical shape whose axial length is substantially idential with or longer than the width of the recording sheet l7, and the recording member l2 is constituted by a porous cylindrical base l2c formed in the mesh of a varied type of alloy such as stainless steel and having an average pore diameter of 0.l - 3.0 mm, the inner layer l2a laminated on the outer peripheral surface of the base l2c, and the outer layer l2b laminated on the outer peripheral surface of the inner layer l2a. The inner layer l2a is arranged such that a member which allows the ink ll to be impregnated therewith, e.g., a porous member constituted by a sponge of silicone rubber having an average pore diameter of about 0.2 - 0.5 mm (the number of cells: approx. 50 - l00 pcs/25 mm), is formed in a cylindrical shape with an outer diameter of about 20 - 200 mm. Meanwhile, the outer layer l2b is constituted by a member which, when the ink ll has melted or its viscosity has been lowered, allows the same to be permeated therethrough, e.g., a membrane which is arranged such that a porous ethelene tetrafluoride resin having an average pore diameter of about 3 - l0 µm is formed with a thickness of about l0 - l00 µm.

The belt l9c is trained between the pulley l9a installed on a rotational shaft and the pulley l9b of the motor l3, and the recording member l2 is adapted to be rotated in the direction of the arrow 'a' by the drive of the motor l3.

The ink replenishing means 226 is disposed inside the recording member l2. The arrangement is such that the ink ll having heat-transfer characteristics is filled inside the base, and the ink ll filled in the inside is agitated by a blade member 226a provided in the base l2c.

As shown in Fig. 34, the aforementioned blade member 226a is constituted by a metal such as iron or aluminum, or a resin or the like such as plastics of various kind, and a supporting portions 226b are formed at both ends thereof. These supporting portions 226b are supported by the rotational shaft of the recording member l2, and the arrangement is such that, even if the recording member l2 rotates, the blade member 226a does not rotate. The supporting portions 226b are made hollow to form an ink replenishing hole 226c. The arrangement is such that, as shown by the arrow B in Figs. 32 and 34, the ink ll having heat transfer characteristics is supplied from the outside into the base l2c via the ink replenishing hole 226c by such means as a filler or syringe, and the ink is agitated by the blade member 226a so as to be replenished inside the inner layer l2a.

Thus, since the recording member l2 can be automatically replenished with the ink ll, it becomes possible to employ the same recording member l2 for extended periods of time. Furthermore, since the ink ll is agitated by the blade member 226a when the ink ll is caused to pass through the base l2c and to be replenished in the inner layer l2a, it becomes possible to effect the replenishment of ink efficiently.

Next, description of another example of the ink replenishing means 226 will be made.

Although, in the first embodiment, the arrangement is made such that the ink ll filled in the base l2c is agitated by the blade member 226a provided in the base l2c, an arrangement may alternatively be provided such that, as shown in Fig. 35, a roller member 226b constituted by a metal such as iron or aluminum, or a resin such as plastics various kind, is rotatably provided instead of the blade member 226a, and the roller member 226b is rotated clockwise or counterclockwise so as to agitate the ink ll accommodated in the base l2c and to replenish the same from the ba l2c to the inside of the inner layer l2a.

It should be noted that, if, as shown in Fig. 35, the rotational axis of the roller member 226b is disposed such as to be offset from the rotational center of the recording member l2, the ink ll accommodated in the base l2c can be agitated sufficiently without necessarily rotating the roller member 226b.

In the above-described example, at the time when the ink ll is agitated for replenishment by the blade member 226a or the roller member 226b, if a heating means such as a heater is provided inside the base l2c, the viscosity of the ink ll in the base l2c is lowered, so that replenishment into the inner layer l2a can be facilitated.

Although, in the first embodiment, the ink replenishing means 226 is driven after each fixed amount of recording, an arrangement may alternatively be provided such that, after detecting the amount of ink impregnating the inner layer l2a by means of a density sensor or the like, the ink is replenished by the ink replenishing means 226 in correspondence with the measured value.

As described above, according to the present invention, since the means for replenishing the ink is provided for the recording member, it is possible to use the same recording member for extended periods of time, so that the running costs become low. At the same time, since the recording member per se impregnated with the ink can be formed thinly, it is possible to make the recording member compact. Furthermore, it is possible to prevent the deterioration of the image quality caused by a shortage of ink or the like.

A further embodiment will be described with reference to Fig. 36. Fig. 36 is a cross-sectional view of the porous material. In this embodiment, the recording member is constituted by a single-layer porous material, and the pore diameter of the surface portion of the recording member is made smaller than that of the inner portion thereof. This embodiment may be applied to, for example, the recording apparatus shown in Figs. 4, 5, l5, l6, l7, l9, and 20. In the description given below, description will be made of a case where this embodiment is applied to the recording apparatus shown in Fig. 4 by way of example.

The recording member l2 is constituted by a single-layer porous layer formed in a tubular shape with its axial length substantially identical with or longer than the width of the recording sheet l7. As shown by an explanatory cross-sectional view in Fig. 36, the arrangement is such that the diameters of pores l2d in the surface portion l2b thereof are smaller than the diameters of pores l2e in the inner portion.

As for the material constituting the recording member l2, it is possible to use a porous material which is capable of being impregnated with the ink ll, such as rubber sponge, polyvinyl alcohol, polyethylene, or polyurethane foam ["Rubicell" (brandname) manufactured by Toyo Polymer Co., Ltd.], and this porous material is formed into a tubular shape with a diameter of about 20 - 200 mm. The inner portion of the recording member l2 constituted by this porous material is formed as the inner portion l2a such as to be provided, for instance, with an average pore diameter of about l - l00 µm. Meanwhile, the outer portion (the portion with a thickness of about l - l0 µm) is formed as the surface portion l2b such as to be provided, for instance, with an average pore diameter of about 0.l - l0 µm.

Accordingly, since the pore diameter of the surface portion l2b of the recording member l2 is smaller than that of the inner portion l2a, the ink permeating the surface portion l2b at the time of recording forms fine dots, and an ink image is formed by the fine dots. At the same time, it becomes difficult for the ink ll impregnating the recording member l2 to be directly contacted by the recording sheet l7, so that the amount of fogging and the like becomes is reduced, thereby allowing clear images to be recorded on the recording sheet l7.

To the contrary, since the pore diameter of the inner portion l2a of the recording member l2 is made larger than that of the surface portion l2, it is possible to sufficiently impregnate the inner portion l2a with the ink ll.

Furthermore, since the inner portion l2a and the surface portion l2b of the recording member l2 are arranged integrally, the mechanical strength of the recording member l2 can be increased in comparison with a case where it is constituted by different materials, so that the thickness of the surface portion l2b can be made thin. Accordingly, since the surface portion l2b can be made thin, it is possible to facilitate the passage through the surface portion l2b of the ink ll which has melted or whose viscosity has been lowered, thereby allowing the heat transferability to be improved.

A yet another embodiment will now be described with reference to Figs. 37 and 38. Fig. 37 is a schematic cross-sectional view of a recording member which is used in this embodiment, while Fig. 38 is a side-elevational view of the recording apparatus. It should be noted that those members that are similar to those of the embodiment shown in Fig. I are denoted by the same reference numerals.

This embodiment is characterized in that the first porous layer impregnated with the ink is formed by a plurality of materials having different hardness.

According to this embodiment, it is possible to prevent the unnecessary deformation of the first porous layer of the recording member caused by pressurization, and to obtain high-quality images. At the same time, it is possible to effect smooth supply of ink.

In the drawings, reference numeral 5l denotes a recording member formed into a tubular shape, and this recording member is arranged by laminating a second porous layer 5lb on the outer surface of a first porous layer 5la. Incidentally, the first porous layer I is constituted by a multiplicity of doughnut-shaped units (shown in Fig. 37) which are connected together. This one unit is composed of a soft sponge 52a based on ester, ether, silicone, or the like as well as a reinforcement member 52b composed of a hard plastic such as polyacetal resin, a foam including a hard sponge, a metal or the like. The soft sponge 52a is impregnated with the heat fusible ink over the entire surface thereof, and not only serves as a recording member but also serves to supply and retain the ink.

Description will now be made of operation in cases where the apparatus constructed as described above is used.

In effecting recording in according to the above-described recording method, when the heat generating section 4 presses the recording member 5l, the soft sponge 52a tends to be deformed. However, the reinforcement member 52b serves as a support and prevents the first porous layer 5la from being subjected to unnecessary deformation, thereby preventing dropouts and the like in the image caused by the heat generating section 4. In addition, when a platen roller 6 presses the recording member 5l via the recording medium 3, the reinforcement member 52b serves as a support in the same way as the above-described case, and the formation of the first porous layer 5la is hence prevented, thereby prevent dropouts and the like in an image caused by the heat generating section 4.

(l) Incidentally, in the above-described embodiment, although the first porous layer 5la is provided with a doughnut-shaped unit structure, the reinforcement member may alternatively provided with a honeycomb structure.

(2) In addition, although, in the above-described embodiment, the first porous layer 5la is provided with a doughnut-shaped unit structure, the first porous layer 5la may alternatively be arranged such that a belt-shaped material is wound around a shaft into a screw shape.

(3) Furthermore, although, in the above-described embodiment, the first porous layer 5la is provided with a doughnut-shaped unit structure, the reinforcement members may alternatively arranged such that a multiplicity of needle-or bar-like members are erected on a shaft, and porous layers are formed among these reinforcement members.

As described above, according to this embodiment, by virtue of a simple arrangement in which a combination of a plurality of materials having different hardness is used for the first porous layer, it is possible to allow the first porous layer to be readily provided with adequate ink impregnation properties and strength. Consequently, it is possible to prevent unnecessary deformation against pressurization from the heat generating member and the platen roller, maintain linear motion, form ink images accurately on the recording member, and transfer the same onto the recording medium such as paper, thereby meking it possible to obtain high-quality images. Moreover, it is possible to prevent permanent strains occurring in the recording member when only a portion of the recording member is pressurized by the heat generating member and the platen roller during stopping. In addition, it is possible to increase the thickness of the first porous layer, so that the content of the heat fusible ink can be increased. Accordingly, it is possible to use the recording member over extended periods of time without frequently replenishing the ink. Furthermore, if the ink content is large, the supply of the ink to the pattern of the recording member can be effected favorably during recording, and the replenishment of the ink can be effected favorably for the ensuing recording. In addition, since the unit structure is adopted, the partial distribution of the ink can be eliminated, thereby allowing an uneven recording to be prevented.

A yet another embodiment will be described with reference to Figs. 39 and 40.

This embodiment is characterized in that a heating means is further provided between a heat applying means for applying heat to the surface of the recording member in a pattern and a transfer means for transferring ink images onto the recording medium.

According to this embodiment, it is possible to prevent an ink image formed on the second porous layer from solidifying, and higher-quality images free of nonuniformity in recording can be obtained.

Fig. 39 is a schematic diagram of a recording apparatus in accordance with this embodiment, while Fig. 40 is an explanatory cross-sectional view of the recording apparatus. Incidentally, those members that are similar to those shown in Fig. I are denoted by the same reference numerals, and description thereof will be omitted.

In the drawings, reference numeral 57 denotes a heating section and is constituted by a nichrome heater, an infrared heater, a high-frequency heater or the like. Reference numeral 58 denotes a heat-insulating member and is constituted by glass wool, asbestos, a foam, or the like. The heat-insulating member 58 is so arranged that the heat generating member 5 will not be subjected to thermal impact from the heating section 57.

Description will now be made of operation in cases where the apparatus having the above-described arrangement is used.

In effecting recording in accordance with the above-described recording method, the viscosity of the ink accommodated in the recording member I is lowered by applying heat in a pattern by means of the heat generating member 5 of the heat generating section 4, this ink is thereby caused to permeate the porous membrane layer Ib, and an ink image is formed on the surface of the recording member. Moreover, in this embodiment, the heating section 57 heats the ink image while it is being transferred onto the recording medium 3, and hence maintains the ink image in the state of low viscosity. Consequently, the ink image can be transferred favorably onto the recording medium 3.

(I) Although, in the above-described embodiment, the ink image is heated to maintain the viscosity at a low level, the transfer of the ink image onto the recording medium can be effected more favorably, for example, by simultaneously heating the recording medium as well.

(2) In addition, although, in the foregoing embodiment, the heating section is provided with a U-shape so as to conform with the configuration of the recording member, the transfer of the ink image onto the recording medium can be effected more favorably if the heating section is formed, for instance, into a cylindrical roller shape or the like.

(3) Furthermore, although, in the foregoing embodiment, the ink image is heated to maintain the viscosity at a low level, if the ink image which has once solidified is caused to melt again, the heat-insulating section can be eliminated by disposing the heat generating section further upstream of the recording member.

As described above, according to this embodiment, since the heating section is provided between the heat generating section for applying heat to the recording member in a pattern and the means for transferring an ink image onto the recording medium downstream of the heat generating section, it is possible to maintain the ink image formed on the recording member in a state of low viscosity. Consequently, since the molten state can be maintained, the ink image can be transferred favorably onto the recording medium. In addition, since the impact of the atmospheric temperature upon the ink image is very small, there are virtually no difference in the image quality resulting from the difference in districts or seasons, so that stable, high-quality images can be obtained. Furthermore, if the recording medium is also heated simultaneously with the heating of the ink image formed on the recording member, the amount of water contained in the recording medium is reduced, so that it is possible to obtain stable, high-quality images with no difference in the image quality which may otherwise be caused by the humidity. Moreover, since the heat fusible ink impregnating in the first porous layer is maintained at a fixed temperature under the influence of the heating section, the permeation of the ink through the second porous membrane layer can be effected favorably during the application of heat by the heat generating member. In addition, since the state of low viscosity of the heat fusible ink can be maintained by the heating section, the transfer can be effected favorably without any need to restrict the location of the heat generating section within a certain distance from the transfer position, or to restrict the linear velocity of the recording member above a fixed velocity. In consequence, the degree of freedom of the arrangement of the apparatus increases, so that it is possible to make the apparatus compact in size.

A still further embodiment will be described with reference to Figs. 4I and 42.

This arrangement is further provided with a means for heating the recording member and a means for cooling the same.

In the drawings, reference numeral 67 denotes a means for heating and cooling the recording member, and is constituted by a heater 68 such as a nichrome heater, an infrared heater, or a high-frequency heater, a fan 70 for blowing the air heated by the heater 68 as hot air or for blowing unheated air as cool air, and a motor 69 for rotating the fan 70.

In addition, reference numeral 7I denotes a section for measuring the temperature of the recording member, and this temperature measuring section 7I is constituted by a temperature sensor 72 such as a thermocouple as well as a heat-insulating member 73 for preventing the temperature sensor 72 from being subjected to effect of the heating and cooling section.

In this embodiment, in a recording process, the temperature of the recording member I is low immediately after the start of recording, and it can be estimated that, depending on the ambient temperature, it may be difficult for the ink 2 impregnating in the first porous layer Ia to pass through the second porous layer Ib. Therefore, the heater 68 in the heating and cooling section 67 is turned ON by a control signal from a controlling section (not shown), hot air is blown from the fan 70 to heat the recording member I so as the facilitate the passage of the ink 2 through the second porous layer Ib. In the meantime, the temperature of the recording member I is constantly measured by the temperature sensor 72 in the temperature measuring section 7l, and heating is stopped when the temperature of the recording member I reaches a minimum temperature T_1 at which the ink 2 can still readily pass through the second porous layer Ib. Subsequently, when the temperature of the recording member I becomes lower than T_1, heating is resumed, so that the temperature of the recording member I rises owing to the heat accumulated in the heat generating section 4. When the temperature of the recording member I subsequently reaches a temperature T_2 at which the state is unfavorable for recording since fogging and the like occurs, cool air is blown from the fan 70 with the heater 68 turned OFF to effect cooling, and the temperature of the recording member I is lowered to T_1. As described above, the temperature of the recording member I is maintained between T_1 and T_2, and stable, favorable recording is effected.

Incidentally, although, in the above-described embodiment, the arrangement is such that the section for heating the recording member and the section for cooling the same are combined, if they are installed independently, the efficiency is improved further since the heater will not be cooled during cooling. In addition, although, in the above-described embodiment, the arrangement is such that a heater using such as a nichrome wire and a fan are used for heating and cooling, it is also possible to effect heating and cooling efficiently by the use of a heat pipe, Peltier element, and the like. Moreover, if an arrangement is provided such that a heat-insulating member is disposed between the heating/cooling sections and the heat generating section, the thermal effect from the heating and cooling sections to the heat generating section can be reduced.

A further embodiment will now be described with reference to Figs. 43 and 44.

Fig. 43 is a schematic diagram of a recording apparatus in accordance with this embodiment, while Fig. 44 is an explanatory side elevational view of that recording apparatus.

In the drawings, reference numeral 8l denotes a recording member, which is installed on two shafts 87a, 87b in the form of a belt. The arrangement of the recording member 8l is such that a first porous layer 8la constituted by a soft sponge or the like based on such as ester, ether, or silicone is provided on a base 8lc composed of a rubber material such as natural rubber or synthetic rubber, or a soft plastic material such as polyvinyl chloride or ethylene resin. Furthermore, a second porous membrane layer of a porous ethylene tetrafluoride resin or the like is laminated on the outer surface of this first porous layer 8la. The first porous layer 8la is impregnated with heat fusible ink 82 over the entire surface thereof, and not only serves as a recording member but also serves to supply and retain the ink. The base 8lc is provided in such a manner that the ink 82 will not flow out from the first porous layer 8la. The shafts 87a, 87b are located inside the belt-shaped recording member 8l so as to move the recording member 8l. Further more, at least one of the shafts 87a, 87b is pulled by springs or the like (not shown) to provide fixed tension to the recording member 8l. Reference numeral 83 denotes a recording medium such as paper, which is held in contact with the recording member 8l.

In addition, reference numeral 84 denotes a heat generating section disposed upstream of the recording member 83, which is arranged by juxtaposing in an array a multiplicity of heat generating elements 85 that are capable of selectively generating heat in response to image signals supplied from the outside. This heat generating section 84 is adapted to allow the ink 82 inside the recording member 8l with its viscosity lowered to permeate the porous layer 8lb. Reference roller 86 denotes a platen roller, which is held in pressure contact with the recording member 8l via the recording medium 83.

Description will now be made of operation in cases where the apparatus as constructed above is used.

If the embodiment of this invention is used, tension is applied to the first porous layer 8la by means of the shafts 87a, 87b, and its hard is thus increased. Accordingly, the first porous layer 8la is not liable to be subjected to pressurization from the outside. Even if the first porous layer 8la is pressurized from the outside, and the thickness of the first porous layer 8la becomes small as a result, the two shafts 87a, 87b apply tension to the first porous layer 8la, expanding the interval between the shafts 87a, 87b. Hence, the second porous layer 8lb maintains a fixed tension, the second porous layer 8lb is prevented from forming creases or the like.

Although, in the above-described embodiment, the base is provided inside the first porous layer of the belt-shaped recording member, it is possible to use the ink without replenishing it for extended periods of time if the ink is filled in the space inside the first porous layer after removing the base. In addition, although, in the above-described embodiment, the two shafts are provided inside the belt-shaped recording member, if the number of the shafts is increased to three or more, the position of the heat generating section and transfer can be set freely. Furthermore, in the above-described embodiment, if the tension between the two shafts in changed, the amount of the ink permeating the second porous layer is varied, so that, if an arrangement is provided such as to allow the tension to be controlled, it is possible to control the recording density. In addition, although the diameters of the two shafts shown in the drawings relating to the embodiment are different, it is also possible to use shafts of the same diameter.

By adopting the arrangement of this embodiment, the following advantages can be obtained.

(l) Tension is applied to the first porous layer by means of the shafts and its hardness increases as a result. Consequently, the first porous layer is not liable to be subjected to impact with respect to pressurization from the outside. Even if it is deformed by pressurization from the outside, since a fixed tension is applied thereto, the problem of the second porous layer forming creases or the like can be prevented, so that recording can be effected favorably.

(2) When the shafts apply a fixed tension to the recording member, they act such as to extrude the ink impregnating in the first porous layer to the outside of the first porous layer. Therefore, it is possible to prevent the density from becoming lighter dowing to shortage of the ink in the vicinity of the heat generating section, with the result that recording can be effected favorably.

(3) Since the volume of the first porous layer can be made larger, the amount of the ink that can be impregnated also increases. Hence, extended periods of use is made possible without replacing the ink.

(4) Since the position of the heat generating section and transfer can be set freely to some extent, the degree of freedom of the arrangement of the apparatus can be enhanced.

As described above, this embodiment provides a recording apparatus which is capable of effecting a favorable recording of images.

Still another embodiment will be described with reference to Figs. 45 to 47.

This embodiment is further provided with a cleaner.

In the recording apparatus shown in Fig. 45, if the ink image on the recording member I fails to be transferred fully onto the recording medium 3, it can be anticipated that the ink image will remain on the recording member I. That residual ink image is removed by a cleaner 97 which is in contact with the recording member I downstream of the position of transfer. Incidentally, the cleaner 97 is capable of simultaneously removing deposits on the recording member I.

Incidentally, although, in this embodiment, the cleaner, in terms of its configuration, has a roll shape, it is also possible to arrange the cleaner as a blade type as shown in Fig. 46 and a belt type as shown in Fig. 47. When this cleaner is used, the other arrangements and the recording method are the same as those of the embodiments described above.

In Fig. 46, reference numeral 98 denotes a blade-type cleaner composed of a various kind of plastics, rubber, metal, or the like. Since the edge portion of the cleaner 98 works at an acute angle, the residual ink and other deposits on the surface of the recording member I can be removed efficiently. Furthermore, in Fig. 47, reference numeral 99 denotes a cleaner of a belt type which is composed of a urethane foam, fillings, a various kind of fiber, or the like and is so arranged as to be suspended on shafts l00a, l00b. In this case, since the area of contact between the recording member I and the cleaner 99 becomes large, the residual ink and other deposits on the surface of the recording member I can be removed efficiently.

Incidentally, although, in the embodiment described above, the arrangement is such that the cleaner is disposed downstream of the position of transfer, if it is disposed upstream of the heat generating section, cleaning is effected immediately before aplying heat, so that it is possible to reduce the distance at which stains, etc. are adhered to the recording member. In addition, if the cleaner is so arranged as to be brought into contact with the recording member by means of pressurization, cleaning can be effected more effectively.

By using the arrangement of this embodiment, the following advantages are obtained.

(l) The ensuing recording can be effected favorably since the residual ink which remains on the recording member without the ink image formed on the surface of the recording member being fully transferred onto the recording medium as well as other deposits on the surface of the recording member.

(2) If paper or the like is used as the recording medium, there are cases where paper dust or the like becomes adhered to the recording mem-

ber, but since they can be removed by using the cleaner, it is possible to effect recording favorably even if nappy paper or the like is used.

(3) Since the cleaner is in contact with the recording member, the cleaner not only effects cleaning but also serves as a heat sink, so that heat accumulation in the recording member can be prevented.

As described above, this embodiment provides a recording apparatus which is capable of effecting recording of images favorably.

Another embodiment will be described with reference to Fig. 48.

This embodiment concerns a method of and an apparatus for recording characterized in that the arrangement is made by a recording member having a first porous layer impregnated with ink and a second porous layer constituted by a porous membrane wound around the first porous layer in multiple layers and forming ink layers between the respective layers of the porous membrane; and a means for applying heat to the surface of this recording member in a pattern.

According to this embodiment, since the second porous layer is arranged in multiple layers, it excels in terms of strength, so that this second porous layer can be arranged by a thin membrane. Consequently, the heat conductance can be improved, and the ink permeability and the filtering effect can be enhanced remarkably, thereby preventing the phenomenon of the fogging of the ink and allowing clearer printing to be effected. At the same time, since ink layers are interposed between the layers of the second porous layer, the reaction of the lowering of the ink viscosity can be accelerated, with the result favorable recording can be effected.

Fig. 48 is an explanatory cross-sectional view of the recording apparatus in accordance with the present embodiment. In the drawing, reference numeral II0 is a recording member formed into a tubular shape, which is arranged such that a porous membrane layer II0b is laminated on the outer surface of a porous base II0a formed of a various kind of alloy fiber such as stainless steel in mesh. This porous membrane layer II0b is arranged in such a manner that a porous membrane II0c of a porous ethylene tetrafluoride resin [e.g., "GORE-TEX" (brandname) manufactured by JAPAN GORE-TEX INC.] formed into a thickness of 20 microns and a maximum pore diameter of 3 microns is wound around the outer surface of the porous base II0, as described above, in two layers. In winding the porous membrane II0c, it is wound along the rotational direction, and its outer end portion is adhered by making use of the adhesiveness of ink III, as shown in the drawing.

The ink III is a heat fusible ink impregnating the porous base II0 over the entire surface thereof, while reference numeral IIIa denotes an ink layer interposed between the porous membranes II0c of the porous membrane layer II0b. Numeral I04 denotes a heat generating section, which has heat generating elements I05 at the tip portion thereof. These heat generating elements I05 are arranged to be capable of abutting against the porous membrane layer II0b of the recording member II0.

Next, description will be made of a method of recording using the apparatus of this embodiment.

First, signals from the outside are sent to the heat generating section, and the heat generating elements I05 arrayed in the heat generating section are selectively caused to generate heat. As the heat is transmitted to the porous membrane layer II0b and the porous base II0a on the recording member II0 against which the heat generating section I04 abuts, the viscosity of the ink impregnating in this portion is lowered. The ink in the ink layer IIIa between the porous membranes of the porous membrane layer II0 passes through the outer membrane of the porous membrane II0c, and an ink image having a given configuration corresponding to the heat generating portion of the heat generating section I04 is fomed on the porous membrane layer II0b. In the portion where the ink of the ink layer IIIa has passed, the ink III impregnating in the porous base II0a passes the inner membrane of the porous membranes II0c, thereby replenishing the ink.

In addition, the porous membrane II0c is arranged to have properties that allow the ink III to permeate only when the viscosity of the ink III has been lowered by heat.

Subsequently, the ink image thus formed on the porous membrane layer II0b is transferred onto a recording medium I03 which is pressed by the platen roller I06 at a position contacting and opposed to the recording member II0, thereby forming an image on the recording medium I03.

Here, description will be made of the ink III accommodated in the recording member II0. Typically, a heat fusible ink may be used. Furthermore, the ink is preferably such as to be capable of maintaining a state in which it is constantly filled in the porous base, i.e., a semisolid ink or the like is preferable.

The heat fusible ink is arranged such that a colorant is dispersed or melted in a heat fusible binder, and the melt viscosity, adhesiveness, etc., are adjusted by adding elastomer or the like to the heat fusible binder. Although, in the above-described embodiment, the porous membrane layer II0b is formed of an ethylene tetrafluoride resin, a porous resin of such as other fluoride-based resin, silicon-based resin or a porous metallic membrane layer may also be used insofar as they meet the above-described conditions.

If a pressurizing means such as an external air compressor which is capable of applying pressure to the inside of the recording member 110 is provided in the foregoing embodiment, it is possible to facilitate the passage through the porous membrane layer 110b of the ink 111 which is accommodated in the recording member 110 and whose viscosity has been lowered by heat.

Furthermore, as for the recording medium, in addition to paper, it is possible to use one in which a high molecular film of Teflon, polypropylene, or the like is coated or laminated on its surface, such a sheet being generally used as a blackboard sheet.

In the foregoing embodiment, the arrangement is such that the porous membrane 110c constituting the porous membrane layer 110b is wound around the surface of the porous base 110a in two layers. However, if it is wound in a greater number of layers, the filtering effect of the porous membrane 110c increases, and fogging or the like can be reduced. Furthermore, since the thickness of the porous membrane 110c can be made thin in terms of the strength, the heat from the heating section can be transmitted to the ink layer 111a efficiently.

As described above, according to the present invention, since the arrangement is made by combining a recording member, in which a second porous layer is provided on the outer side of a first porous layer impregnated with ink by winding in multiple layers a porous membrane with an ink layer interposed between the membranes therearound, and a means for applying heat to the surface of this recording member in a pattern, the strength of the second porous layer is increased. Consequently, this porous membrane can be made even thinner, the heat conductance to the ink layer formed between the membranes and the first porous layer can be improved, so that the passage of the ink through the porous membrane can be effected favorably. In addition, the filtering effect can be enhanced with respect to the tendency of the ink to be lowered by heat accumulation. As a result, the phenomenon of fogging and the like can be reduced, and very clear recording can be effected positively. Furthermore, since the end portion of the porous membrane of the second porous layer can be secured by means of the adhesiveness of the ink when it is wound around the recording member, so that fixing with an adhesive is not required. Hence, there is an additional advantage in that an area in which printing is impossible owing to the adhesion of the adhesive can be eliminated.

Referring now to Figs. 49 to 51, another embodiment will be described.

Since this embodiment is provided with a means for replenishing the ink, it is possible to replenish the ink to the first porous layer. As a result, the thickness of the first porous layer can be made small, and, at the same time, it is possible to effect recording continuously for extended periods of time by using the same recording member. In addition, the deterioration of the image quality resulting from a shortage of ink can be prevented, so that stable, high-quality images can be obtained.

Fig. 49 is a schematic diagram of a recording apparatus in accordance with this embodiment, while Fig. 50 is an explanatory cross-sectional view of the recording apparatus.

In the drawings, reference numeral 121 is a recording member formed into a tubular shape, and is arranged such that a porous membrane layer 121b is laminated on the outer surface of a porous base 121a formed of a various type of alloy fiber of such as stainless steel in mesh. The porous base 121a is formed into a cylindrical shape as a whole, and is so arranged as to allow the ink to be reserved in its inside. This porous membrane layer 121b is arranged by forming a porous ethylene tetrafluoride (e.g., "Fluoropore" (brandname) manufactured by Sumitomo Electric Industries Ltd.) with a thickness of 100 μ and an average pore diameter of 10 μ. Reference numeral 122 denotes a heat fusible ink, and is impregnated in the porous base 121a over the entire surface thereof. Reference numeral 123 denotes a recording medium such as paper, which is in contact with the recording member 121.

In addition, the arrangement is such that a rotational shaft 121c of the recording member 121 is formed into a hollow shape, and the ink 122 is pored into the end portion thereof in the direction of 'C' shown in Fig. 49, thereby allowing the ink 122 to be filled into the hollow portion of the porous base 121a.

The ink 122 filled in the inside of the recording member 121 via the rotational shaft 121c in the direction of the arrow 'C' shown in Fig. 49 flows in conjunction with the rotation of the recording member 121 in the direction of the arrow 'A', and is brought into contact with or adhere to the inner wall of the first porous layer 121a. At that juncture, the ink 122 enters the space between fibers in the direction of the arrow 'E' by virtue of the capillarity of fibers of the first porous layer 121a and impregnates the entire surface of the first porous layer 121a.

In the above-described embodiment, in the arrangement of the recording member 121 the porous base 121a formed of alloy fibers in mesh is used and the porous membrane layer 121b is laminated on the outer surface thereof. However, as shown in Fig. 5l, in arranging the recording member l2l, an arrangement may also be provide such that, by using a pipe-shaped core material l28 formed in alloy mesh which allows the ink l22 to pass through the peripheral wall surface thereof, a sponge base l27 of silicone rubber impregnated with the ink l22 in the outer surface thereof is provided, and the porous membrane layer l2lb similar to the one used in the above-described embodiment is laminated on the outer surface thereof. When using this recording member l2l, the other arrangements and the recording method are entirely the same as those of the above-described embodiment.

Since the inside of this recording member l2l is constituted by the sponge base l27, the recording member l2l per se is elastic, so that, since adhesion thereof to the recording member l23 is improved, it is possible to effect the transfer of ink images efficiently.

Furthermore, since the ink l22 is reserved in the pipe-shaped core member l28 in the core portion of the sponge base l27, the ink l22 can be replenished gradually to the sponge base l27.

Incidentally, if a pressurizing means such as a compressor is provided in replenishing the ink in the above-described embodiment, it is possible to facilitate the impregnation the first porous layer with the ink.

In addition, if a heating means such as a heater is provided in replenishing the ink in the above-described embodiment, it is possible to facilitate the lowering the viscosity of the ink and the impregnation of the first porous layer with the ink.

According to this embodiment, since a means for replenishing the ink to the recording member is provided, it is possible to replenish the ink to the recording member. Consequently, it is possible to employ the same recording member over extended periods of time, so that the running costs can be reduced. At the same time, since the replenishment of the ink becomes possible, the first porous layer or the sponge base can be made thin, with the result that the recording member can be compact and light in weight. Furthermore, since the ink replenishment can be readily effected, it is possible to prevent the deterioration of ink images resulting from an ink shortage or the like. Thus, stable, high-quality images can be obtained advantageously.

Furthermore, another embodiment will be described with reference to Figs. 52 and 53.

This embodiment is provided with a means for pressing and cooling the surface of the recording member. According to this embodiment, since the arrangement is such that a pressing and cooling means is provided on the surface of the recording member consisting of a first porous layer impregnated with ink and a second porous membrane layer disposed of said layer, even if the amount of ink impregnating the first porous layer is reduced, the ink accommodated in the first porous layer is extruded to the surface side of the recording member. At the same time, the ink extruded to the surface side of the recording member is immediately cooled to increase the ink viscosity, thereby preventing the ink from returning to the inner side of the first porous layer. Since the ink can thus be reserved sufficiently on the surface side of the first porous layer, it is possible to prevent the reduction in the density of recorded images.

In the drawings, reference numeral l38 denotes a pressing and cooling roller, and, as shown in Fig. 52, the pressing and cooling roller is brought into pressure contact with a recording member l3l and is disposed upstream of the contacting position of a heat generating member l35 and downstream of the position of pressure contact with a recording medium l33. The pressing and cooling roller l38 rotates in the direction of the arrow illustrated in the drawings in conjunction with the rotation of the recording member l3l.

Incidentally, this pressing and cooling roller l38 is composed of a highly heat-conductive material such as pipe-type metal. Its longitudinal length is the same as that of the recording member l3l. In addition, reference numeral l32 denotes a core metal.

Description will then be made of a mechanism and the like in cases where recording is effected by using the apparatus of this embodiment.

First, external signals are sent to the heat generating section l34, and the heat generating elements l35 juxtaposed in array in this heat generating section l34 is thereby caused to generate heat. By transmitting the heat to the porous membrane layer l3la and the sponge base l37 of the recording member l3l with which the heat generating section l34 is in contact, the viscosity of the ink impregnating that portion is lowered. Meanwhile, the ink whose viscosity has been lowered permeates the porous membrane layer l3la, with the result that an ink image having a predetermined configuration corresponding to the heat-generated portion of the heat generating section l34 is formed on this porous membrane layer l3la.

Next, as shown in Fig. 52, the ink image thus formed on the porous membrane layer l3la moves in conjunction with the rotation of the recording member l3l in the direction of the arrow, and is then transferred onto the recording medium l33 which is pressed by the platen roller l36 downstream at a position of abutting and opposed to the recording member l3l, thereby forming an image on the recording medium l33.

Description will be made of the operation and effect of the pressing and cooling roller I38. The surface of the recording member I3I is pressure-contacted by the roller I38, and, at this time, the sponge base I37 impregnated with the ink is pressed and the heat at the surface releases heat to the side of the roller I38. Consequently, the following phenomenon takes place in the portion of the sponge base I37 thus pressed.

In other words, the ink in the lower layer of the sponge base I37 is extruded to the surface side and is cooled, so that the viscosity of the ink is increased. At the time when the sponge base I37 after passing along the roller I38 is restored to its original state, it becomes difficult for the ink whose viscosity has been lowered and which is placed in the vicinity of the surface to return to the lower layer of the sponge base I37 since its viscosity has been increased, so that most of it is reserved there.

Consequently, as the recording member passes along this roller I38, the ink accommodated in the sponge base I37 moves to the surface side.

As described earlier, in this embodiment, since the ink accommodated in the sponge base I37 is forced to move to the surface side of the sponge base I37, even if the amount of the ink contained in the sponge base I37 is reduced to some extent, the adverse effect on the recording characteristics and the density of recorded images can be alleviated remarkably.

In addition, the porous membrane layer I3Ia is arranged to have properties which allow the ink to permeate therethrough only when the viscosity of the ink is lowered by heat.

Furthermore, although, in the above-described embodiment, the porous membrane layer I3Ia is composed of an ethylene tetrafluoride resin, it is also possible to use a porous resin such as other fluoride-based resin or silicon-based resin, a porous metallic membrane or the like.

As described above, if the porous membrane layer I3Ia used has small surface tension such as the ethylene tetrafluoride, since it excels in ink releasibility, the ink on the porous membrane layer I3Ia can be transferred smoothly onto the recording medium I33.

In addition, with respect to the pressing and cooling roller I38 in the above-described embodiment shown in Fig. 52, an arrangement in which a heat medium such as fleon gas circulates in the hollow portion thereof, i.e., a heat pipe, may be adopted. If this arrangement is adopted, the cooling performance can be further enhanced, and the hindrance to the mechanism due to heat accumulation can be prevented.

Fig. 53 shows an embodiment which is different from the above-described one, and is arranged such that, in place of the roller I38 of the above-described embodiment, a radiating plate I39 with fins is fixed such as to press the recording member I3I. In this embodiment as well, since the same mechanism as that of the above-described embodiment can be produced, there is an effect that the ink accommodated in the sponge base I37 can be moved to the surface side. In this embodiment, since a drive portion is not provided, there is an advantage in that the arrangement of a holding member, etc. for the radiating plate I39 can be made simpler than in the case of the above-described embodiment.

A further embodiment will now be described with reference to Figs. 54 to 56.

This embodiment is provided with a means for absorbing the heat of the surface of the recording member after the ink is transferred onto the recording medium.

In the drawings, reference numeral I4I denotes a recording member formed into a tubular shape. The arrangement of the recording member I4I is such that a porous layer I4Ib is laminated on the peripheral surface of a porous base layer I4Ia, and is adapted to rotate in the direction of the arrow 'a' by means of a driving means (not shown).

The base layer I4Ia is composed of a sponge of silicone rubber, and is impregnated with ink I42 on the entire surface thereof. In addition, the membrane layer I4Ib is composed of a porous ethylene tetrafluoride [e.g., "Fluoropore" (brandname) manufactured by Sumitomo Electric Industries Ltd.], and is formed into a thin layer with a thickness of about 20 μm and with an average pore diameter of I0 μm.

Subsequently, when the surface of the recording member rotates after the transfer of the ink and is brought into contact with a heat sink roller I47, the heat generated by a recording head I43 is absorbed by the roller I47. Consequently, the heat accumulation of the recording member I4I ceases, the occurrence of fogging in a non-image portion resulting from heat accumulation is prevented. In addition, since the heat sink roller I47 rotates in contact with the recording member, even if unnecessary deformation occurs in the base layer I4Ia of the recording member I4I, the heat sink roller I47 rotates while correcting said deformation.

If transfer recording is effected by repeating the above-described process, and the rear end of the recording medium I44 is detected by a light-emitting device I46a and a light-receiving device I46b upon completion of the recording, the recording head I43 is moved to separate from the recording member I4I.

By effecting recording as described above, it becomes possible to record desired images without using any ink film and without staining the recording head by ink.

Although, in the above-described embodiment, the recording member is arranged such that the membrane layer 141 is laminated on the base layer 141a, as shown in Fig. 55, the recording member 141 may be arranged by forming, for example, a porous ethylene fluoride resin or the like into a roll shape with a thickness of about 5 mm without using the membrane layer, and by impregnating the roll with the ink 142. In this case, since the recording layer is constituted by a single layer, the arrangement becomes simple and the costs can be reduced.

In addition, recording may be effected with an arrangement shown in Fig. 56. The apparatus shown in Fig. 56 is arranged as follows: The heat generating elements 43a of the recording head 143 are brought into pressure contact with the peripheral surface of the platen roller 148 rotating in the direction of the arrow 'c', and the recording member 141 is brought into pressure contact with the peripheral surface of the plan roller 148 and is rotated in conjunction with the rotation of the roller 148.

Although, in the above-described embodiment, an attempt is made to prevent heat accumulation and correct the deformation of the recording member 141 by means of the heat sink roller 147, separate members may be provided for these functions. For instance, as a means for correcting the deformation of the recording member 141, a blade or the like may be used.

Another embodiment will now be described with reference to Figs. 57 to 61.

This embodiment is characterized in that a conveying means for conveying a recording medium after heating such as to be in planar contact with the surface of a recording member, thereby to effect transfer recording.

According to the above-described embodiment, if heat corresponding to image signals is applied to the recording member, the ink in the porous layer is melted or its viscosity is lowered, whereby the ink is transferred onto the recording medium. Furthermore, by conveying the recording medium as it is held in planar contact with the surface of the recording member after the recording member has been heated, the ink which has been melted or whose viscosity has been lowered is transferred onto the recording medium and is then cooled. Accordingly, clear images are transferred onto the recording medium.

The arrangement of this conveying means is as follows. As shown in Fig. 57, a pair of feed rollers 155a and a pair of discharge rollers 155b provided in the vicinity of an inlet port 154a and a discharge port both disposed at an outer casing of the apparatus for insertion and discharge of the recording medium are respectively rotated in the direction of the arrows by means of a driving means (not shown). In addition, a guide plate 155c is provided along the peripheral surface of the recording member 141. Also, guide plates are provided between the pairs of rollers 155a, 155b, respectively. Accordingly, the recording medium 153 being conveyed by the pair of feed rollers 155a and the pair of discharge rollers 155b is conveyed along the peripheral surface of the recording member 141 while being guided by the guide plates 155c, 155d.

In addition, a recording head 156 is disposed in a conveying passage of the recording medium 153. This recording head 156 is brought into pressure contact with the surface of the recording member 141 via the recording medium 153, and is adapted to heat the surface of the recording member 141 in response to image signals. The recording head 156 has a length substantially identical with that of the recording member 141, and a multiplicity of arrays of heat generating elements which generate heat in response to image signals are disposed in the longitudinal direction thereof. The recording head 156 is arranged as a so-called line-type recording head.

Furthermore, a metallic heat sink roller 157 having good heat conductivity is brought into pressure contact with the surface of the recording member 141 via the recording medium 153 downstream of the recording head 156 in the advancing direction of the recording medium 153. This heat sink roller 157 has the functions of absorbing the heat of the surface of the recording member heated by the recording head 156 and of preventing the deformation of the recording member 141, thereby smoothening the surface thereof.

Incidentally, reference numeral 158 denotes a sensor for detecting the presence or absence of the recording medium, and this sensor is constituted by a photo-coupler or the like disposed in the vicinity of the inlet port 154a for insertion of the recording medium 153. Meanwhile, numeral 159 denotes a control section for controlling the drive of the apparatus.

Description will now be made of a method of recording using the recording apparatus as constructed above.

First, if the recording medium 153 is inserted into the inlet port 154a, the detection sensor 158 detects the same, and upon receipt of the detection signal the pair of feed rollers 155a and the pair of discharge rollers 155b are driven. Consequently, the recording medium 153 is conveyed, and when the tip of the recording medium 153 is conveyed to between the recording member and the recording head 156, the recording member 141 rotates in the direction of the arrow 'a'. At the same time, the heat generating elements 156a of the recording head 156 generates heat in response to image signals. This heat is transmitted to the membrane layer 141b and the base layer 141a of the recording member 141 via the recording medium 153, and melts the ink 142 impregnating the base layer 141a or lowers its viscosity. Subsequently, the ink 142 which has melted or whose viscosity has been lowered permeates the fine pores of the membrane 141b so as to be transferred onto the recording medium 153.

Furthermore, the recording medium 153 which has passed the position of the recording head 156 is conveyed in a state in which it is in planar contact with the peripheral surface of the recording member 141 while being guided by the guide plate 155c. Accordingly, the recording medium 153 on which the ink remains adhered by heating by the recording head 156 is conveyed for a fixed duration of time as it is adhered on the surface of the recording member 141. Consequently, the ink which has melted or whose viscosity has been lowered is positively transferred onto the recording medium 153, and is, at the same time, cooled to become solidified or undergoes an increase in viscosity. For this reason, ink in the pattern of the image is positively transferred onto the recording medium 153, and a clear image is obtained.

Furthermore, when the surface of the recording member 141 heated by the recording head 156 rotates and is brought into contact with the heat sink roller 157 via the recording medium 153, the heat is absorbed by the roller 157. Consequently, the heat accumulation on the surface of the recording member 141 ceases, so that the occurrence of fogging or ghost in the non-image portion resulting from heat accumulation can be prevented. In addition, since this heat sink roller 157 rotates in pressure contact with the recording member 141, even if unnecessary deformation occurs in the base layer 141a of the recording member 141, the heat sink roller 157 rotates while correcting the same.

By effecting recording as described above, it is possible to effect transfer recording of images clearly onto the recording medium 153 without using any ink film.

Although, in the above-described embodiment, the arrangement is such that the recording medium 153 is brought into planar contact with the surface of the recording member 141, an arrangement may also be provided as shown in Fig. 58.

This arrangement is such that a plurality of pressure rollers 160 are disposed along the peripheral surface of the recording member 14a, and guide plates 160a are provided between the adjacent pressure rollers 160, in such a manner that the recording medium 153 being conveyed by the rollers 160 is pressed against the surface of the recording member 141. This arrangement makes it possible to apply contacting pressure to the recording medium 153 being conveyed in planar contact with the surface of the recording member 141, and the ink heat-transferred by the recording head 156 can be positively transferred onto the recording medium 153.

Incidentally, in the above-described arrangement, if the pressure rollers 160 are composed of a material having good radiating properties, such as a metal, the surface of the recording member 141 is free of heat accumulation without specially providing the heat sink roller as in the case of the embodiment shown in Fig. 57, and the occurrence of fogging and ghost can be prevented.

Furthermore, if, as shown in Fig. 59, an arrangement is provided such that a pressing belt 161 which is brought into planar contact with the surface of the recording member 141 is trained among the pressure rollers 162, and if these members are made to rotate in synchronization with the rotation of the recording member 141, the recording medium 153 which has been heated by the recording head 156 and onto which the ink has been transferred can be adhered to the surface of the recording member 141 with uniform contacting pressure and can be conveyed in that state. Therefore, it becomes possible to positively transfer the ink 142 onto the recording member 153.

In this case as well, if the pressing belt 161 is composed of a material having good heat conductivity, such as stainless, since the belt 161 is in contact with the recording member 141 over a wide area, the radiation from the recording member 141 is accelerated. As a result, even if the recording speed is increased, fogging and ghost can effectively be prevented.

In addition, in the arrangement shown in Figs. 57 to 59, an arrangement may alternatively be provided such that the guide plate 15c, the pressure rollers 160, or the pressing belt 161 are made movable so as to freely change the area of contact between these members and the recording member 141.

In the above-described embodiment, if a means for applying pressure to the inside of the recording member 141, such as an air compressor, is provided on the outside, it becomes possible to facilitate the passage through the porous layer of the ink I42 which is accommodated in the recording member I4I and whose viscosity has been lowered by heat.

Although, in the above-described embodiment, the recording member I4I is arranged such that the membrane layer I4Ib is laminated on the base layer I4Ia composed of a sponge of silicone rubber, an arrangement may be provided such that the recording member I4I is constituted by a single layer using, for instance, a porous ethylene fluoride resin formed into a roll shape without providing the membrane layer I4Ib. On the contrary, the recording member I4I may be provided with a multi-layer structure having three or more layers.

In addition, although, in the above-described embodiment, an example is shown in which the base layer I4Ia of the recording member I4I is composed of a sponge of silicone rubber, the base layer I4Ia may be composed of metallic mesh, porous rubber, or the like insofar as it is capable of being impregnated with the ink I42.

Similarly, although, in the above-described embodiment, an example is shown in which the membrane layer I4Ib of the recording member I4I is composed of an ethylene tetrafluoride resin, the membrane layer I4Ib may be composed of a porous resin such as other fluoride-based resin, or silicon-based resin, a fabric such as aramid fiber or fluoride fiber, or a porous metallic membrane, or other similar material.

In the embodiment described above, the heating of the recording member I4I by the recording head I56 is effected via the recording medium I53. However, by using the ink having supercooling characteristics as described above, it is also possible to adopt the following arrangement: The heat generated by the heat generating elements I56a is applied directly to the surface of the recording member I4I by bringing the recording head I56 into direct contact with the recording member I4I, and after a thermal latent image has been formed on the surface of the recording member I4I, the recording medium I53 is adhered to the recording member I4I. Then the ink I42 which has melted or whose viscosity has been lowered is transferred onto the recording medium I53.

Furthermore, as shown in Fig. 6I, it is also possible to adopt an arrangement in which a thermal latent image is formed on the recording medium I53 in the pattern of an image by bringing the recording head I56 into contact with the recording medium I53, and the ink is melted into the pattern of the image or its viscosity is lowered by bringing the recording medium I53 in contact with the recording member I4I.

Thus, according to this embodiment, since the recording medium is conveyed in planar contact with the surface of the rotating recording member I4I, the ink whose viscosity has been lowered by heating can be made to thoroughly fixed on the recording medium and be transferred positively thereonto. Consequently, it is possible to effect transfer recording of images clearly.

As described above, the present invention provides a method of and apparatus for recording which are capable of recording clear images on a recording medium at low cost.

Claims

1. A method of recording images on a recording medium, comprising the steps of:
heating a recording member having ink for effecting recording of an image on said recording medium and a porous material allowing the ink to permeate therethrough in response to an image signal;
conveying said recording medium to said recording member after heating; and
transferring the ink onto said recording medium via said porous material.

2. An apparatus for recording images on a recording medium, comprising;
a recording member having ink for effecting recording of an image on said recording medium;
heating means for heating said recording member in response to an image signal; and
conveying means for conveying said recording medium in such a manner as to bring said recording medium into contact with said recording member which has been heated by said heating means.

3. An apparatus for recording images on a recording medium, comprising:
ink for effecting recording images on said recording medium;
a recording medium having porous material allowing the ink to permeate therethrough, the pore diameter of the porous material constituting a surface region of said porous material being identical with or smaller than the pore diameter of the porous material constituting an inner region of said porous material;
heating means for heating said recording member in response to an image signal, and
conveying means for conveying said recording medium in such a manner as to bring said recording medium into contact with said recording member which has been heated by said heating means.

4. A recording apparatus according to claims 2 or 3, further comprising dispersing means for dispersing inside said recording member the ink accommodated in said recording member.

5. A recording apparatus according to claim 4, wherein said dispersing means is constituted by means for applying heat to the surface of said recording member.

6. A recording apparatus according to any of claims 2 to 5, wherein said conveying means conveys said recording medium in planar contact with the surface of said recording member which has been heated.

7. A recording apparatus according to any of claims 2 to 6, wherein the application of heat to said recording member by said heating means is effected via said recording medium.

8. A recording apparatus according to any of claims 2 to 7, further comprising ink replenishing means for replenishing the ink to said recording member.

9. A recording apparatus according to claim 8, further comprising cooling means for cooling said recording member downstream of said ink replenishing means in the rotational direction of said recording member.

10. A recording apparatus according to claim 3, wherein said porous material has a first porous layer impregnated with the ink and a second porous layer disposed on said first porous layer.

11. A recording apparatus according to claim 10, wherein said first porous layer is constituted by a plurality of materials with different hardness.

12. A recording apparatus according to any of claims 2 to 11, further comprising further heating means disposed between said heating means and a position for transferring an ink image onto said recording medium.

13. A recording apparatus according to any of claims 2 to 12, further comprising means for heating said recording member and means for cooling the same.

14. A recording apparatus according to claim 13, wherein the temperature of said recording member is measured, and the heating and cooling of said recording member is controlled on the basis of the result thereof.

15. A recording apparatus according to claim 3, wherein said porous material has the shape of a belt.

16. A recording apparatus according to any of claims 2 to 15, further comprising a cleaner for removing residual ink or deposits adhered on the surface of said recording member.

17. A recording apparatus according to claims 2 or 3, wherein said recording member has a first porous layer and a second porous layer wound around said first porous layer multiple times.

18. A recording apparatus according to any of claims 2 to 17, further comprising means for pressing and cooling the surface of said recording member.

19. A recording apparatus according to claim 3, wherein said porous material is constituted by a single layer, and the pore diameter on the surface side thereof is made identical with or smaller than the pore diameter on the inner side.

20. A recording apparatus according to claim 3, wherein the porous material comprises a plurality of layers, the surface layer of which has a pore diameter equal to or smaller than that of the inner layer or layers.

21. A recording apparatus, comprising a recording member having a first porous layer impregnated with a heat-fusible ink and a second porous layer disposed on the first porous layer, means for applying heat to the surface of the recording member in a pattern, and means for applying a recording medium to the recording member, whereby ink is transferred to the recording medium in said pattern.

Fig. 1

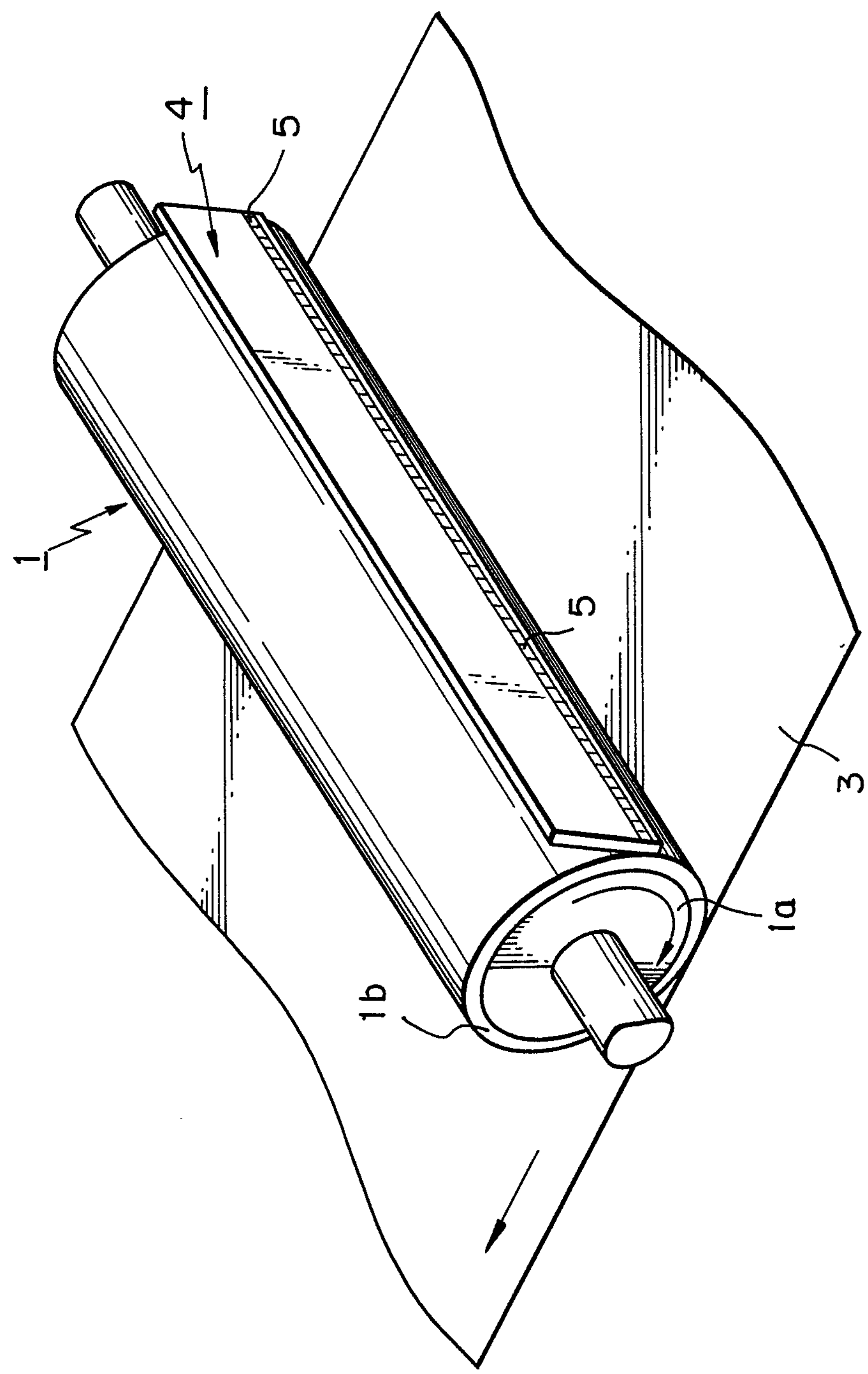


Fig. 2

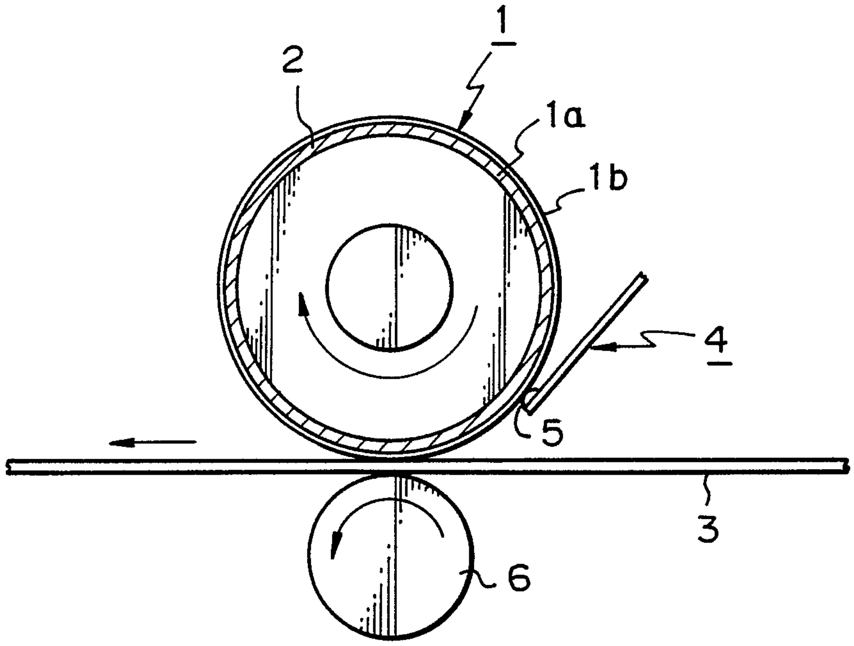


Fig. 3

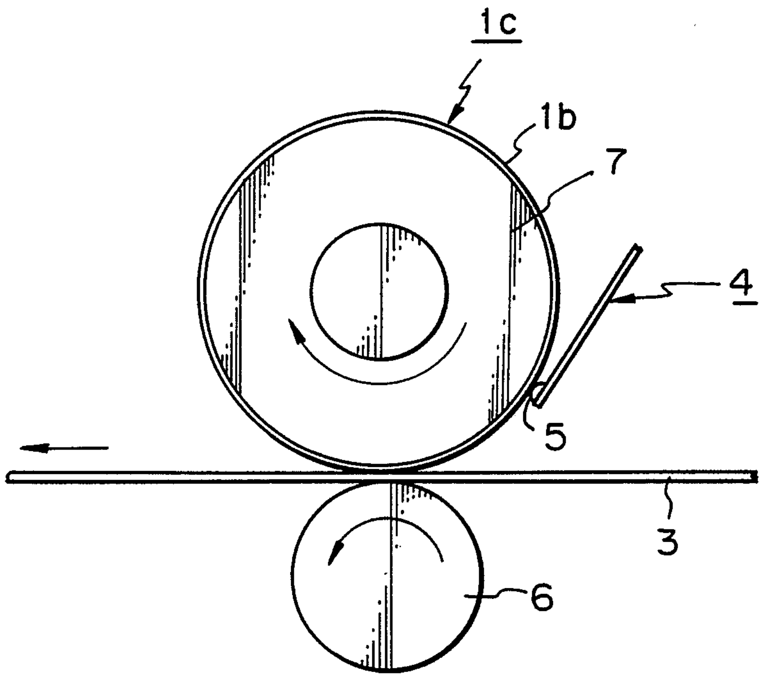


Fig. 4

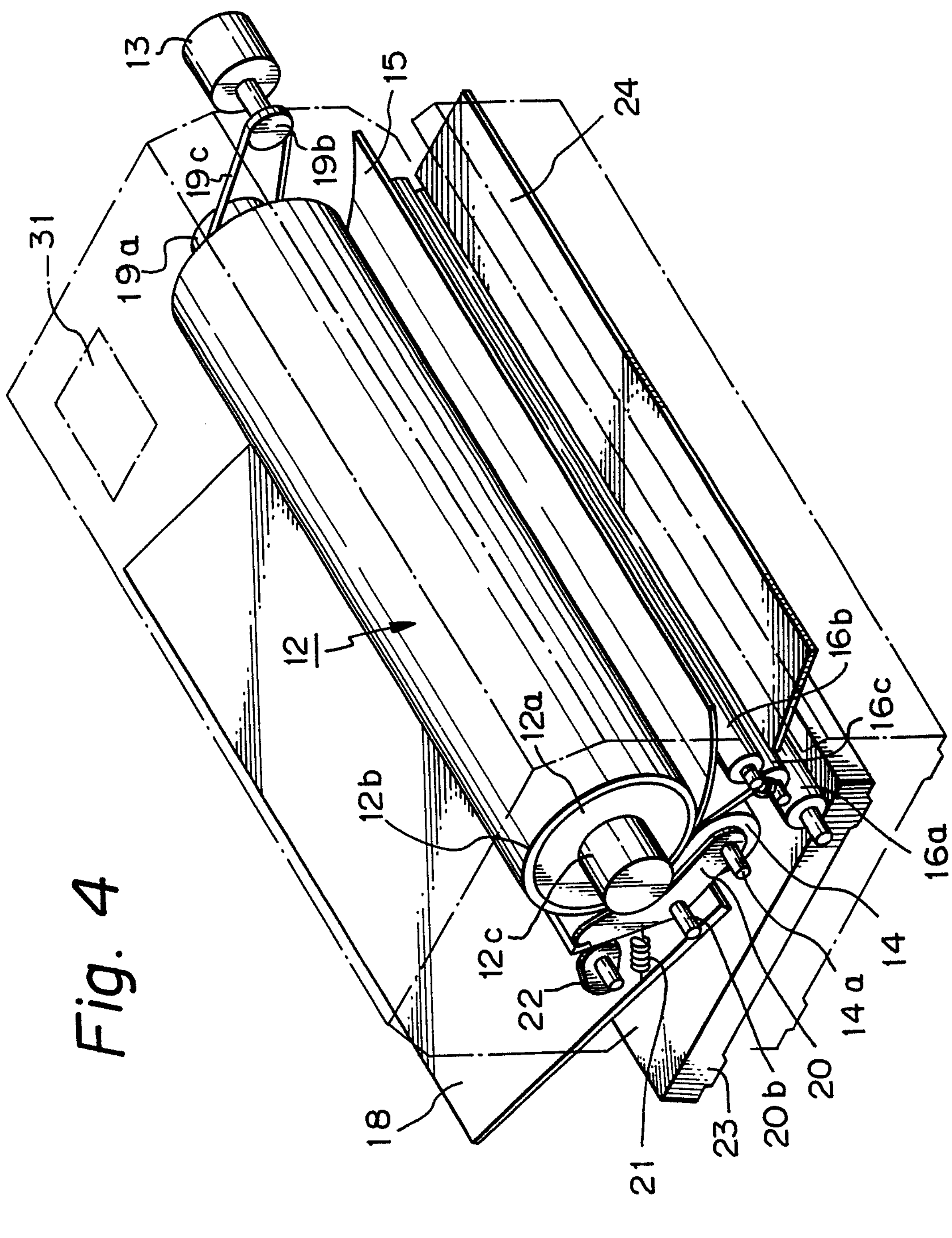

13
15
24
19b
19c
31
19a
12
12a
12b
12c
16b
16c
16a
14
14a
20
20b
22
23
21
18

Fig. 5

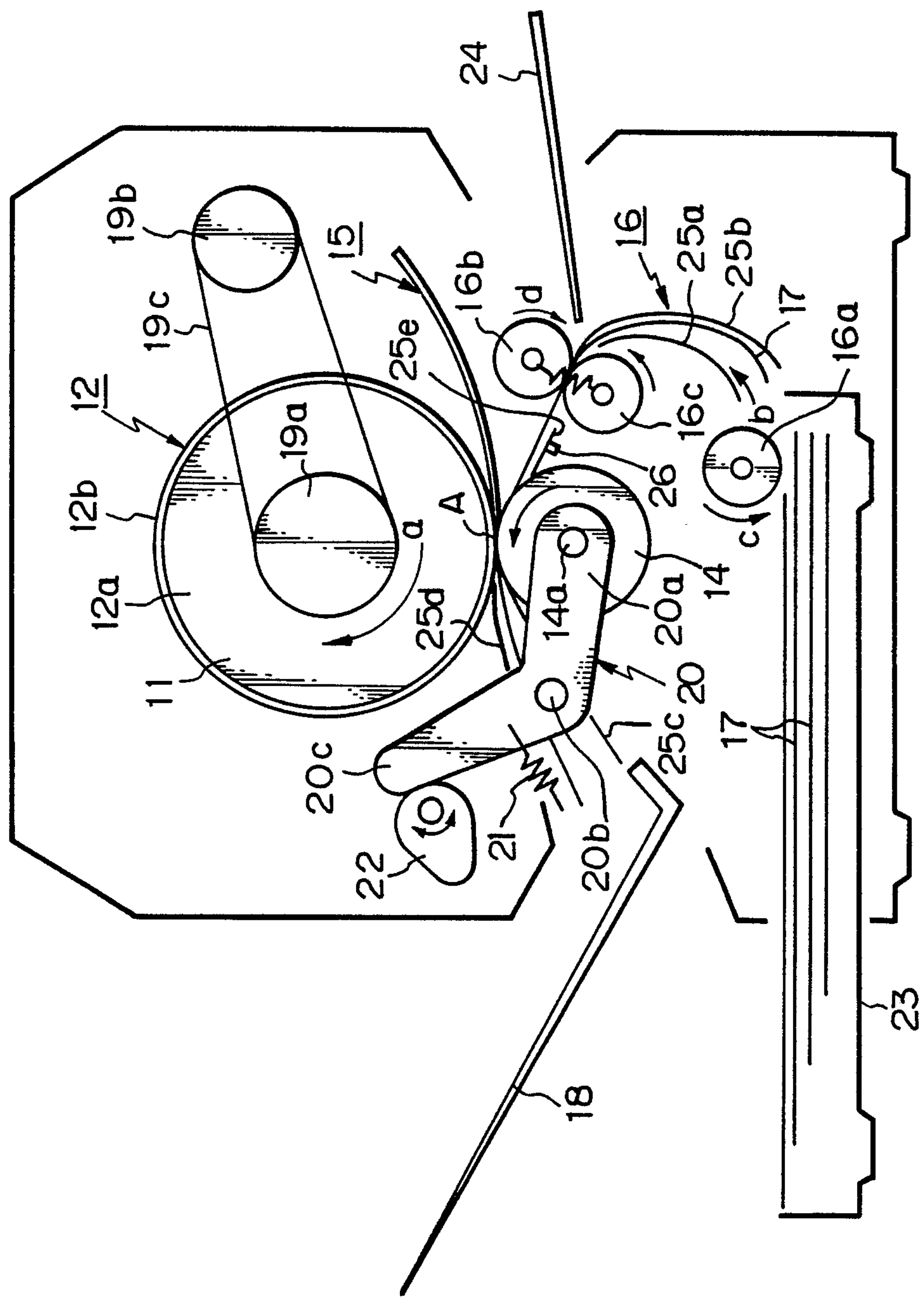

24
19b
15
16
25a
25b
17
16b
d
19c
25e
16c
16a
b
12
19a
26
A
c
12b
a
14
12a
14a
20a
25d
20
11
17
25c
20c
21
20b
22
23
18

Fig. 6

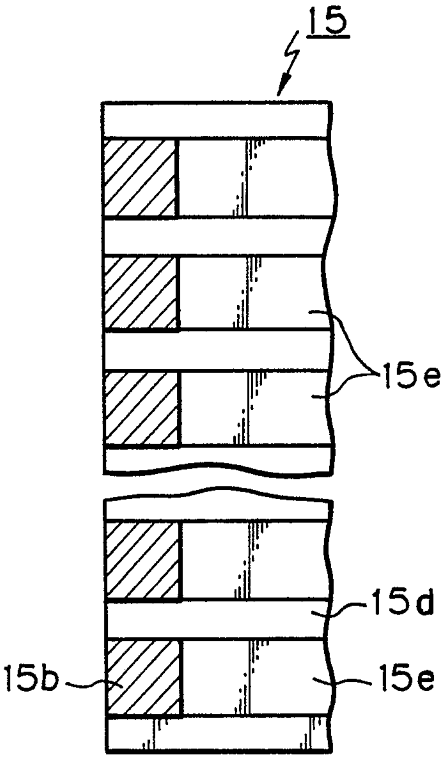


Fig. 7

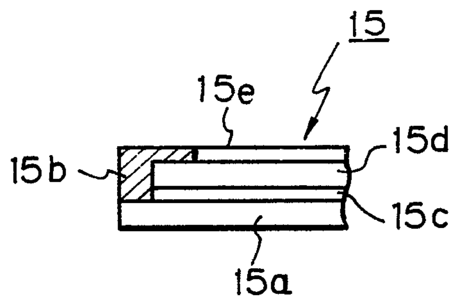
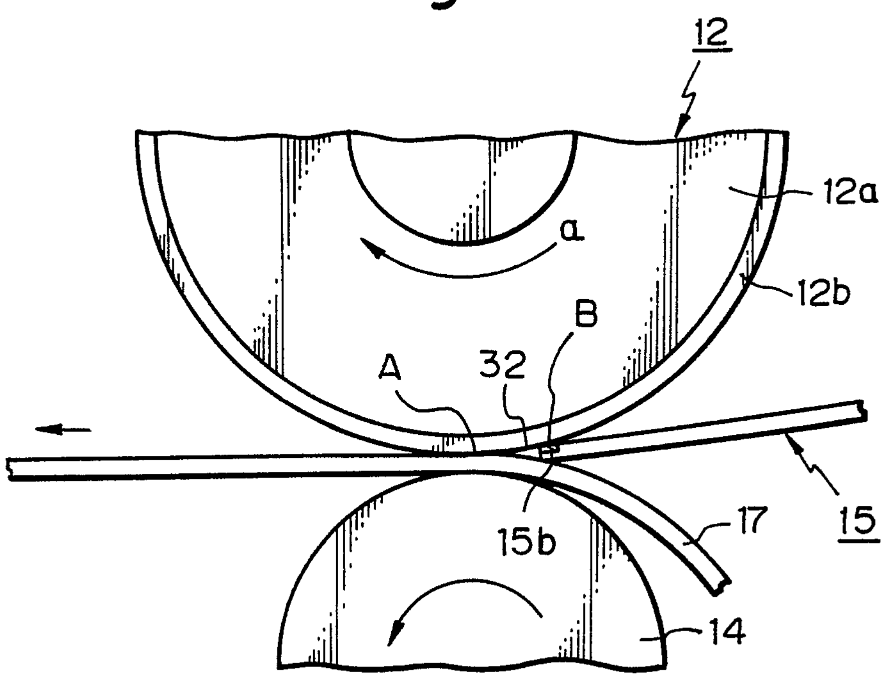


Fig. 8



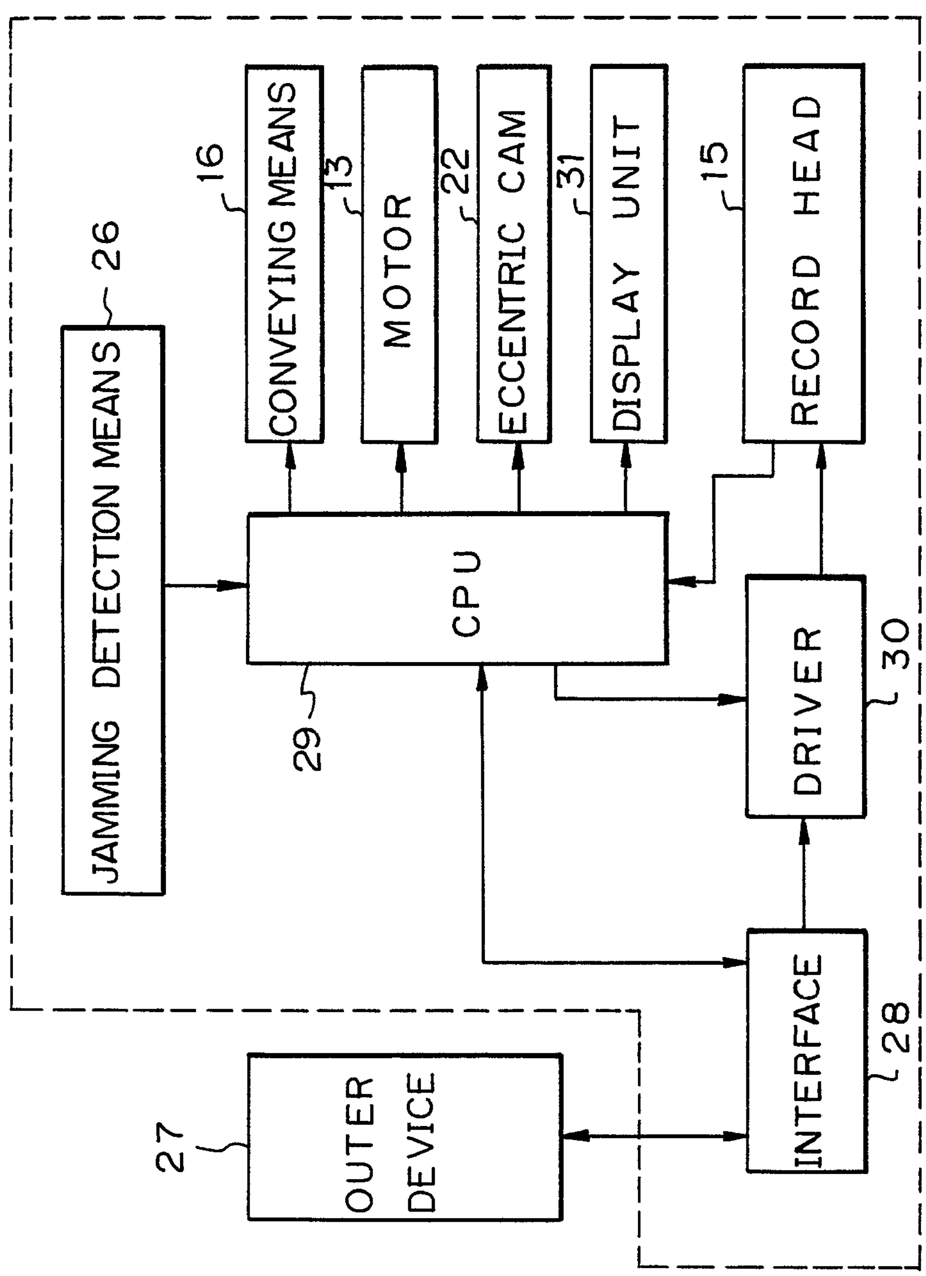

JAMMING DETECTION MEANS
26
CONVEYING MEANS
16
MOTOR
13
ECCENTRIC CAM
22
DISPLAY UNIT
31
RECORD HEAD
15
CPU
29
DRIVER
30
INTERFACE
28
OUTER DEVICE
27

Fig. 9

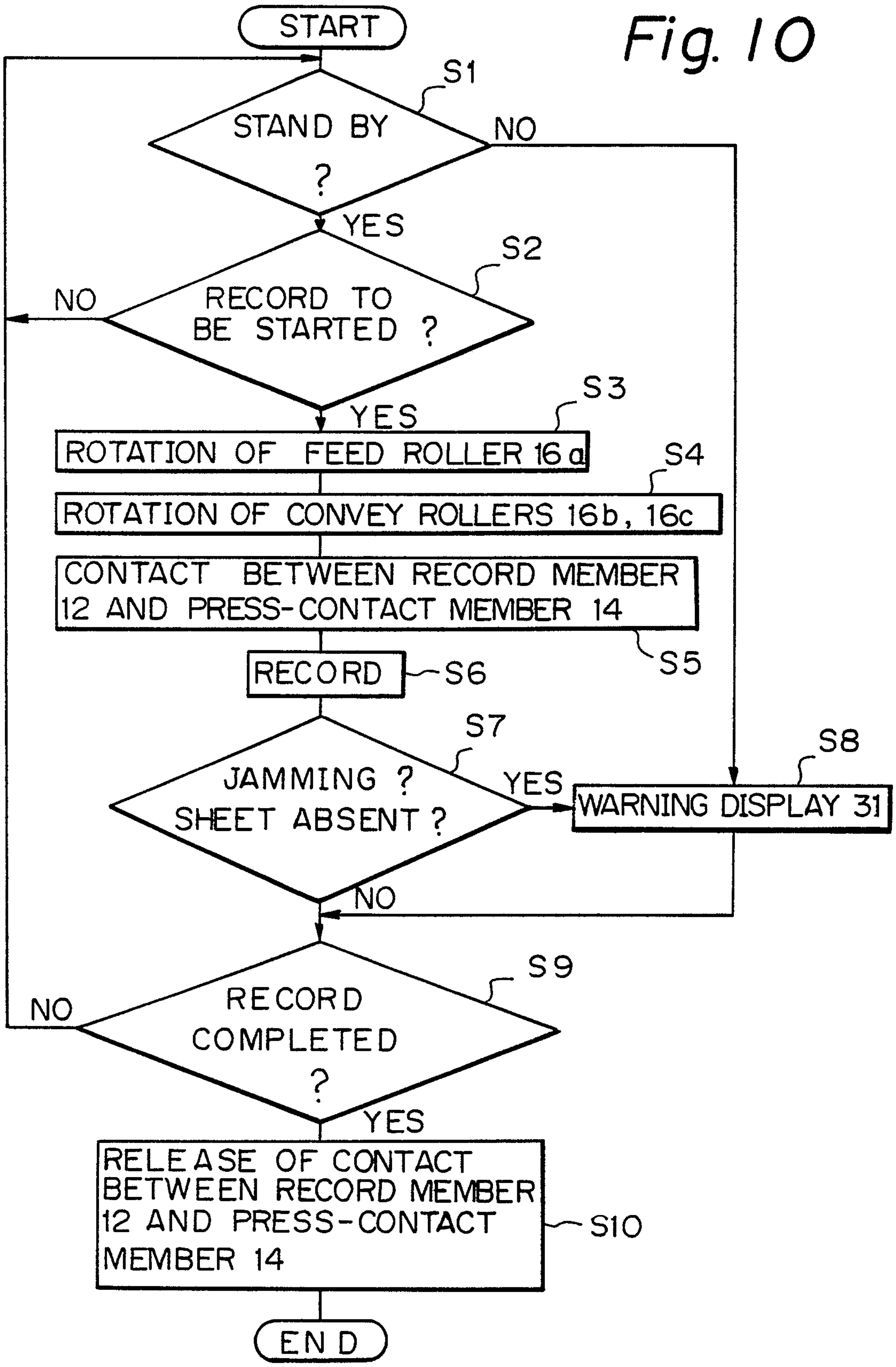

START
S1
STAND BY ?
NO
YES
S2
RECORD TO BE STARTED ?
NO
YES
S3
ROTATION OF FEED ROLLER 16a
S4
ROTATION OF CONVEY ROLLERS 16b, 16c
CONTACT BETWEEN RECORD MEMBER 12 AND PRESS-CONTACT MEMBER 14
S5
RECORD
S6
S7
JAMMING ? SHEET ABSENT ?
YES
S8
WARNING DISPLAY 31
NO
S9
RECORD COMPLETED ?
NO
YES
RELEASE OF CONTACT BETWEEN RECORD MEMBER 12 AND PRESS-CONTACT MEMBER 14
S10
END

Fig. 10

Fig. 11

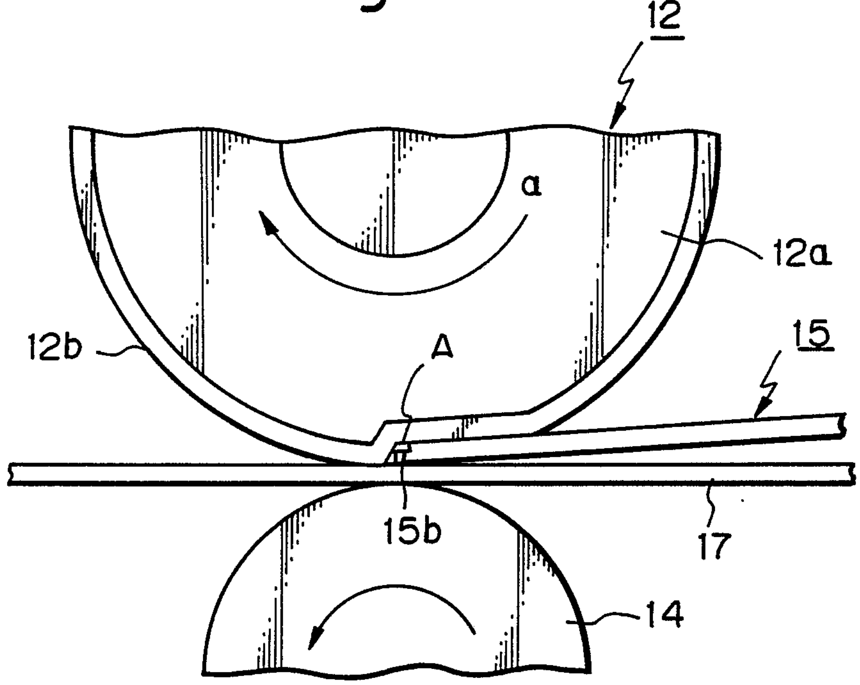
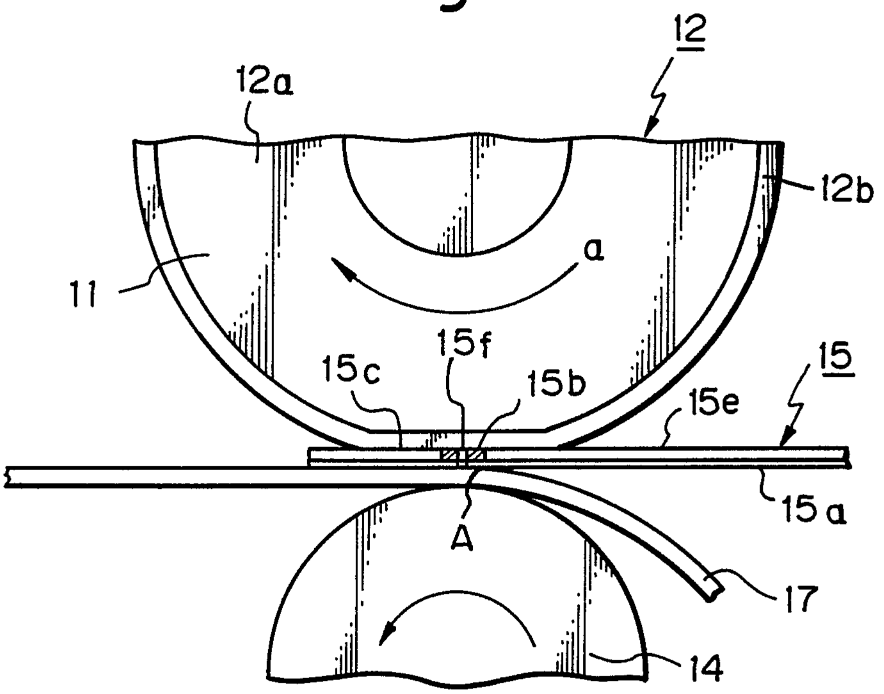

12
a
12a
12b
A
15
15b
17
14

Fig. 12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12a
12b
11
a
15f
15c
15b
15
15e
15a
A
17
14

Fig. 13

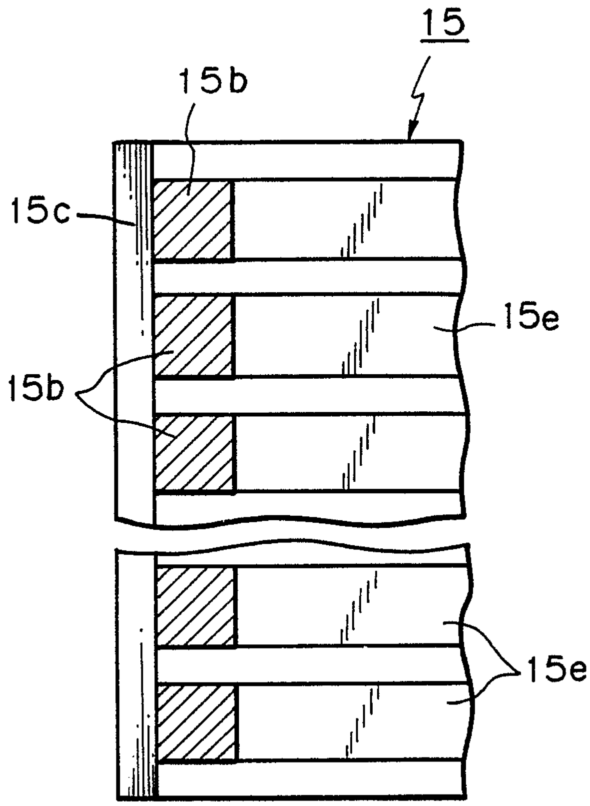
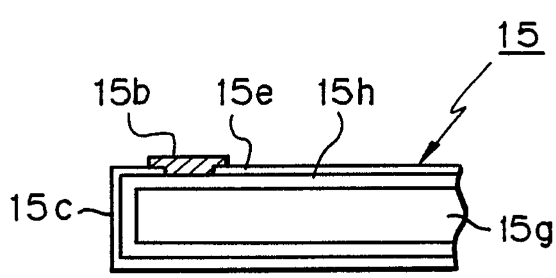
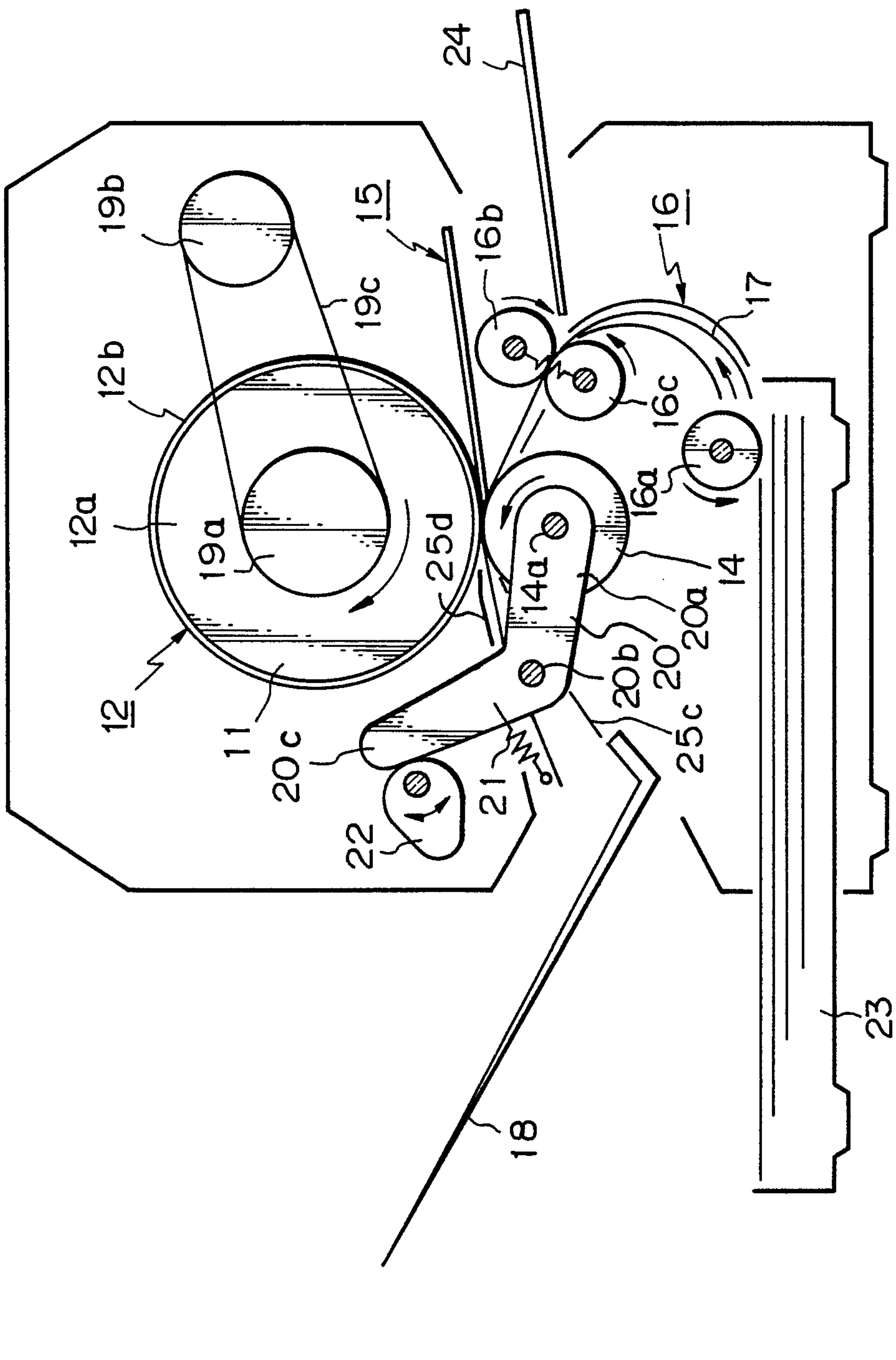


Fig. 14

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12a
12b
11
19a
19b
19c
15
16
16a
16b
16c
17
14
14a
18
20
20a
20b
20c
21
22
23
24
25c
25d

Fig. 15

Fig. 16

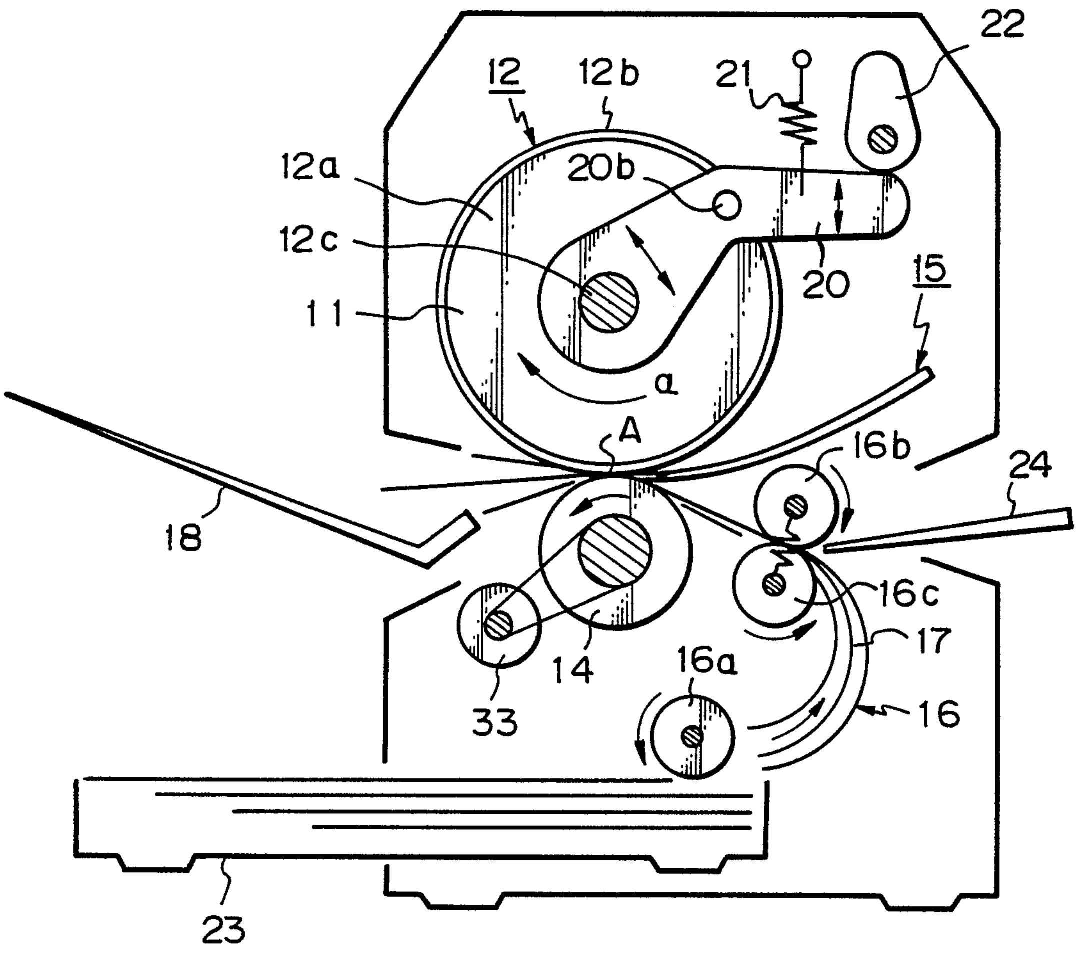
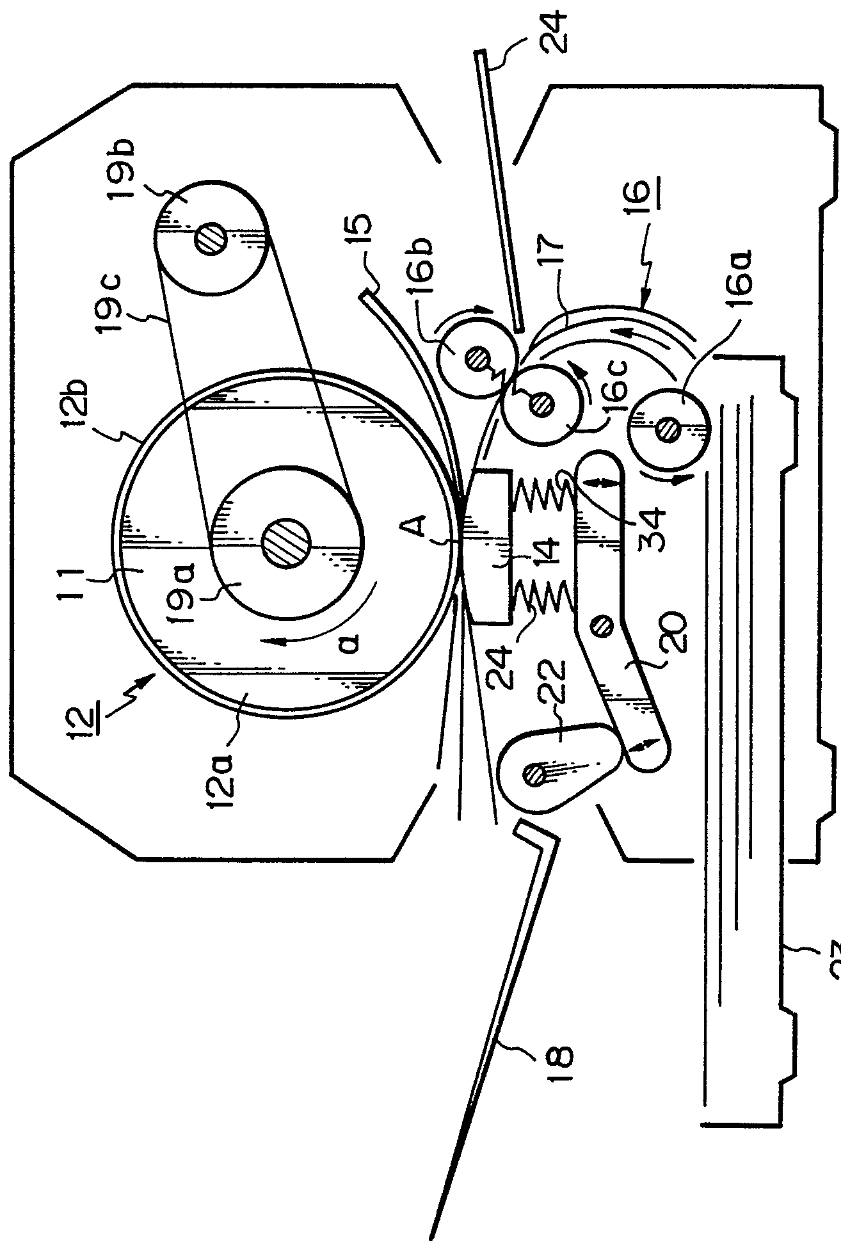


Fig. 17



24
19b
15
16b
17
16
16a
19c
12b
16c
34
A
14
11
19a
a
24
22
20
12
12a
23
18

Fig. 18

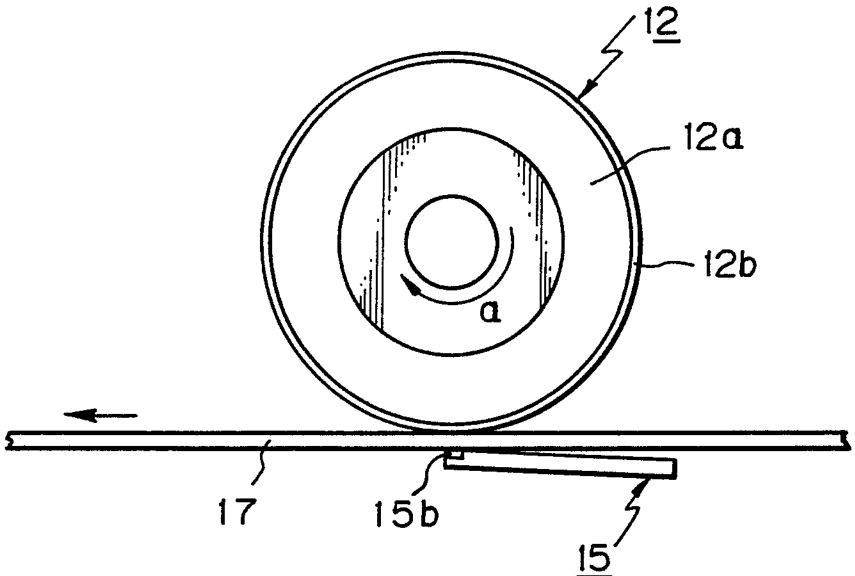


Fig. 21

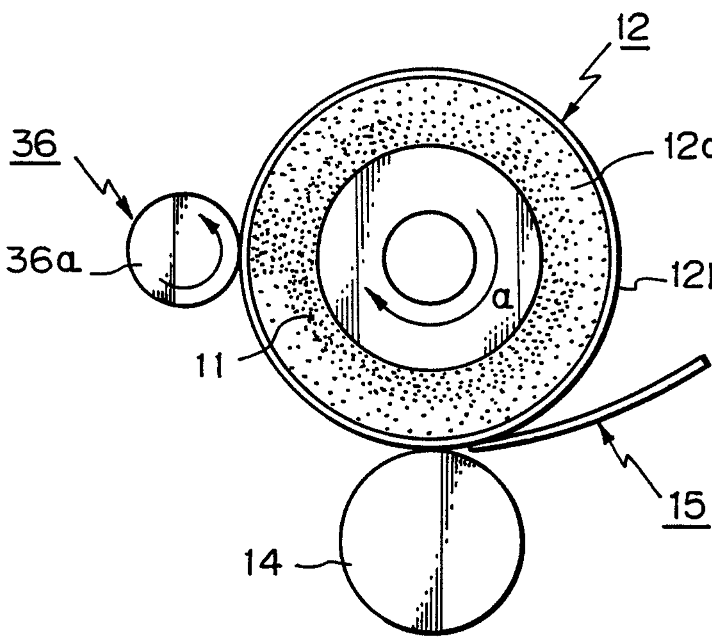
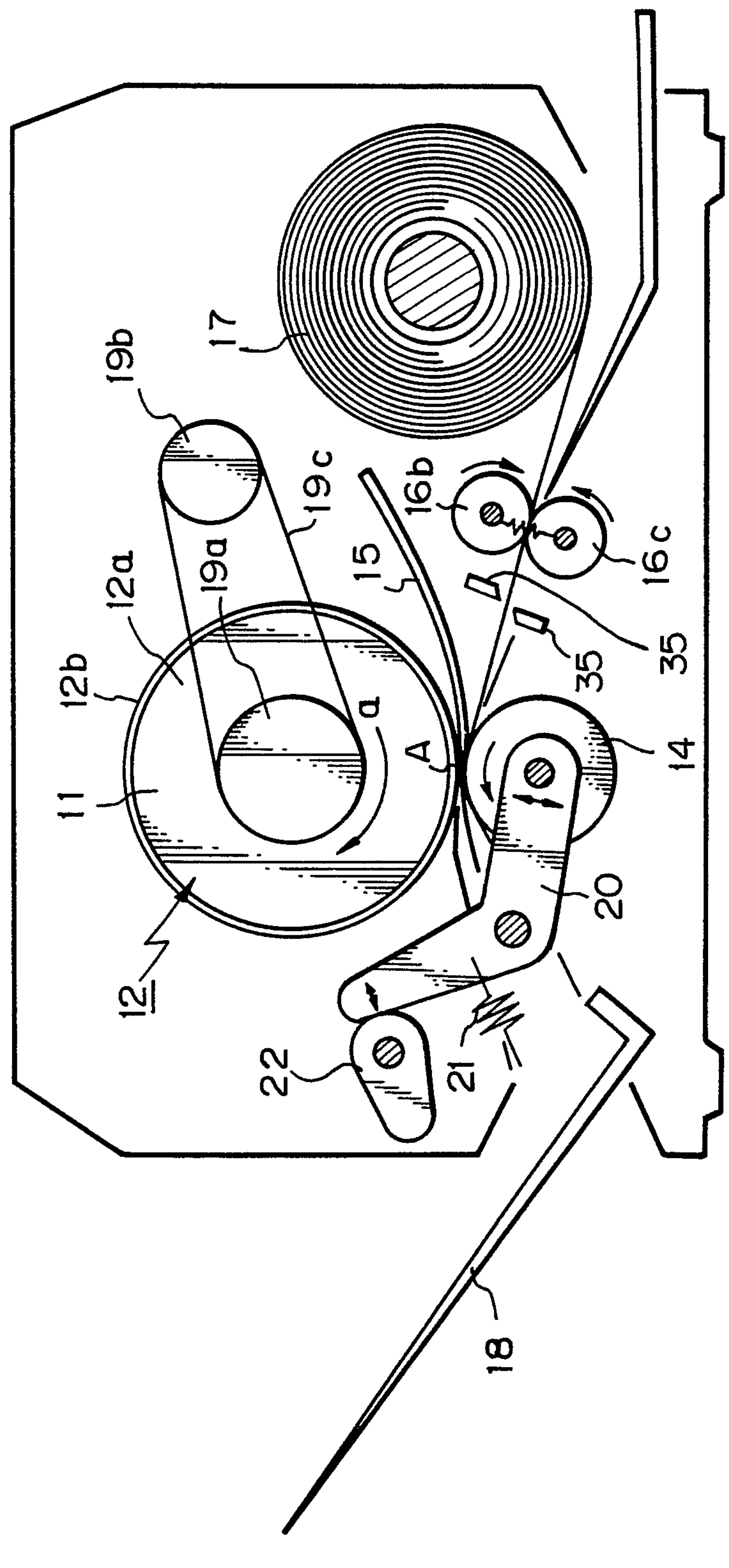
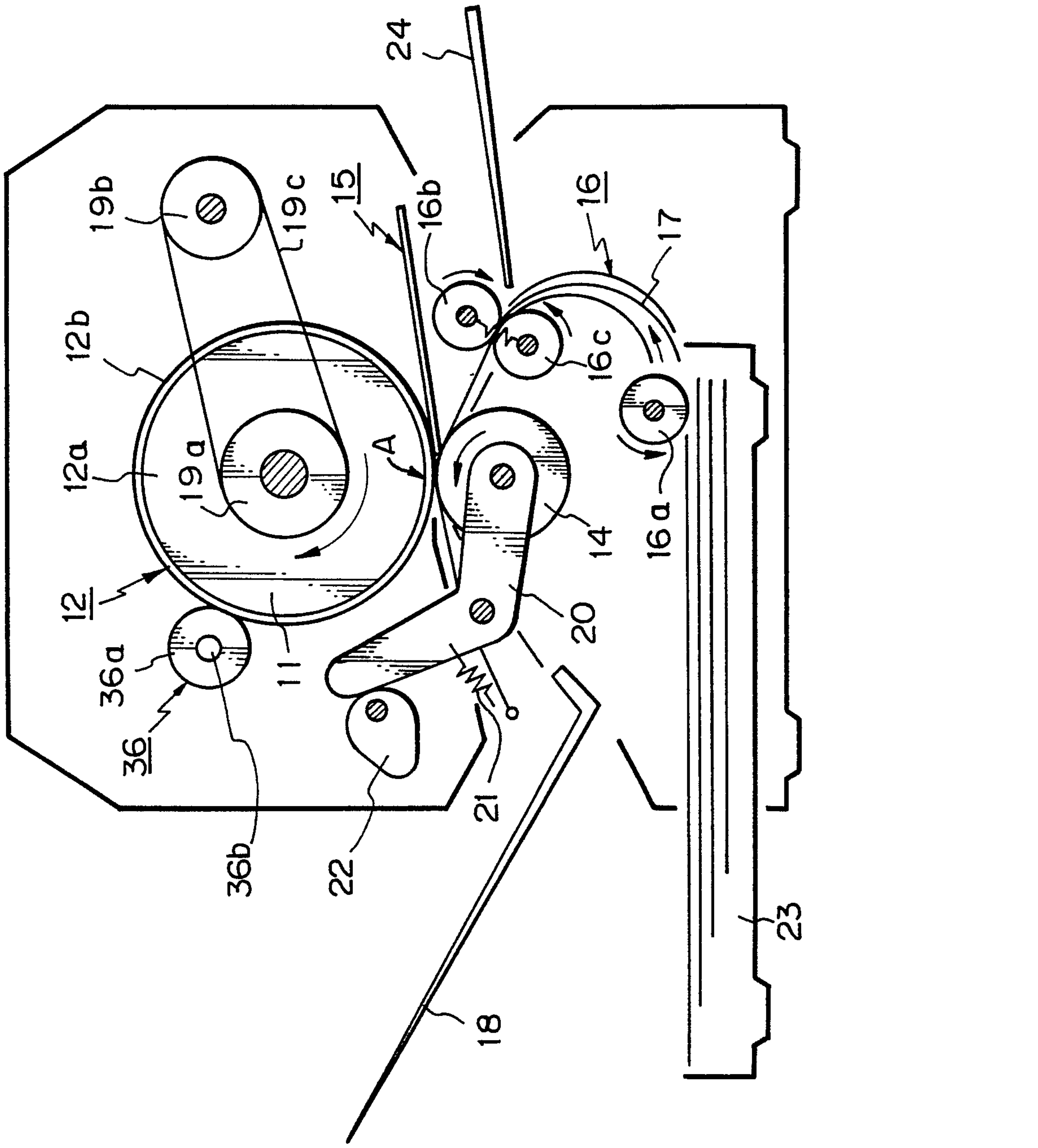


Fig. 19




24
16b
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19b
19c
12b
12a
19a
A
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36a
36
36b
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20
14
16a
16c
16
17
18
23

Fig. 20

Fig. 22

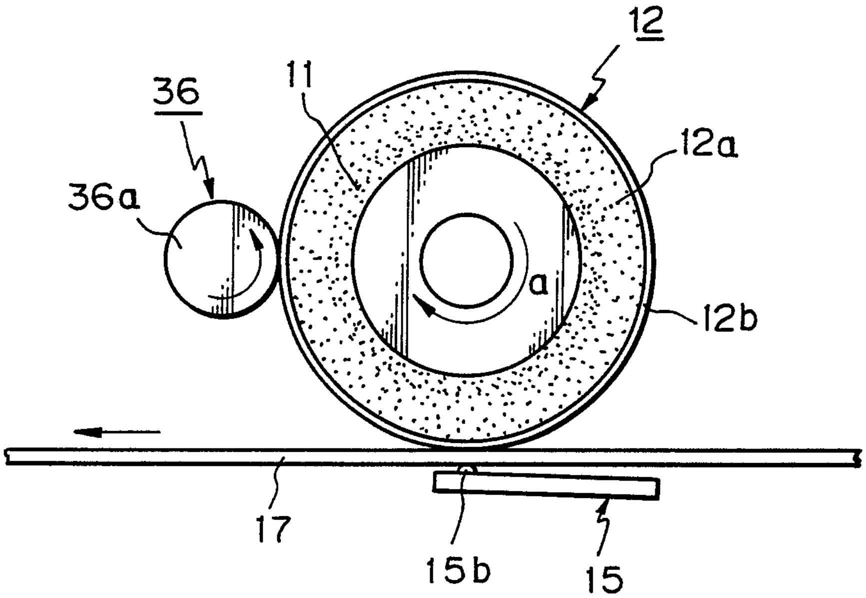


Fig. 23

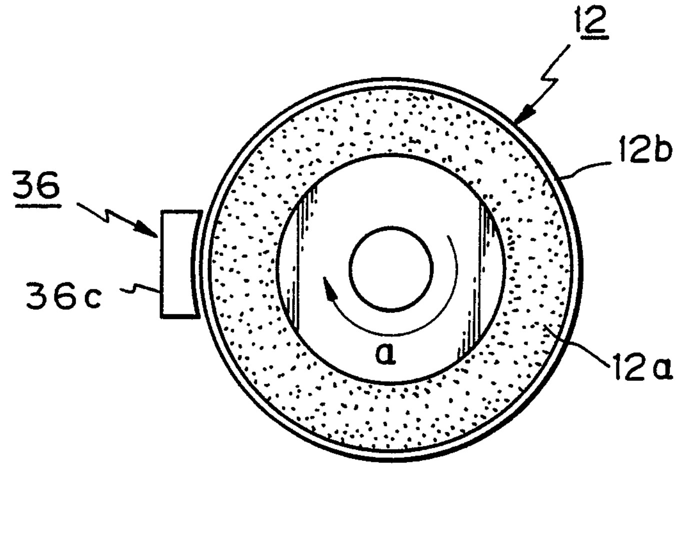


Fig. 24

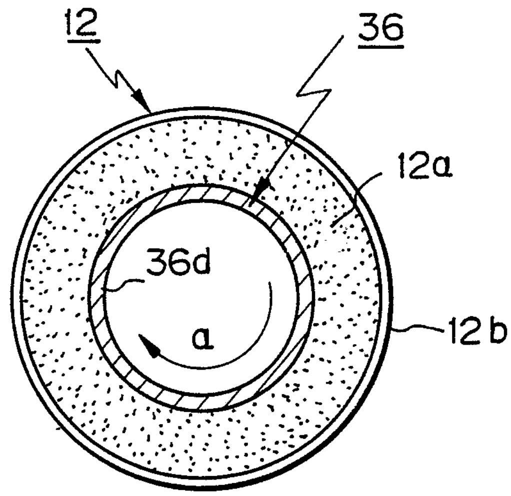
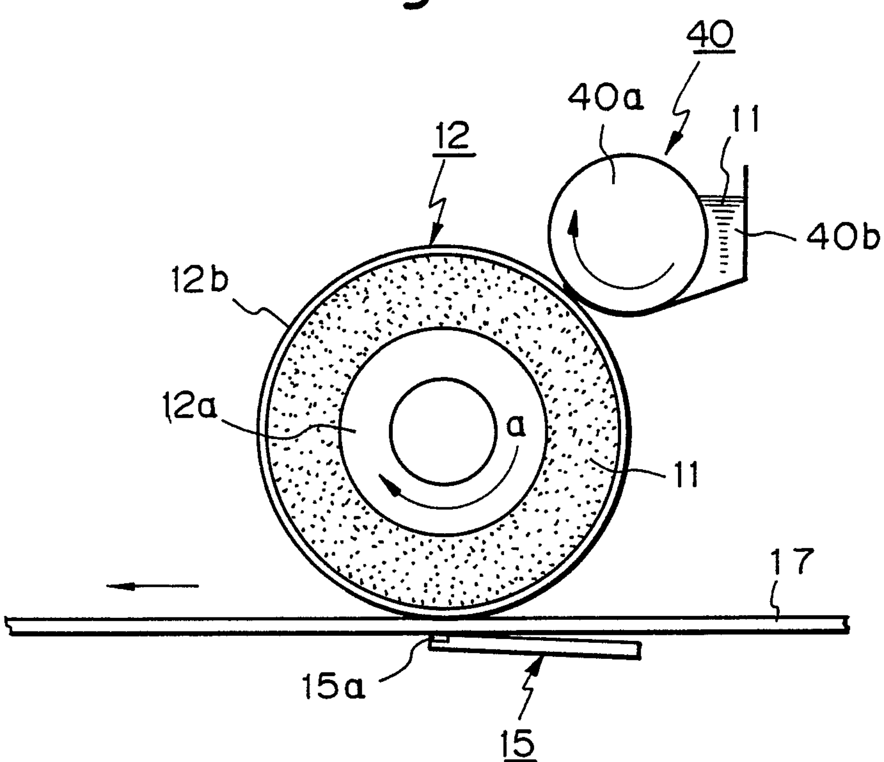
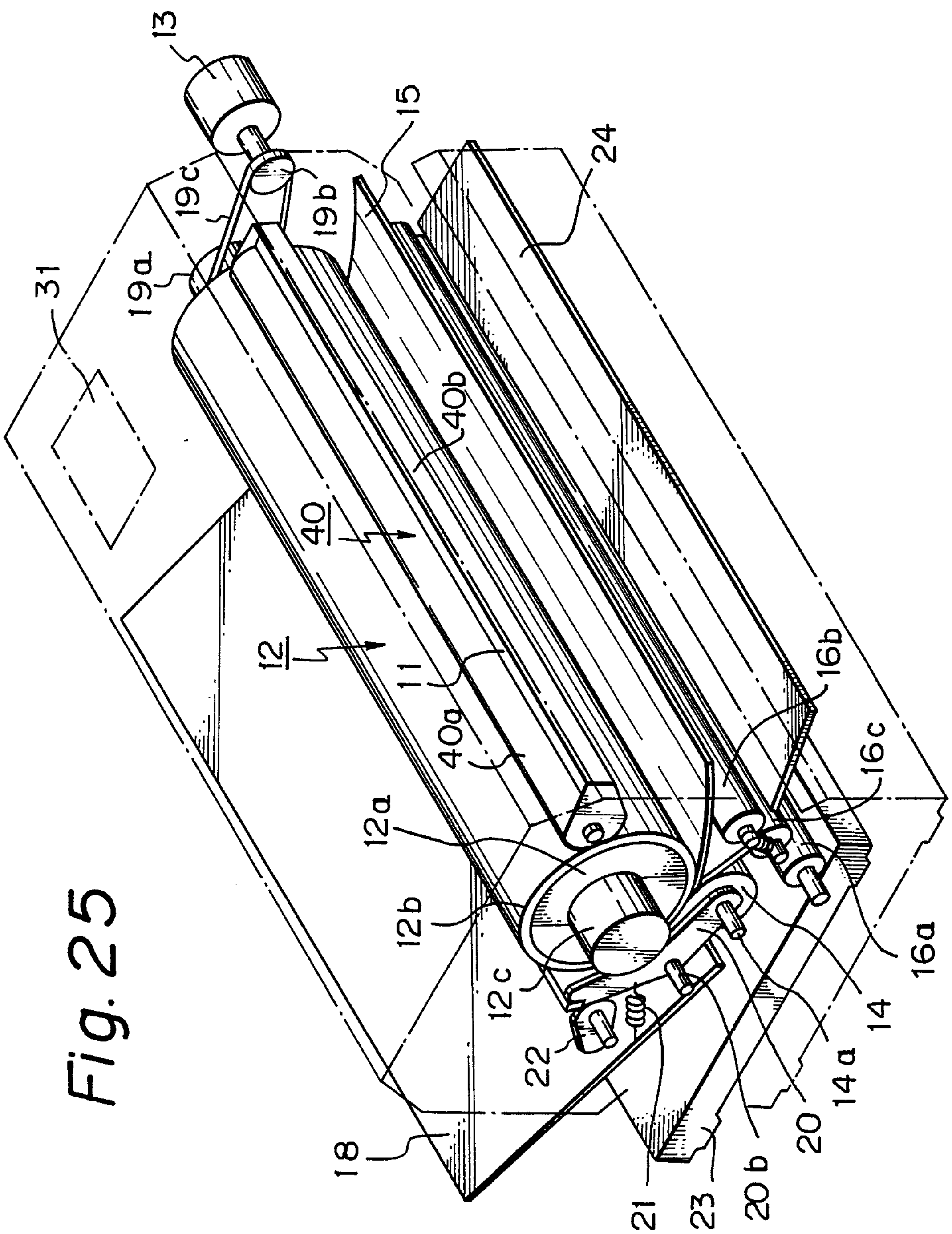


Fig. 27

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19a
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12
11
16b
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16c
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12b
16a
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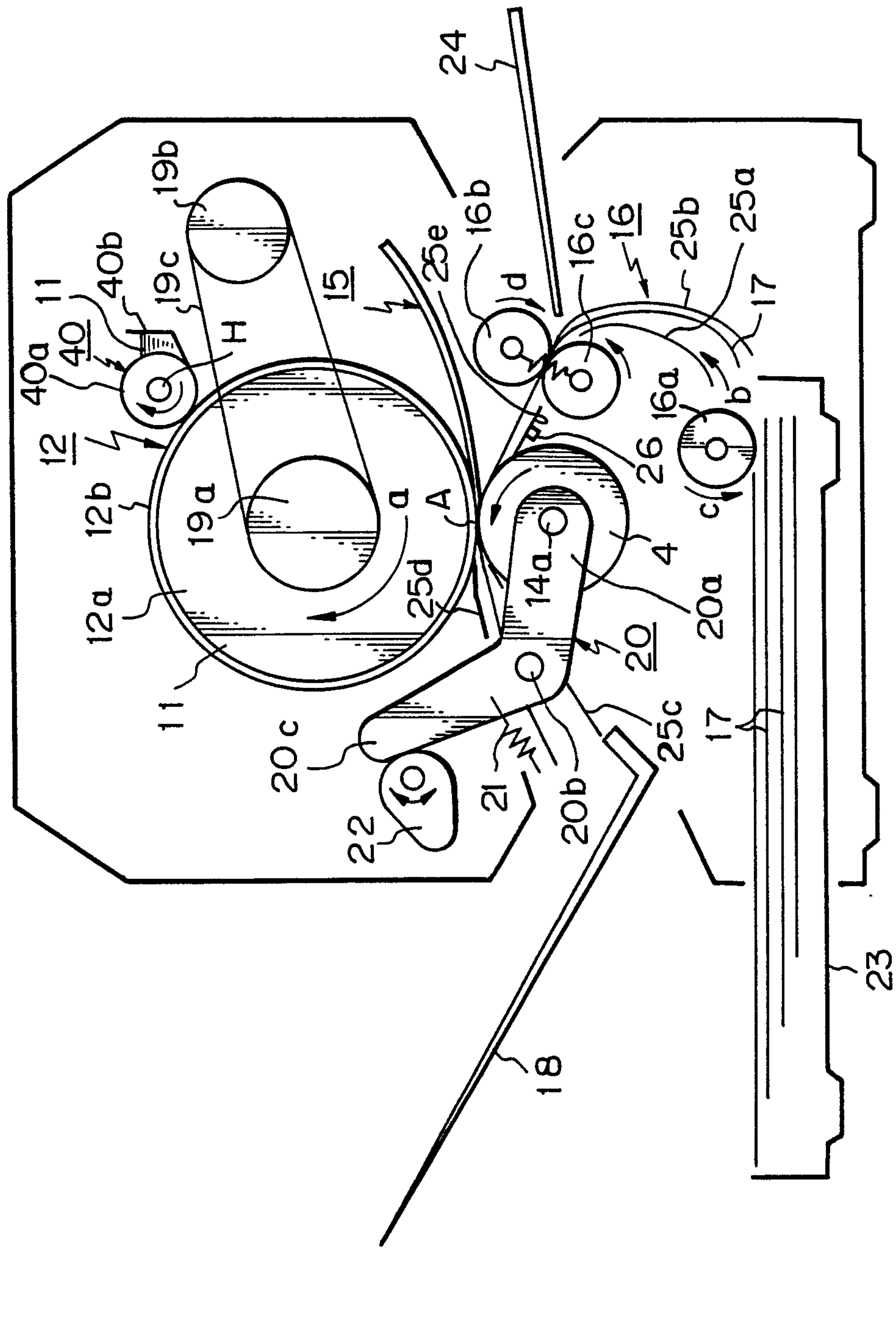
12c
14a
22
20
18
21
23
20b

Fig. 25

Fig. 26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16b
16c
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19b
19c
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20b
20c
21
22
23
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25e
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40a
40b
A
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a
b
c
d

Fig. 28

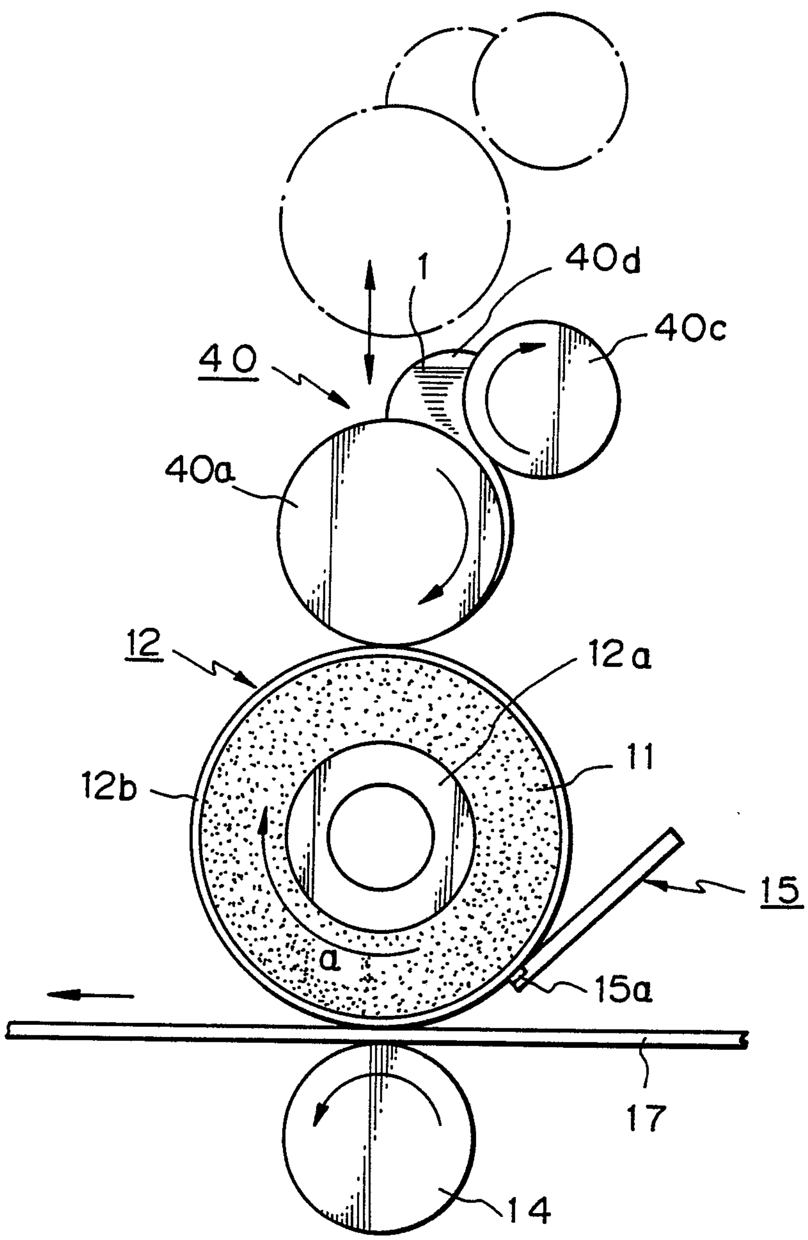
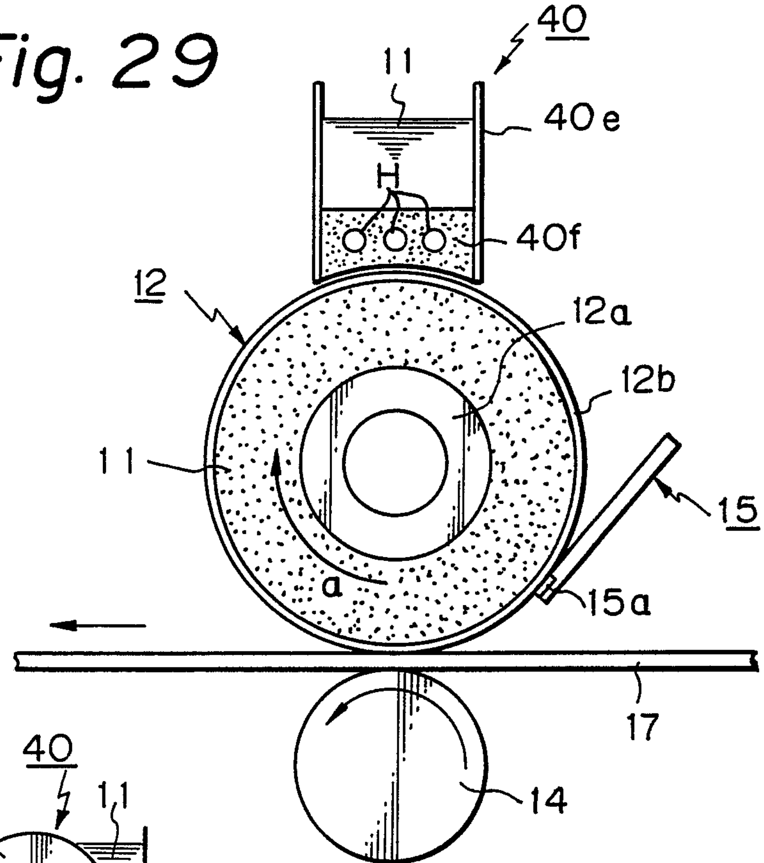


Fig. 29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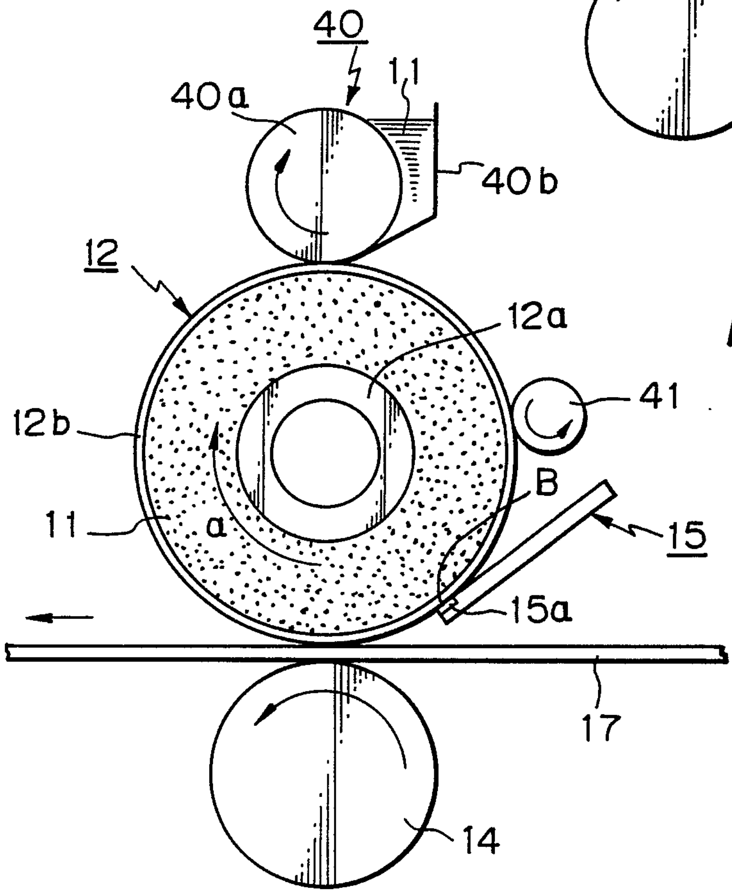
H
40f
12
12a
12b
11
15
a
15a
17
14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40b
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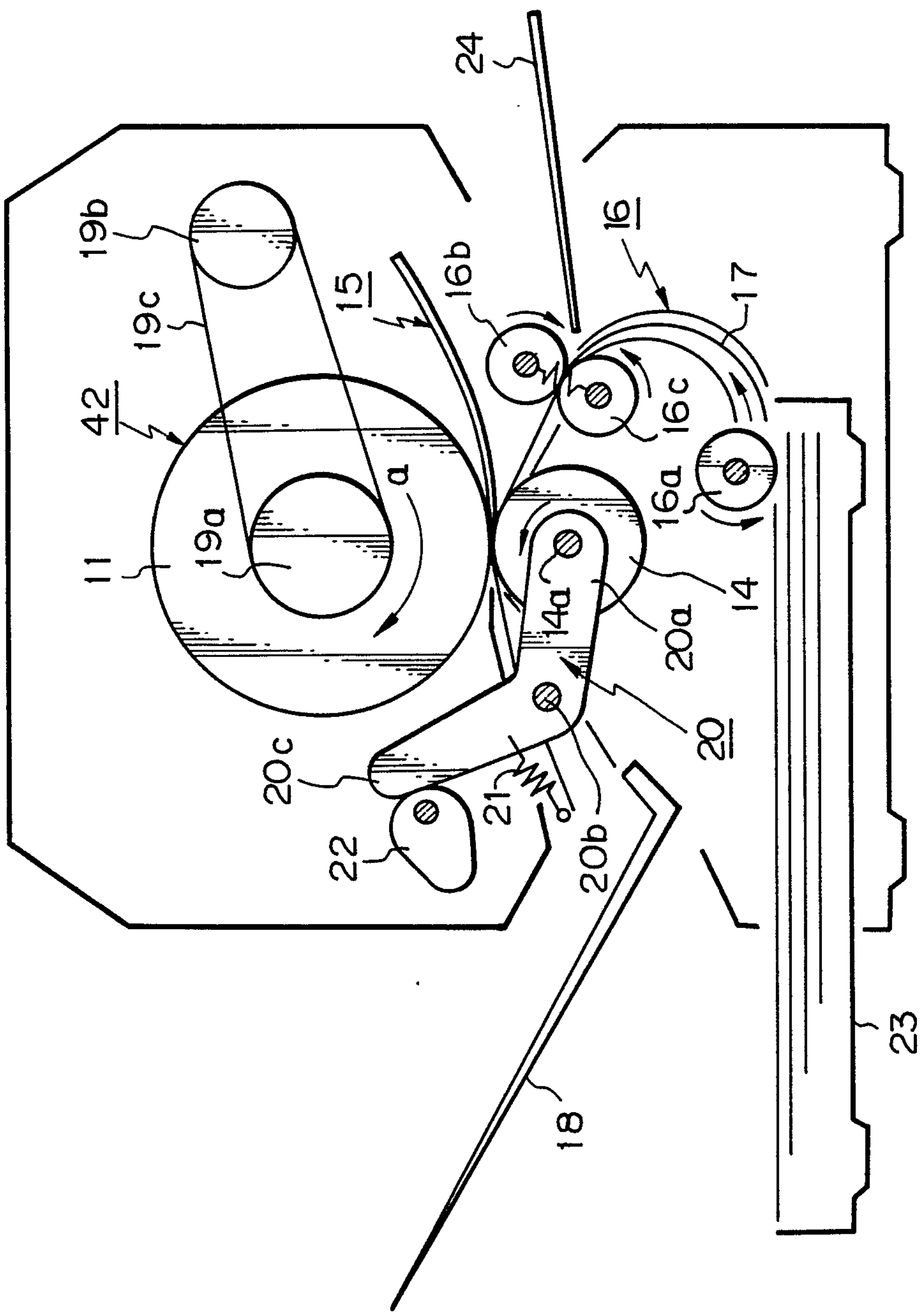
12b
B
11
a
15
15a
17
14

Fig. 30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17
16b
15
19b
19c
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19a
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16c
16a
14
14a
20a
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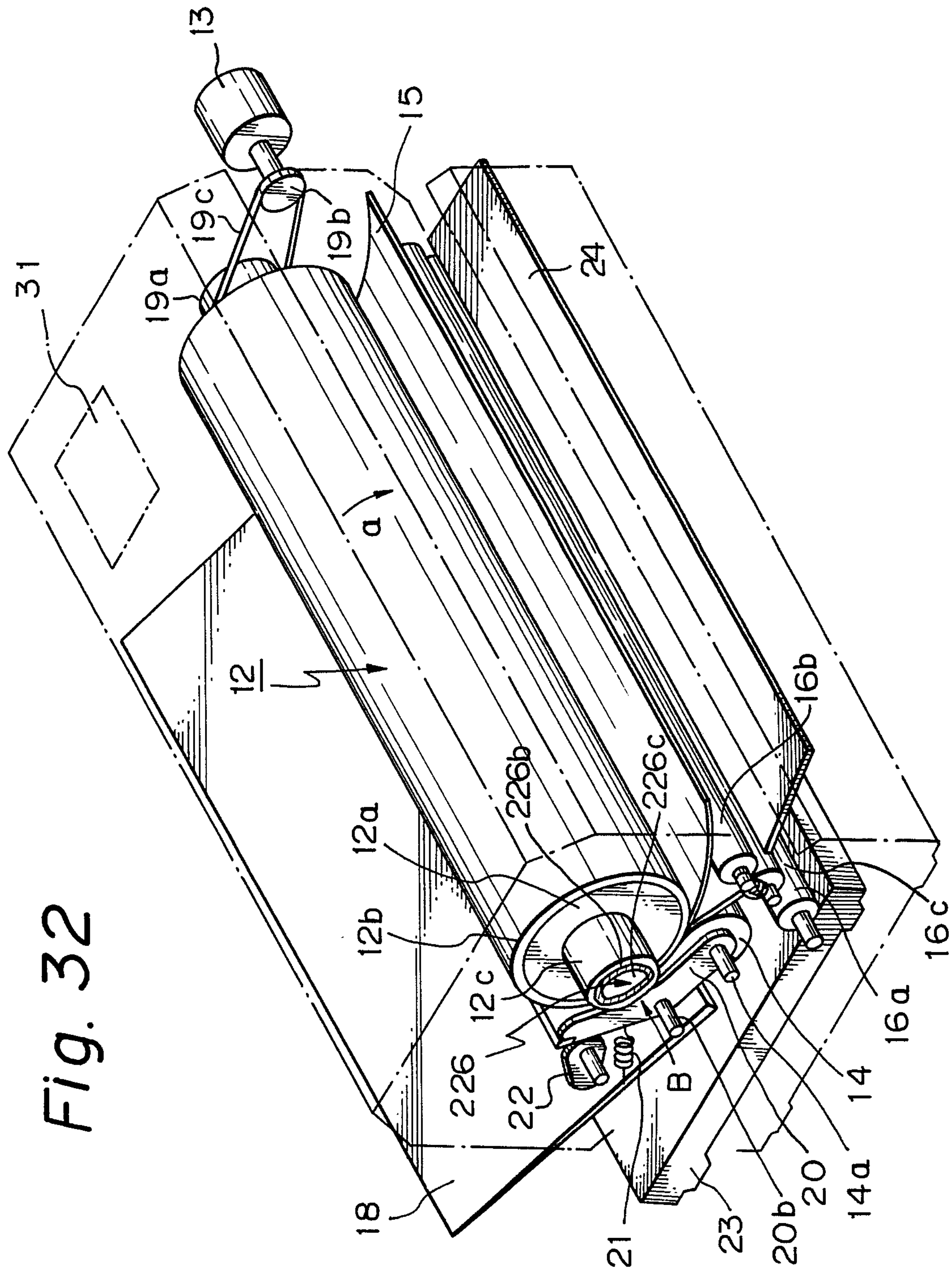
20c
21
20b
22
18
23

Fig. 31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15
19c
19b
19a
31
24
a
12
16b
226b
226c
12a
12b
12c
226
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B
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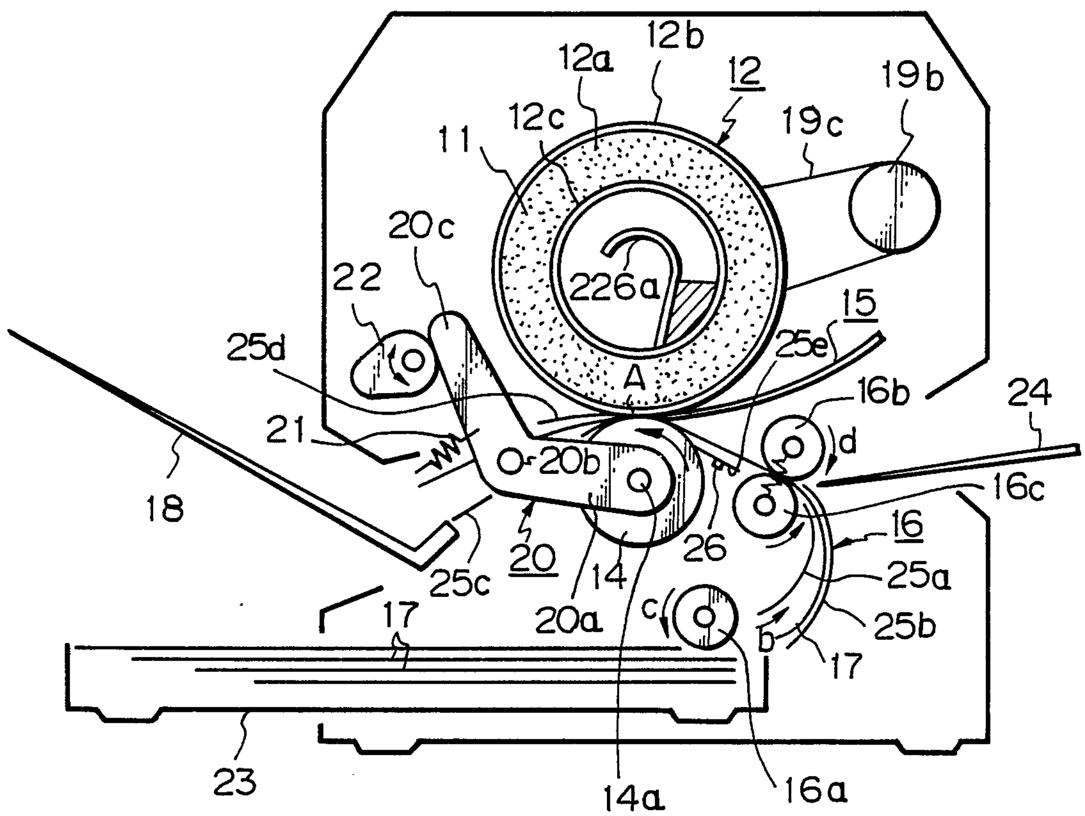
21
23
20b
20
14a
14
16a
16c

Fig. 32

Fig. 33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19b
12c
19c
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20c
226a
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25d
25e
A
16b
24
21
d
20b
16c
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25a
25c
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25b
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c
17
b
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23
14a
16a

Fig.34

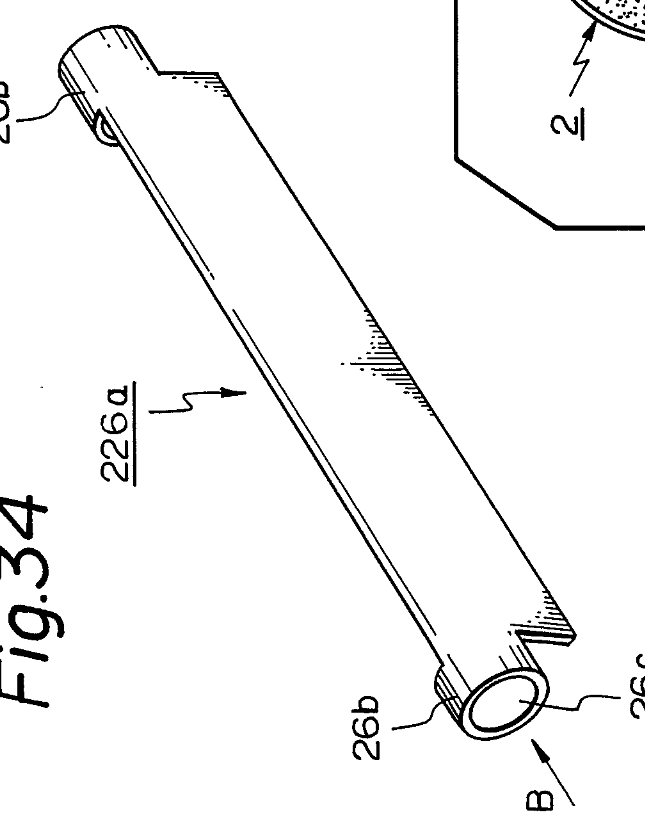


Fig. 35

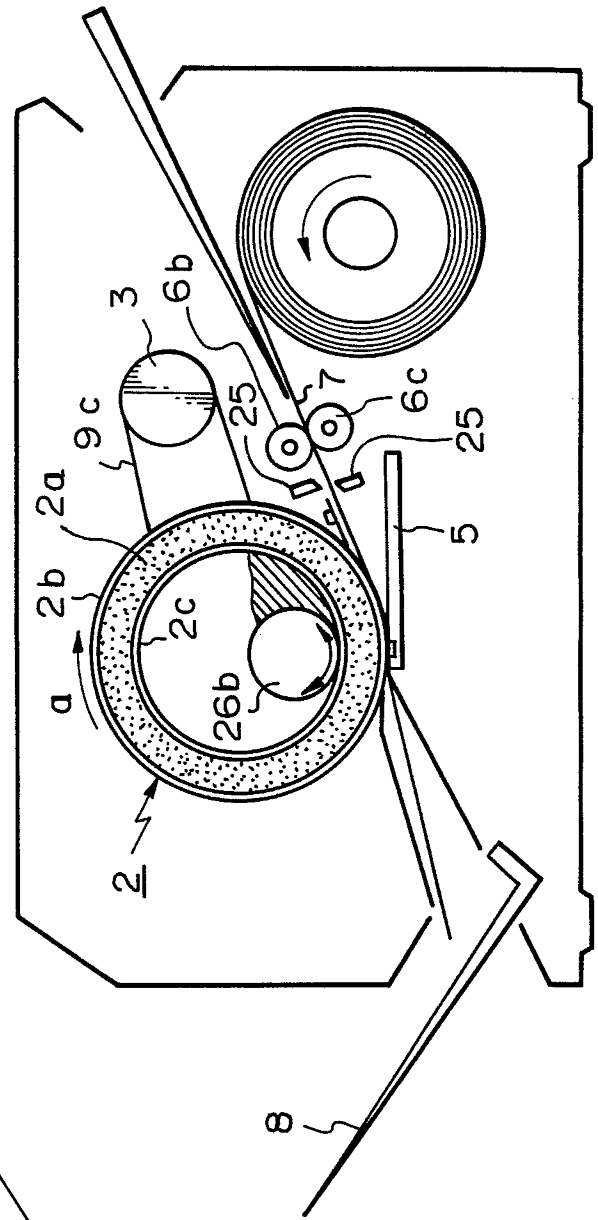


Fig. 36

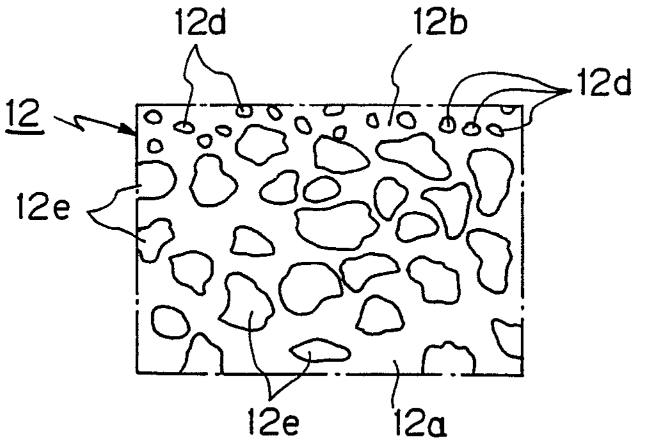


Fig. 37

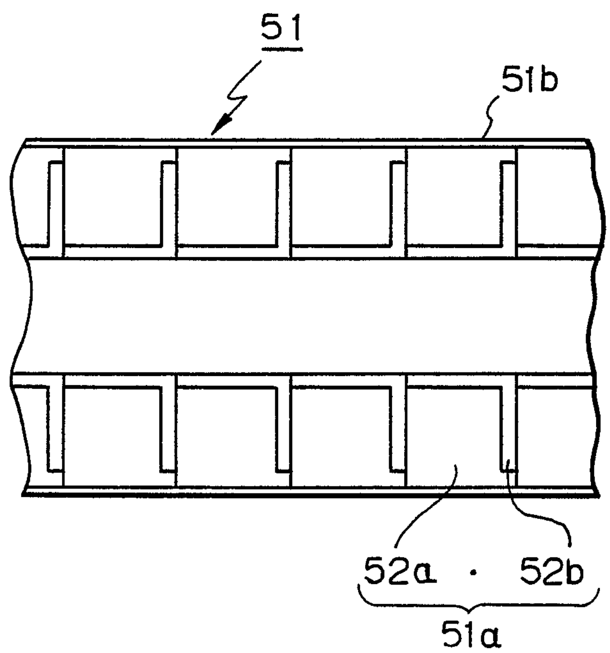


Fig. 38

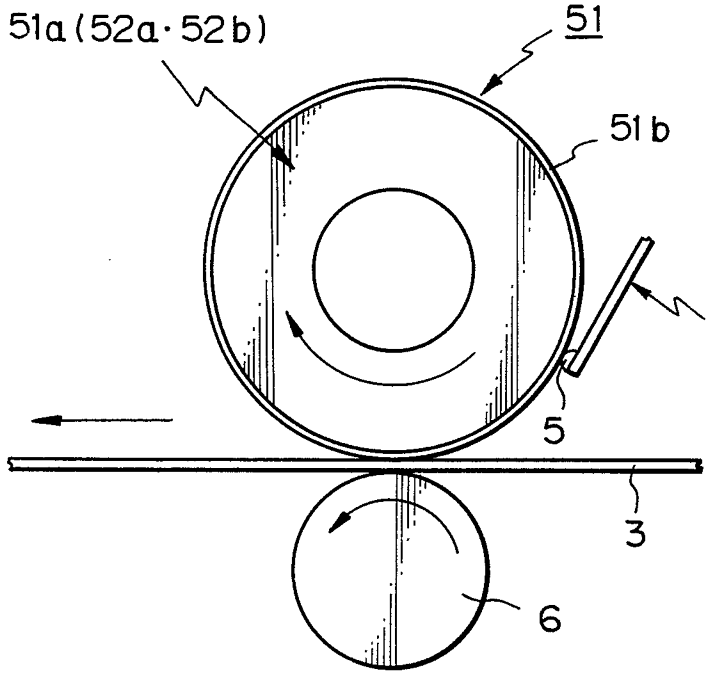
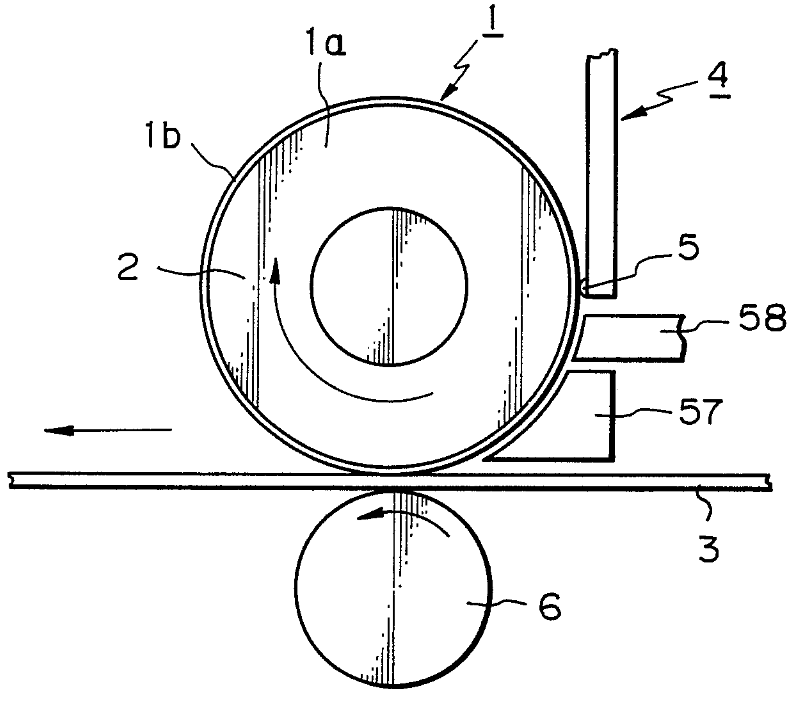


Fig. 40



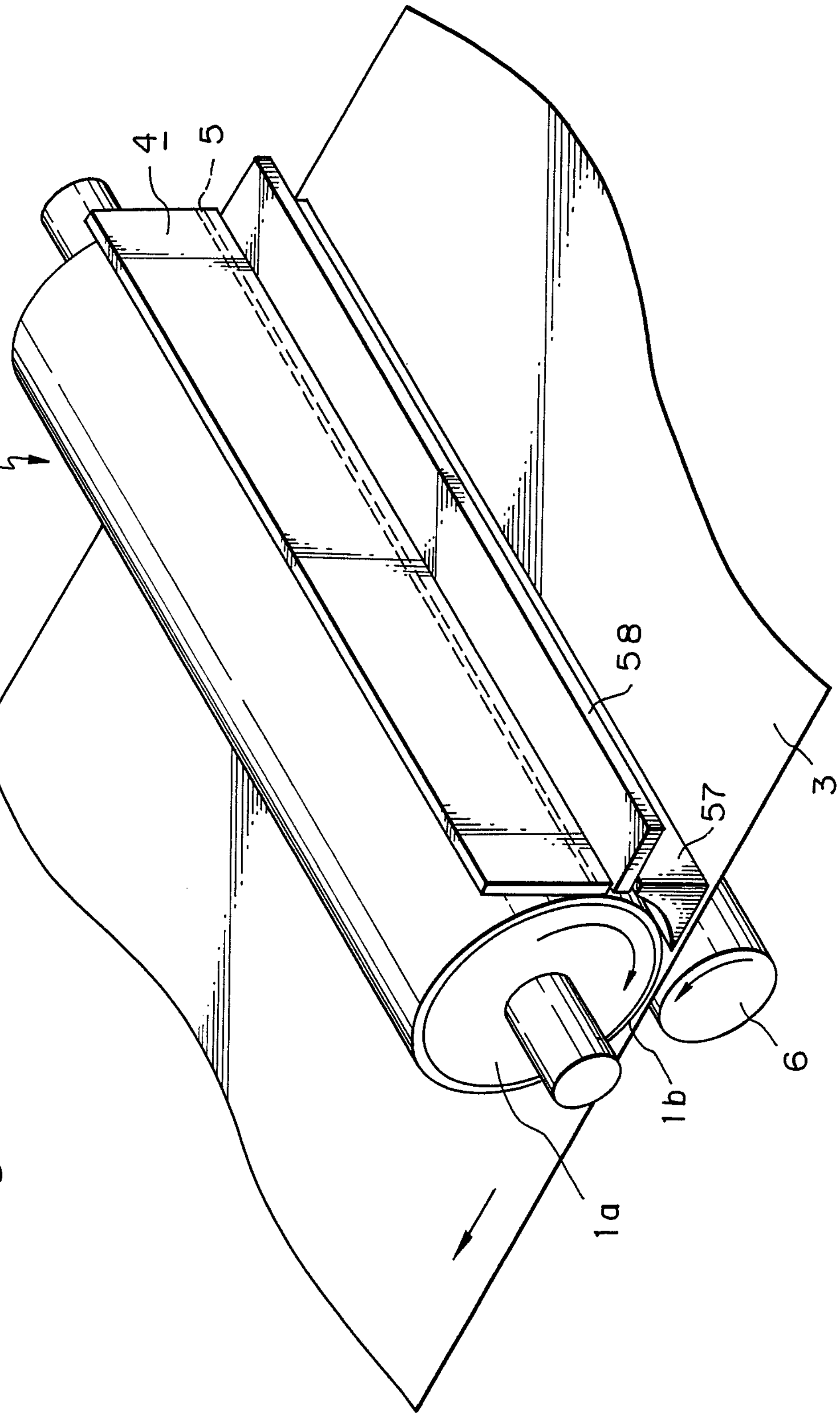


Fig. 39

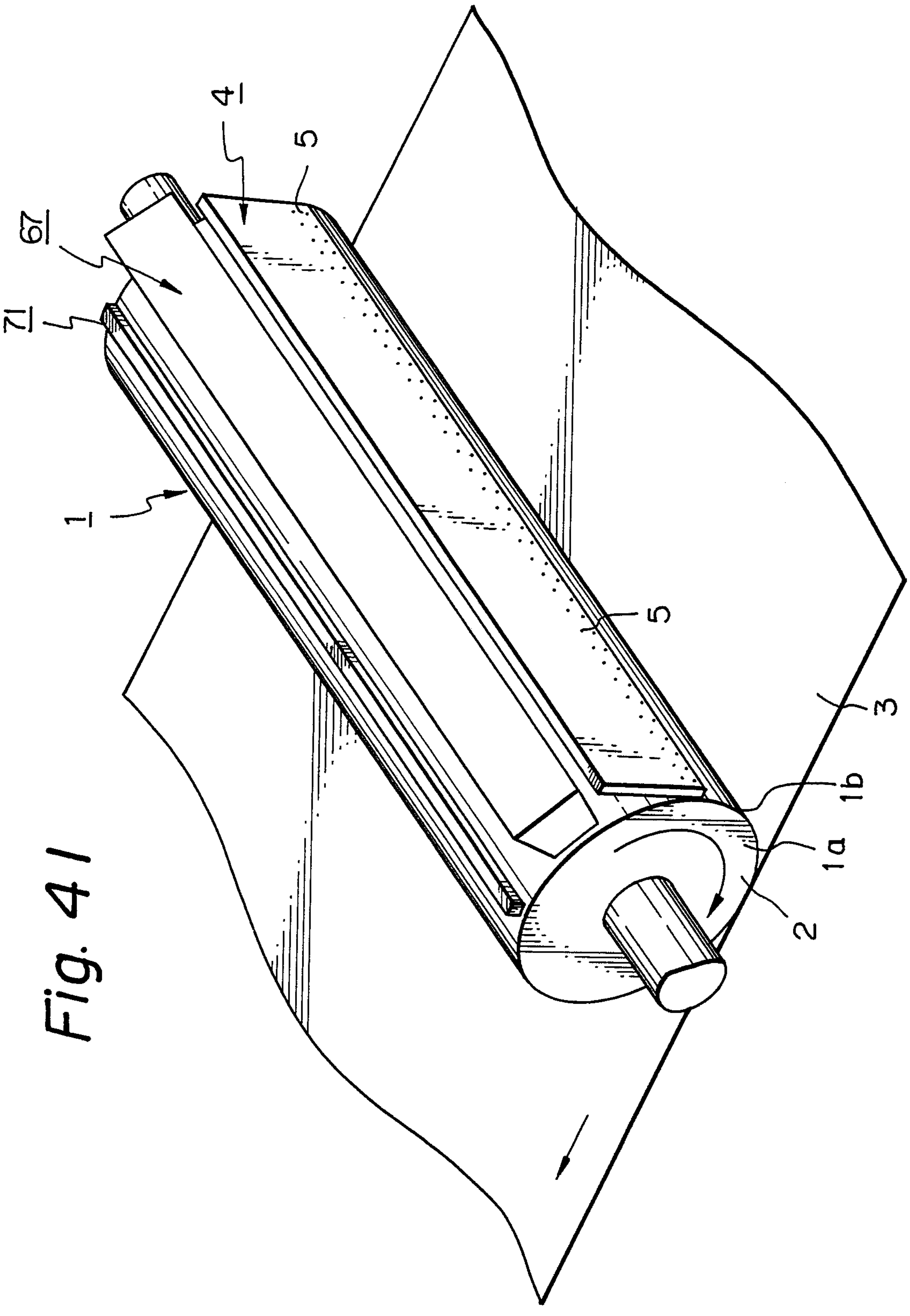
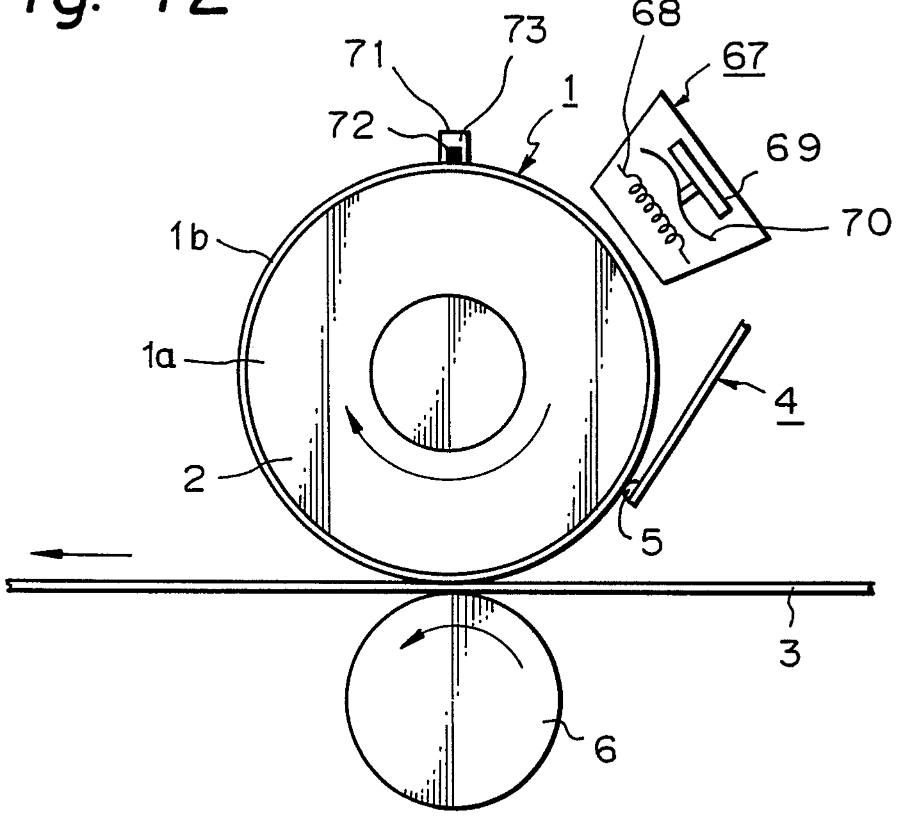


Fig. 41

Fig. 42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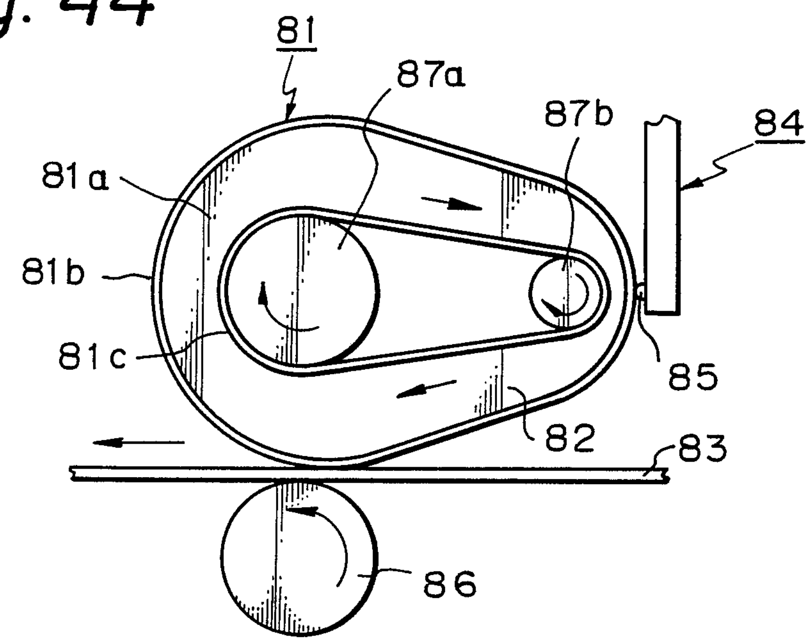
73
68
67
72
1
69
1b
70
1a
4
2
5
3
6

Fig. 44


81
87a
87b
84
81a
81b
81c
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82
83
86

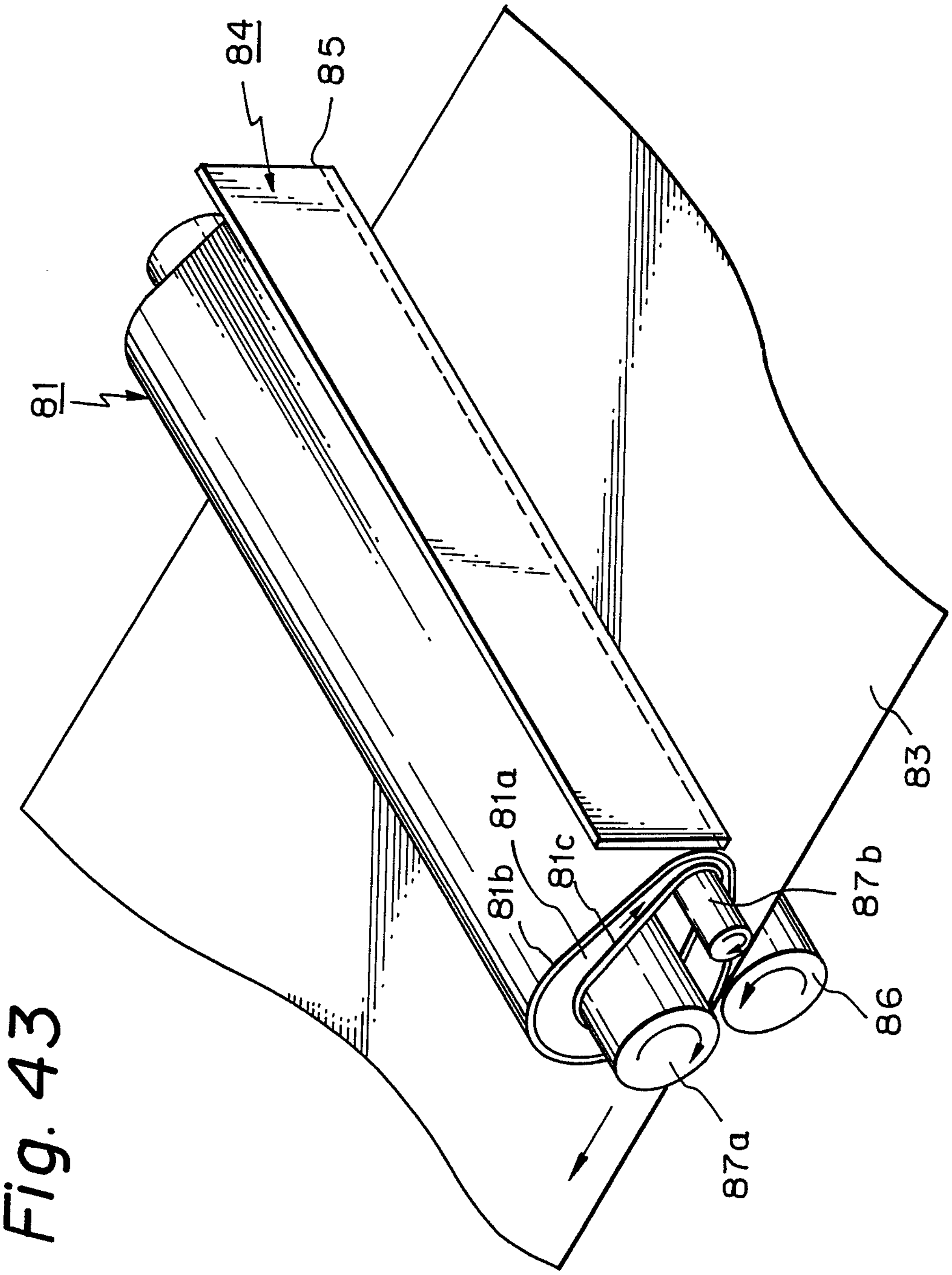


Fig. 43

Fig. 45

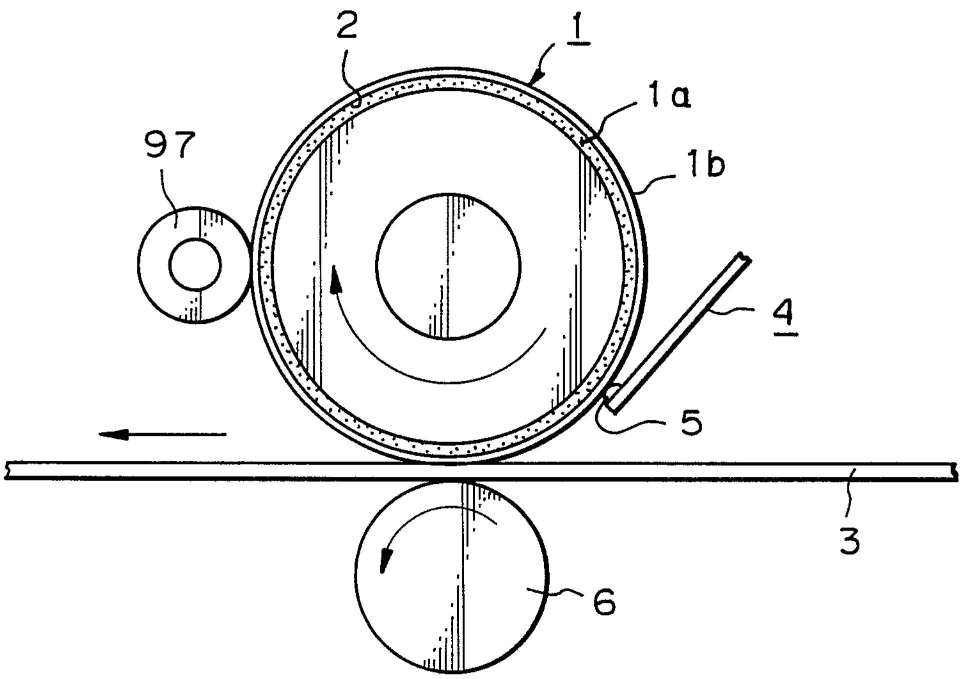


Fig. 46

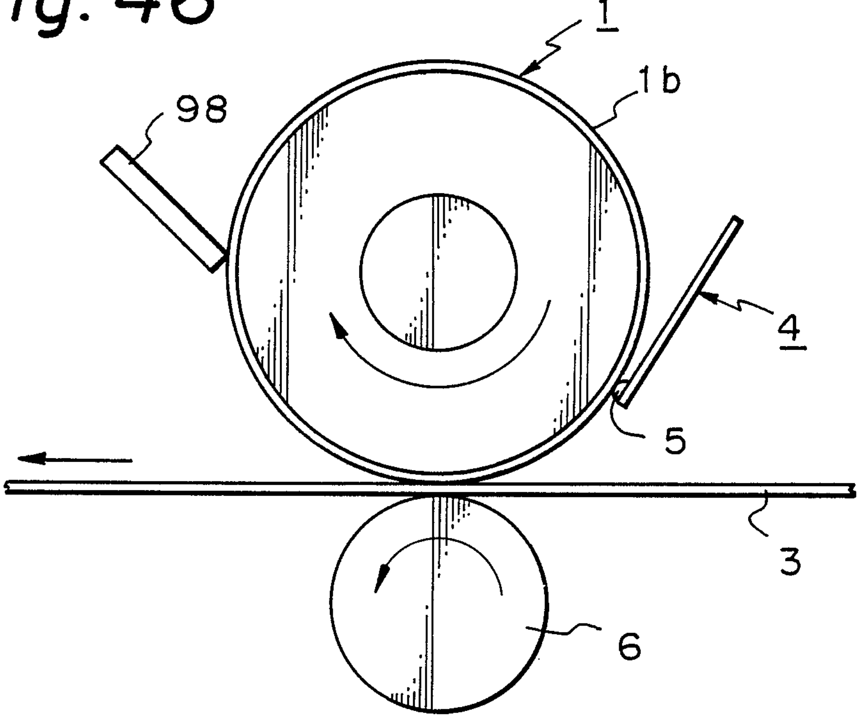
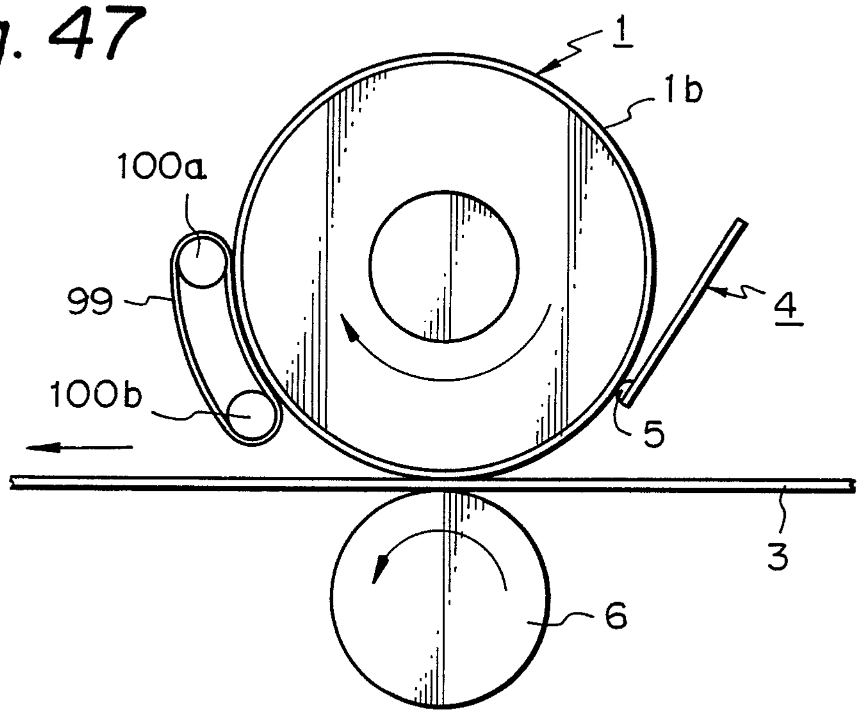


Fig. 47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1b
100a
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100b
5
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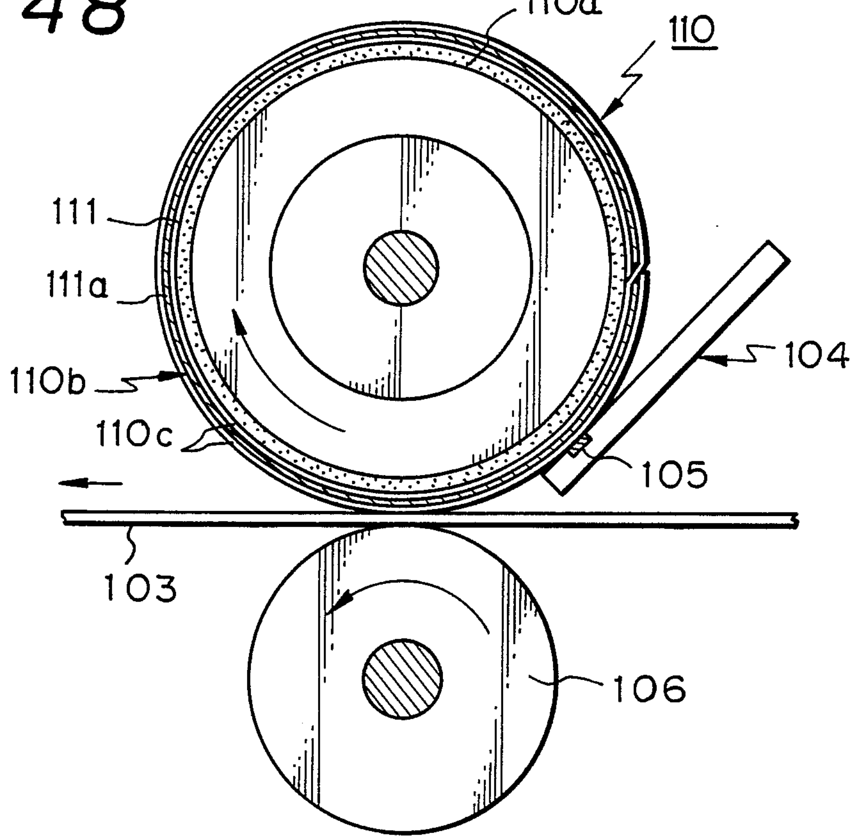
6

Fig. 48


110a
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106

Fig. 49

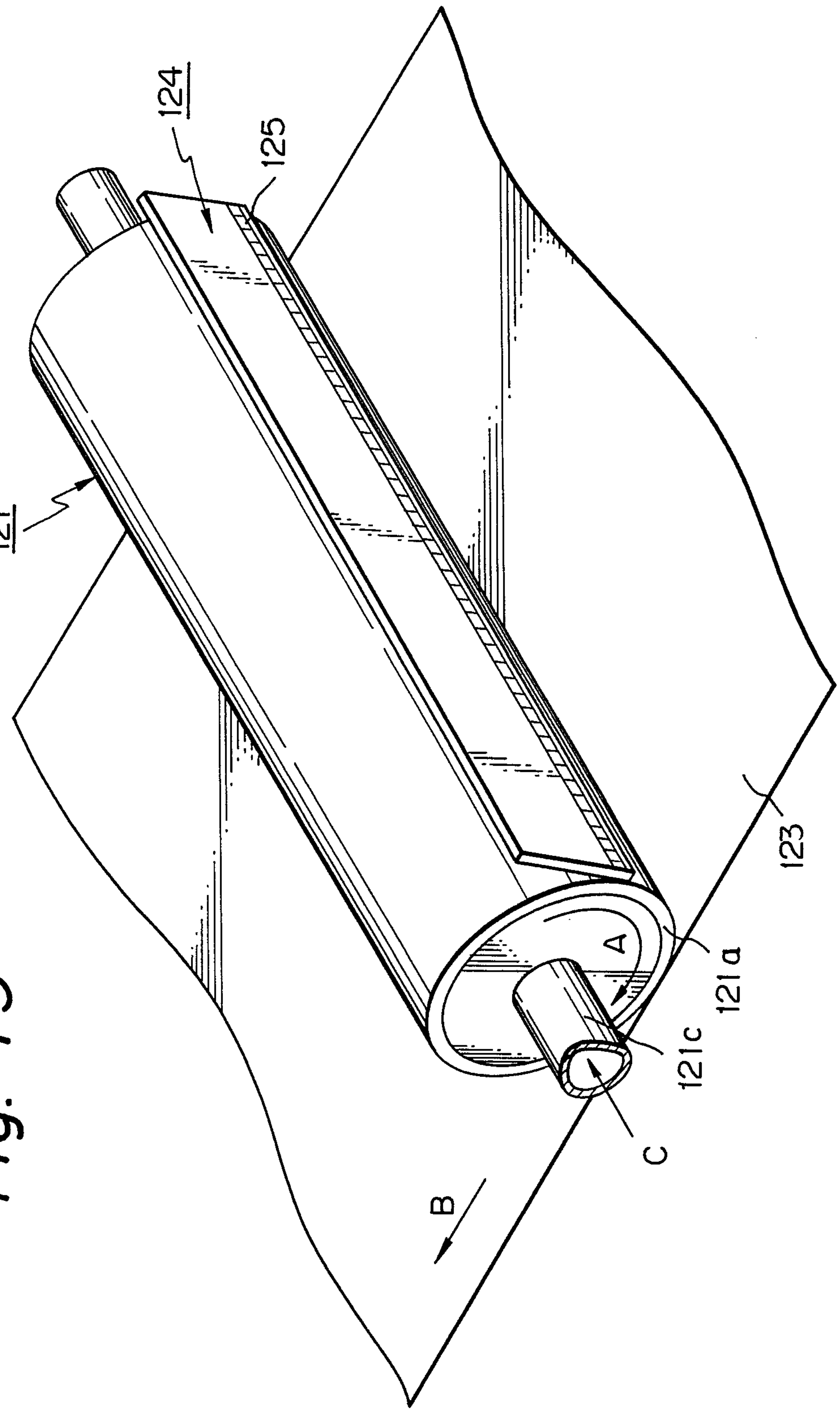
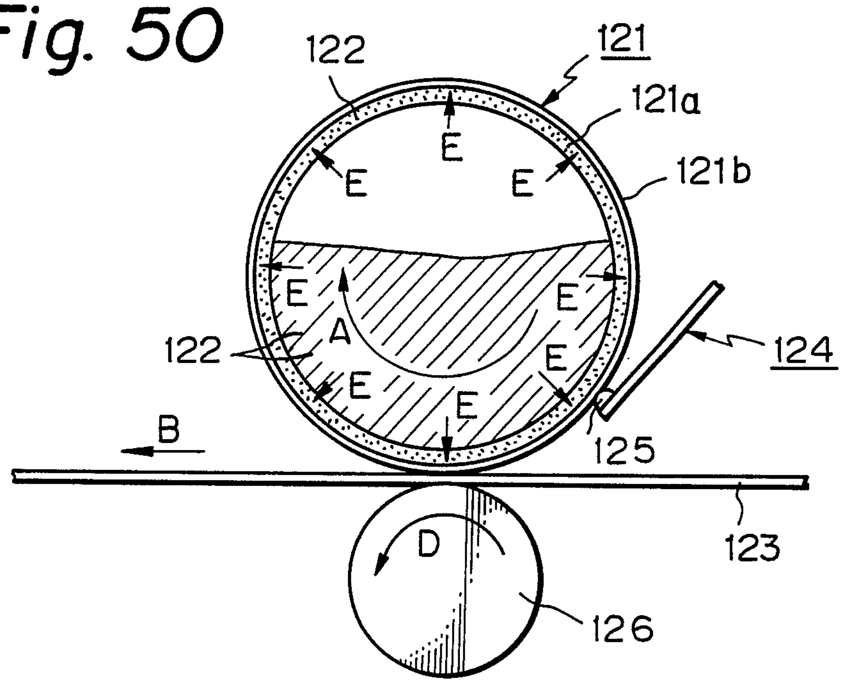


Fig. 50


122
121
121a
E
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121b
E
E
A
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E
E
E
124
B
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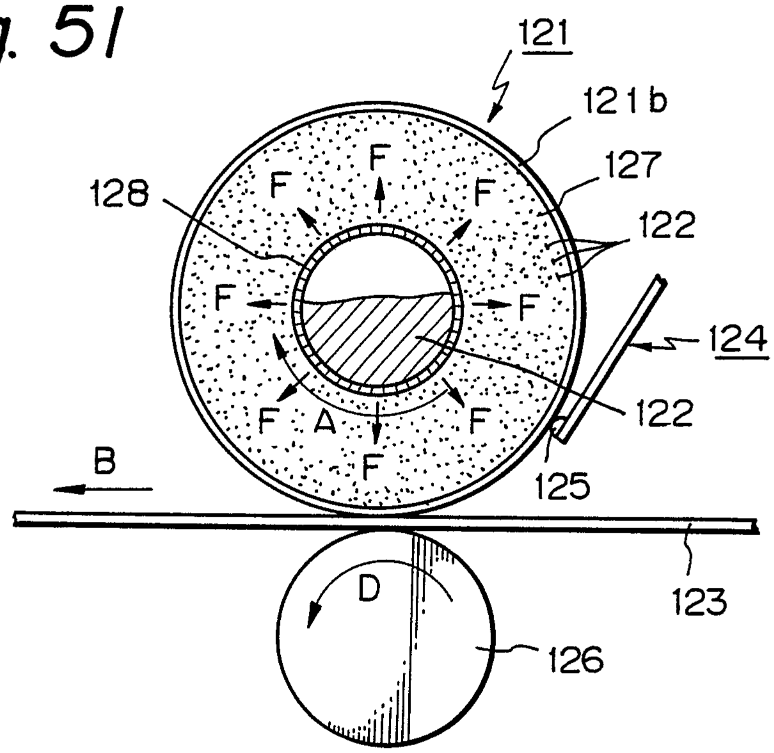
123
D
126

Fig. 51


121
121 b
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A
F
122
F
B
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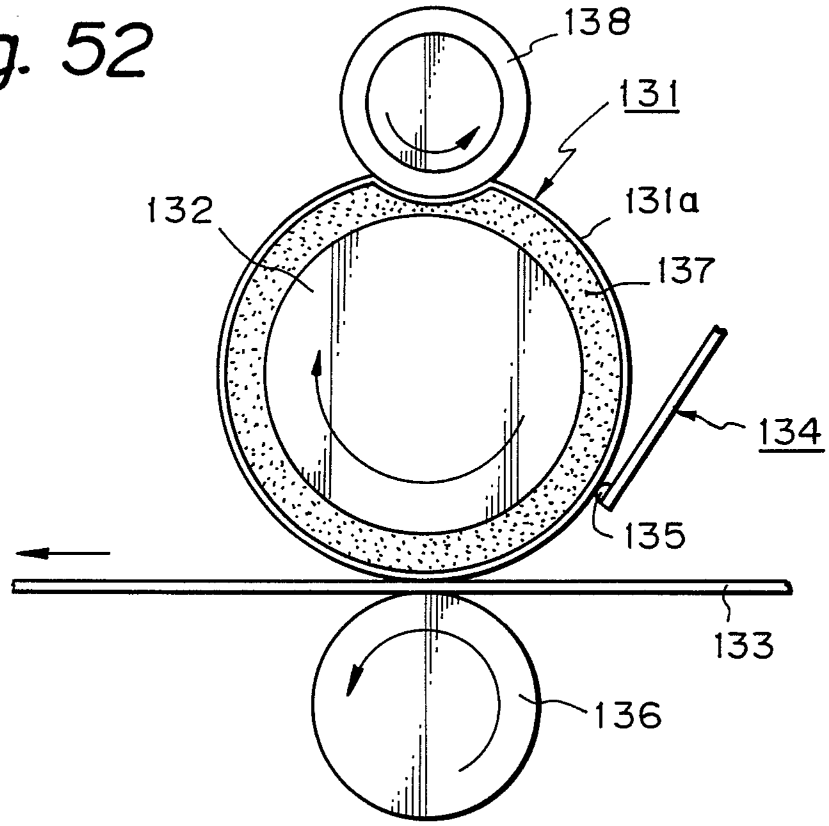
123
D
126

Fig. 52


138
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131a
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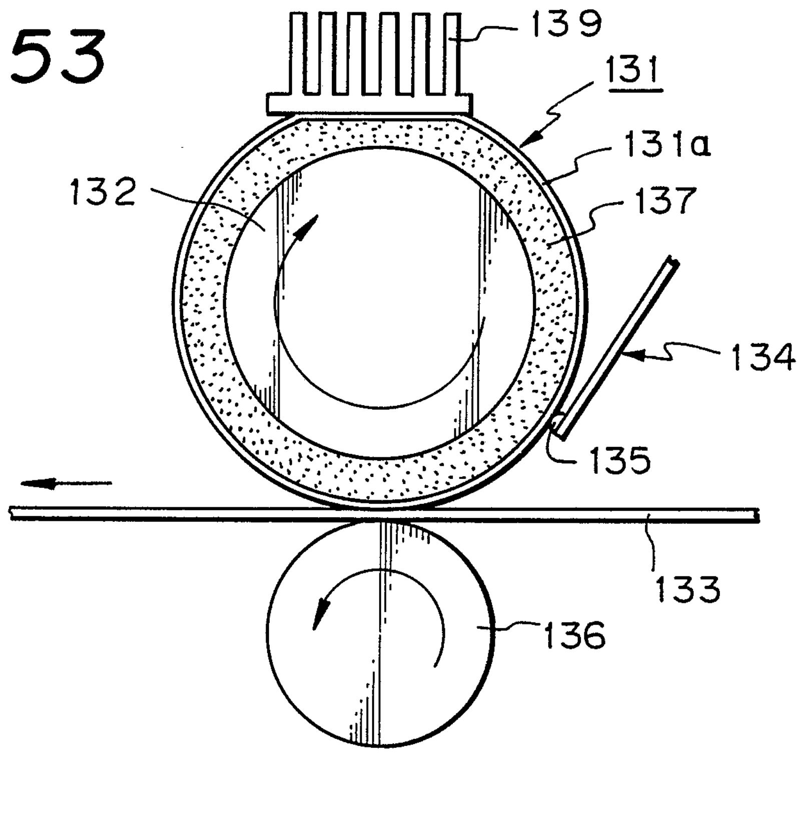
136

Fig. 53


139
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131a
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137
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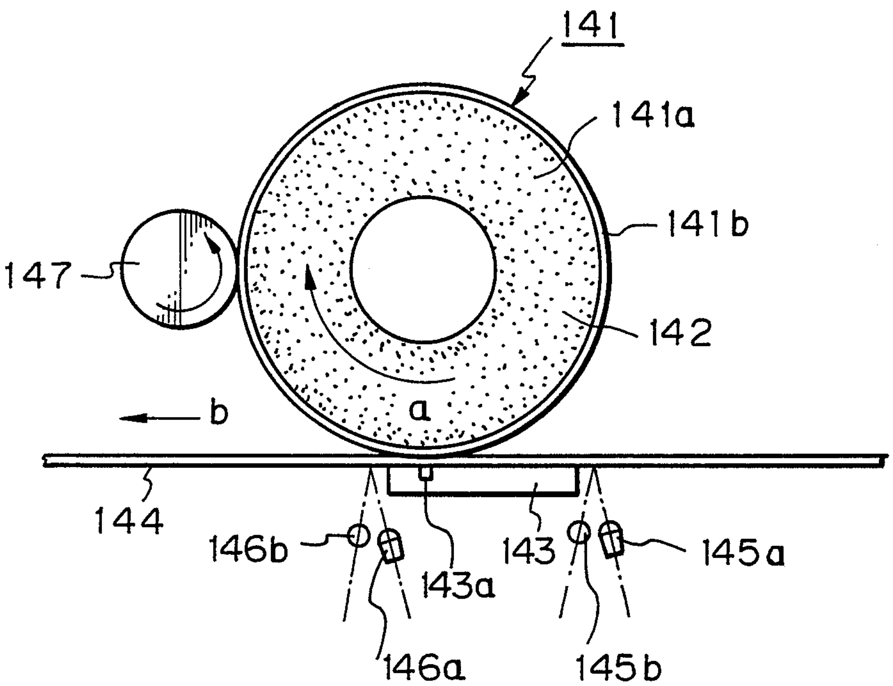
133
136

Fig. 54


141
141a
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b
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146b
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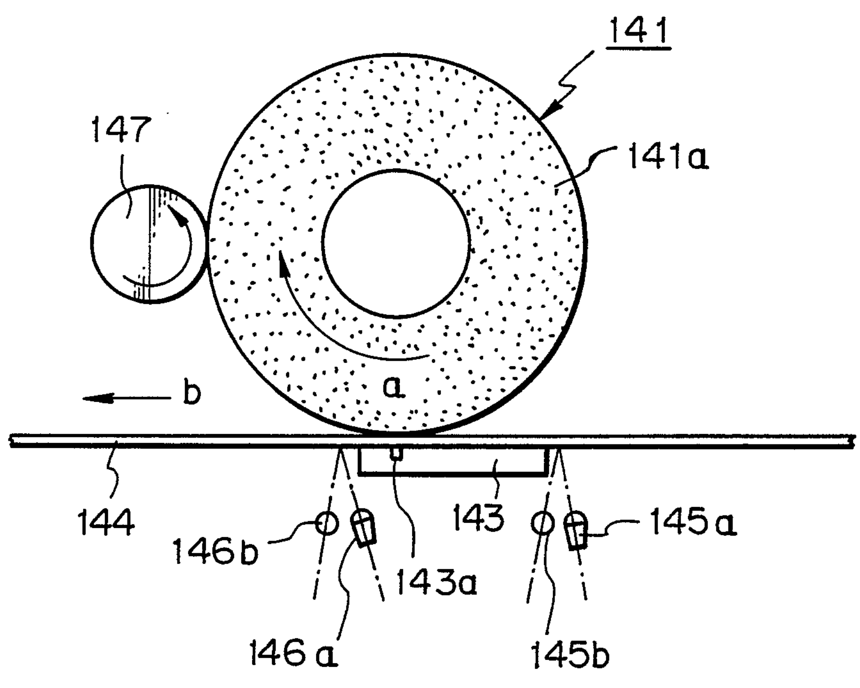
145a
143a
146a
145b

Fig. 55


141
147
141a
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146b
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143a
146 a
145b

Fig. 56

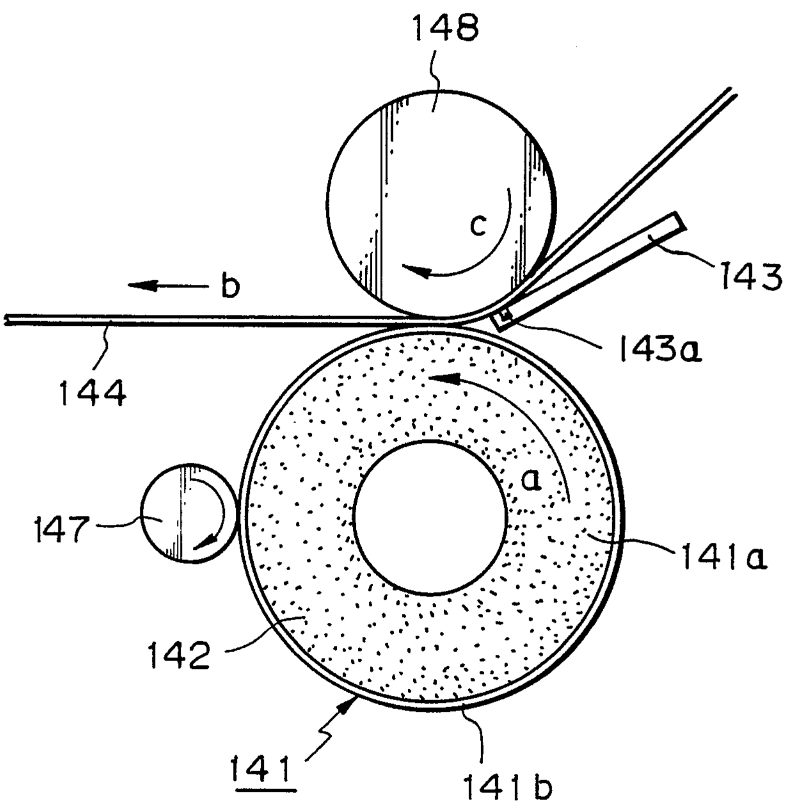
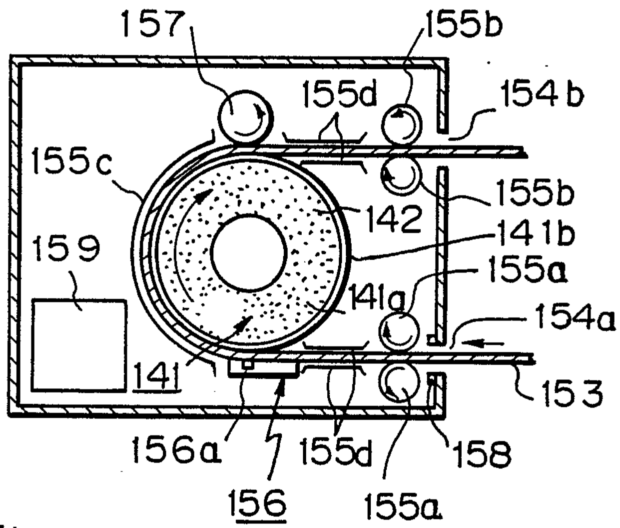


Fig. 57



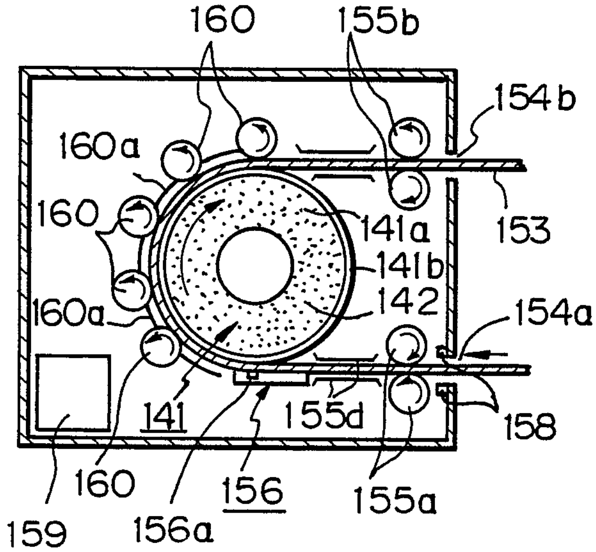


Fig. 58

Fig. 59

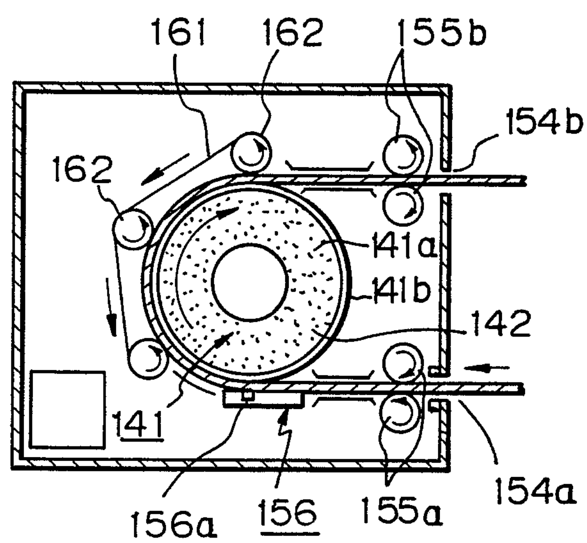
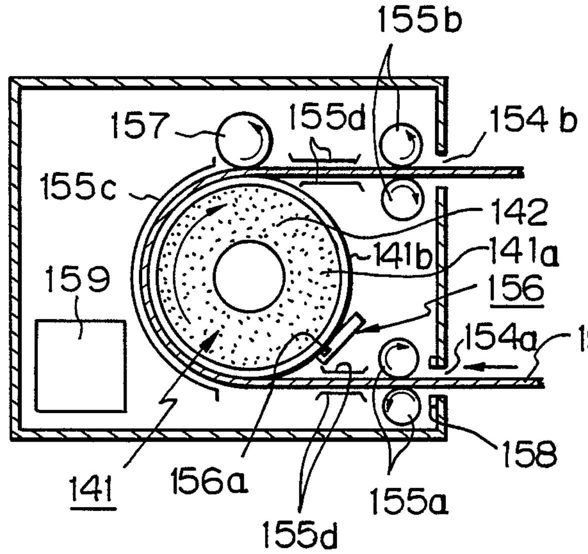


Fig. 60


155b
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154a
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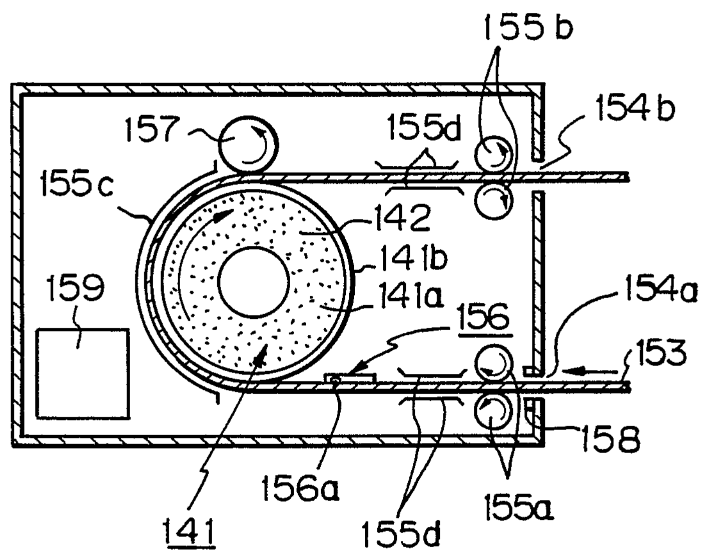
158
141
156a
155a
155d

Fig. 61


155 b
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141
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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 87305479.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 7, no. 24, January 29, 1983 THE PATENT OFFICE JAPANESE GOVERNMENT page 130 M 189 * Kokai-no. 57-178 784 (SEIKOUSHIYA K.K.) *	1,2	B 41 J 3/20 B 41 J 27/20
A		3-6, 12,21	
A	GB - A - 1 563 775 (OKI ELECTRIC IND.) * Totality *	1-3, 6-8, 12,15, 21	
A	EP - A1 - 0 046 985 (BRIDGESTONE TIRE COMP. LTD.) * Totality *	1-3,6, 10,21	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 41 J
B 41 F
B 41 M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	10-09-1987	WITTMANN

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document