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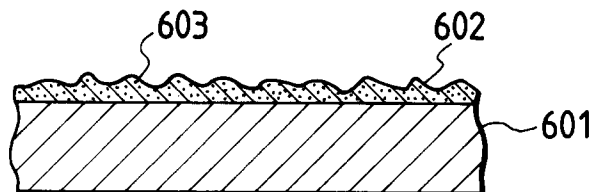
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(54) **Carrying roller for recording apparatus.**

(57) A recording apparatus has a carrying roller that carries a recording material to make a record on said recording material. The carrying roller has on its periphery an electro-deposition coating film containing a filler.

FIG. 6



BACKGROUND OF THE INVENTIONField of the Invention

5 The present invention relates to a recording apparatus having a friction type carrying roller that carries a recording material such as paper by the action of friction.

Related Background Art

10 In recording apparatus such as printers and facsimile machines, it has been common for recording paper to be carried by a paper carrying roller whose periphery is formed of a resilient material such as resin. The present applicant has proposed a recording apparatus making use of such a paper carrying roller (Japanese Patent Applications Laid-open No. 2-158541 and No. 2-169432).

15 Meanwhile, ink-jet recording that mates a record on recording paper by causing ink droplets to fly from orifices. This ink-jet recording has a number of advantageous features such that it can perform high-speed recording or color recording with no noise and on a high quality level. In the high-speed recording and color recording, however, an excellent paper carrying precision is required.

20 The paper carrying roller whose periphery is formed of a resilient material has an excellent paper carrying precision, but has been involved in the problem that it may be affected by environmental temperature. More specifically, in an environment of low temperature, the paper carrying roller whose periphery is formed of a resilient material such as resin, has the problem that it causes a decrease in frictional force to bring about a loss of a satisfactory paper carrying performance.

SUMMARY OF THE INVENTION

25 An object of the present invention is to provide a recording apparatus that can carry paper in a good precision not only at room temperature (25°C) but also in an environment of a lower temperature.

30 The recording apparatus of the present invention comprises a carrying roller that carries a recording material to mate a record on said recording material, wherein said carrying roller has on its periphery an electro-deposition coating film containing a filler.

35 In another embodiment of the recording apparatus of the present invention, the carrying roller has on its periphery an electro-deposition coating film containing a filler and also a pinch sheet is provided in the vicinity of the periphery of said carrying roller in such a manner that said pinch sheet can be pressed against the periphery of said carrying roller.

BRIEF DESCRIPTION OF THE DRAWINGS

40 Fig. 1 is a partially cutaway perspective illustration of an embodiment of the recording apparatus according to the present invention.

Fig. 2 is a side elevation of the recording apparatus shown in Fig. 1.

Fig. 3 is a partial view of the recording apparatus shown in Fig. 1.

Fig. 4 is a perspective view of an outer casing of the recording apparatus shown in Fig. 1.

Fig. 5 is a partial view of the recording apparatus shown in Fig. 1.

45 Fig. 6 is a partial cross section of the carrying roller used in the recording apparatus of the present invention.

Fig. 7 is a perspective illustration of another embodiment of the recording apparatus according to the present invention.

Fig. 8 is a side elevation to illustrate the state in which a pinch sheet is pressed against a carrying roller in the recording apparatus shown in Fig. 7.

50 Fig. 9 is a side elevation to illustrate the state in which the pinch sheet is kept apart from the carrying roller in the recording apparatus shown in Fig. 7.

Figs. 10 and 11 are perspective illustrations of other embodiments of the recording apparatus according to the present invention.

55 Fig. 12 is a side elevation to illustrate a surface property tester that measures the coefficient of static friction of a carrying roller against a copy paper.

Figs. 13, 14 and 15 are enlarged photographs of cross sections of the surface of a carrying roller used in the recording apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described below with reference to the accompanying drawings.

In the following, the present invention is described taking as an example an ink-jet recording apparatus
 5 that mates a record on a recording material such as paper by generating bubbles in ink by the application of a heat energy and causing ink droplets to fly from ejection orifices.

Figs. 1 and 2 illustrate an embodiment of the recording apparatus of the present invention. A recording material 23 such as paper is carried by a main carrying roller (hereinafter simply "main roller") 10. The main roller 10 comprises, as will be more detailed later, a substrate and formed thereon an electro-deposition coating film
 10 containing a filler. In the recording apparatus of the present invention, this main roller 10 is able to carry paper in a good precision without being affected by environmental temperature.

The main roller 10 has a shaft 11 passing through its center and rotatably supported on left and right side plates 12 and 13. A secondary carrying roller (hereinafter simply "secondary roller") 14 is rotatably supported by a roller arm 15 described later, and is comprised of, as shown in Fig. 1, both end paper carrying portions
 15 14a and a transmission portion 14b at the middle, having a little (about 2 to 6%) smaller diameter than the paper carrying portions 14a.

The secondary roller 14 comprises a roller made of a plastic material such as PC and ABS, whose periphery is covered with a resilient material or electrodeposition-coated with the same material as used in the main roller 10 so that its periphery is highly frictional on its both the paper carrying portions 14a and transmission portion
 20 14b.

Spurs 16 are each a thin plate having teeth on its periphery. They are supported on a cover 17 through axes 16a, and are brought into pressure contact with the secondary roller 14 at a given pressure by a pressing means (not shown). The spurs 16 are provided opposingly to the paper carrying portions 14a of the secondary roller 14.

An idle roller 18 is so provided as to come in pressure contact with the main roller 10 and the transmission portion 14b of the secondary roller 14. It transmits the rotational power of the main roller 10 to the secondary roller 14 by frictional transmission.

Reference numeral 19 denotes roller springs provided in pair on the right and the left, which are secured to a platen 20. Their end portions 19a come into pressure contact with shafts 18a provided at both ends of the
 30 idle roller 18, and always press the idle roller 18 in one direction. The platen 20 is positioned above the main roller 10 and also has a print face 20a positioned opposingly to a nozzle face 21a of a recording head 21. The platen is secured to a base 22 through a stay (not shown).

Roller arms 15 are each pivotably fitted to the platen 20 around a shaft 15a. At one end of each roller arm 15, an arm 15b for supporting the secondary roller 14 and a contact portion 15c for coming in contact with a paper guide 24 are formed. A rock button 25 is slidably fitted to the platen 20, where a hook 25a is formed so
 35 that a hook 24a of the paper guide 24 can be hooked when the paper guide 24 is brought down (see Figs. 4 and 5).

A left side plate 12 and a right side plate 13 are upright provided on both sides of the base 22. The base 22 is provided with an opening 22a serving as a bottom path. Reference numeral 26 denotes a first guide shaft, and 27, a second guide shaft, which are supported on the right and left side plates 12 and 13 of the base 22. A carrier 28 is slidably supported on the first guide shaft 26 and second guide shaft 27.

The printing head (recording head) 21 is integrally provided with a printing part and an ink tank, and is mounted on the carrier 28. From ejection orifices of the printing head 21, ink droplets are ejected and a record is made on a recording material 23 such as paper. A flexible printing plate is omitted from the drawings, which
 45 electrically connects a control substrate on the side of the apparatus body and the printing part of the recording head 21.

A carrier motor 29 is secured to the right side plate 13 through a mounting stay 29a. A motor pulley 30 is fixed to a shaft 29b of the carrier motor 29. A timing belt 31 is extended between the motor pulley 30 and a tension pulley (not shown), and is connected in part at the bottom of the carrier 28. A paper carrying motor 32 is secured to the base 22 through a stay (not shown). A roller gear 33 is fitted to the shaft 11 of the main roller 10 and engages with a pinion (not shown) of the paper carrying motor 32.

A paper pan 34 is secured to the right and left side plates 12 and 13, and guides paper 23, a recording material, from the rear to the front of the main roller 10. A paper press plate 35 is secured to the base 22 and is pressed against the main roller 10 at a given pressure. To the paper press plate 35, a Teflon tape may be stuck on its face coming into contact with the main roller 10, or fluorine resin coating may be applied, and is
 55 so made as to have a low coefficient of friction. A pinch roller 36 (see Fig. 2) is pressed against the main roller 10 by the action of a spring (not shown). Besides the paper, various materials such as a resin sheet can be used as the recording material.

As shown in Fig. 2, an upper case 37 is provided with hinges 37a and 37b. Its front side is recessed in part, and is provided with holes 37c through which actuators are partially exposed. The paper guide 24 is so fitted as to be rotatable around the hinge 37a of the upper case 37, and is provided with a hook 24a formed at the top thereof and designed to engage with the rock button 25.

The cover 17 is rotatably supported on the hinge 37b of the upper case 37, and is fitted with a spur 16 at the extremity thereof. As shown in Fig. 3, at the part fitted with the spur 16, a V-shaped groove 17a is formed correspondingly to the thin-plate type spur 16 so that the spur does not come in touch with operator's fingers and also can overlap with the cover 17 in the thickness direction. Reference numeral 38 denotes a lower case. A control base plate 39 is fitted with a controlling switch 40 at a given position. The actuators 40a are so arranged as to be exposed through the holes 37c of the upper case 37.

In the recording apparatus constructed as described above, print paper 23 is set in the following way: The print paper 23 is first inserted from the rear of the main roller 10. At the position where its forward end comes in touch with the pinch roller 36, the paper carrying motor 32 is driven to rotate the main roller 10. At this time, at the front of the main roller 10, the paper press plate 35 is in touch with it. The print paper 23 thus inserted is moved along the circumference in the direction of rotation by virtue of the frictional force of the surface of the main roller 10, and is further carried to the printing position by the action of the thin-plate type paper press plate pressed against the main roller 10.

As shown in Fig. 6, the main roller 10 has an electro-deposition coating film 602 containing a filler 603, which is formed at least on the periphery of a cylindrical substrate 601. Fig. 6 is a partial cross section of the vicinity of the surface along the periphery of the main roller 10.

The electro-deposition coating film refers to a film formed by electro-deposition coating. The electro-deposition coating is a process in which a pair of electrodes are disposed in a solution prepared by dissolving a film-forming material (hereinafter "electro-deposition coating composition") and a direct voltage is applied to the electrodes to deposit the material on one of the electrode. Accordingly, when the main roller 10 is produced, the cylindrical substrate is set as one of the electrodes. As the other electrode, a stainless steel plate may preferably be used.

The cylindrical substrate 601 used may be made of, for example, a metal such as aluminum alloy or stainless steel, or a plastic material such as polycarbonate resin or ABS resin. When, however, a non-metallic material is used as the substrate 601, the substrate 601 must be subjected to conductivity-providing treatment before the electro-deposition coating is carried out.

The cylindrical substrate 601 may preferably be in a size of from 20 mm to 50 mm in outer diameter and 220 mm to 250 mm in length.

The electro-deposition coating composition that provides the electro-deposition coating film 602 is prepared by incorporating a filler in a resin available for the electro-deposition coating.

Various studies have been hitherto made on the resin used in the electro-deposition coating. In order for the resin to be electro-deposited, the resin must be chargeable when formed into the electro-deposition coating composition. Charged resin is attracted to the anode or cathode upon application of a direct voltage, and deposited on the electrode to form a film. The resin used in the present invention can be exemplified by acrylic-melamine resins, acrylic resins, epoxy resins, urethane resins and alkyd resins, which are conventionally used in electro-deposition coating.

The resin used in the present invention may be either anionic resin or cationic resin. From a practical viewpoint, a water-soluble resin or water-dispersible resin having a carboxyl group is preferred. A resin prepolymer having a carboxyl group can be dissolved or dispersed in water after it has been neutralized to an ammonia or an organic amine.

In the electro-deposition coating composition, the resin should be in a concentration ranging from 5% to 20% by weight, and preferably from 7% to 15% by weight.

The electro-deposition coating composition used in the present invention may preferably be prepared by dissolving or dispersing the desired resin in water. The electro-deposition coating composition may further contain an organic solvent of an alcohol type or glycol ether type. The organic solvent may be in a content of several percent to obtain intended results.

The filler 603 contained in the electro-deposition coating film 602 may preferably be a ceramic powder, a metal powder, or a ceramic powder whose particle surfaces are coated with a metal (hereinafter "metallized ceramic powder"). The metal powder and the metallized ceramic powder are effective as conductive inorganic powders.

There are no particular limitations on the ceramic powder, and a vast range of materials can be used, preferably as exemplified by powder of SiC, SiO₂, Si₃N₄, TaC, ZrO, Al₂O₃ or NbC.

There are no particular limitations on the metal powder, preferably as exemplified by powder of Ag, Co, Cu, Fe, Mn, Ni, Pd, Sn or Te.

The metal powder may preferably be those produced by, for example, heat plasma evaporation or pulverization.

As the metallized ceramic powder, it is possible to use a powder of the aforesaid ceramic whose particle surfaces are coated with a metal such as Ag, Ni or Cu, and a powder of the ceramic whose particle surfaces are double-layer coated with Ni and Au. From the viewpoint of cost, electroless plating of nickel or copper is suited for the metal coating applied to particle surfaces of the ceramic powder.

The filler 603 may preferably have an average particle diameter of 0.05 μm to 5 μm , and more preferably from 0.1 μm to 2.0 μm . If the filler 603 has an excessively small average particle diameter, no satisfactory effect can be obtained. If the filler 603 has an excessively large average particle diameter, the filler may drop out of the electro-deposition coating film. In the present invention, the average particle diameter of the filler is a value measured by a centrifugal settling particle size distribution measuring device SACP-3 (manufactured by Shimadzu Corporation).

Electro-deposition coating carried out using the electro-deposition coating composition containing a powder enables deposition of the powder in the film formed. This is presumably because resin molecules are adsorbed around powder particles in the electro-deposition coating composition and the powder particles also are moved toward the electrode as the resin molecules are attracted to the electrode.

The electro-deposition coating film 602 should have an average film thickness (average of distance from the surface of the substrate 601 to the top of a projection formed by the filler 603) of 5 μm or more, and particularly from 7 μm to 50 μm .

The filler may preferably be deposited in a quantity (a content) of from 3% to 40% by weight, and more preferably from 4.5% to 30% by weight, based on the weight of the electro-deposition coating film 602. If the filler 603 is in an excessively small content, no satisfactory effect can be obtained. If the filler is in an excessively large content, the durability of the electro-deposition coating film 602 may become lower. In the present invention, the quantity of deposition is a value analyzed using a thermogravimetric analyzer.

In the case where the electro-deposition coating film 602 is formed by electro-deposition coating, the substrate 601 serving as an electrode is dipped in the electro-deposition coating composition together with another electrode. The electro-deposition coating composition may preferably be prepared by dispersing the resin and the filler in a ball mill for about 12 to 35 hours, followed by dilution with desalted water. In the case where an anionic resin is used as the resin, the substrate 601 serves as the anode. In the case where a cationic resin is used as the resin, the substrate 601 serves as the cathode. The electro-deposition coating composition may preferably have a temperature of from 19 to 25°C, and a hydrogen ion concentration of pH 8 to 9. The applied voltage may preferably be a direct voltage of 50 to 200 V. Current density may preferably be 0.5 to 5 A/dm². The electro-deposition coating may preferably be carried out for 2 minutes to 6 minutes.

After the electro-deposition coating, the substrate 601 with a coating is taken out of the electro-deposition coating composition, and then washed with water. After washing with water, the water is drained. Then this substrate 601 is put in a 100 to 140°C oven for 20 minutes to 180 minutes to effect curing to form the electro-deposition coating film 602. The formation of the electro-deposition coating film 602 is thus completed.

Fig. 7 illustrates another embodiment of the present invention. The recording material 23 is carried while it is pressed against the periphery of a carrying roller 110 by a pinch sheet 117. The carrying roller 110 is constituted in the same manner as the main roller 10 described with reference to Fig. 1. More specifically, the carrying roller 110 is comprised of a cylindrical substrate made of a metal such as aluminum or iron or a hard plastic such as PC or ABS, and the filler-containing electro-deposition coating film formed thereon. A shaft 111 is passed through and secured to the center of the carrying roller 110. At the same time, one end of the shaft 111 is rotatably supported on a left side plate 114a, and the other end thereof is connected with a shaft of a paper carrying motor 113.

The left side plate 114a and a right side plate 114b are formed on both sides of a base 114. A folded portion 114c and a click 114d are integrally formed on the left side plate 114a. A support plate 115 is secured to the side plates 114a and 114b. The support plate 115 is provided at the position kept a little apart from the periphery of the carrying roller 110, and is formed of a resilient material such as stainless steel plate or phosphor bronze. The carrying motor 113 is fitted to the right side plate 114b. A shaft (not shown) of the carrying motor 113 is connected with the shaft 111 of the carrying roller 110 so that the carrying roller 110 also rotates as the carrying motor 113 rotates.

The pinch sheet 117 is formed of a material having a low coefficient of friction, such as a fluorine resin film. One end thereof is fixed to the support plate 115. The sheet is wound around the lower periphery of the carrying roller 110 at a given round angle (about 100 to 150°) and thereafter fixed to a tension shaft 118 in a wound-around state. The tension shaft 118 is rotatably supported on the left side plate 114a and right side plate 114b. The tension shaft 118 has a slit 118a made in its longitudinal direction. To the slit 118a, an end of the pinch sheet 117 having been wound around the tension shaft 118 by 3/4 to 7/8 peripheral length is inserted

and fixed there (see Figs. 8 and 9).

A release lever 119 is fitted to an end of the tension shaft 118.

The bottom end of the release lever 119 is provided with a spring peg 119a. To the spring peg 119a, one end of a spring 120 is hooked, and the other end of the spring 120 is hooked on a column 121. The column 121 is provided on the base 114. Thus, the spring peg 119a of the release lever 119 is pulled toward the column 121, so that a rotational force is given to the tension shaft 118. Thus, as shown in Fig. 8, the tension shaft 118 is rotated in the direction of an arrow A, so that the pinch sheet 117 is pressed against the periphery of the carrying roller 110.

On the other hand, when an upper end 119b of the release lever 119 is moved in the direction opposing to the tension of the spring 120, the tension shaft 118 is, as shown in Fig. 9, rotated in the direction of an arrow B, so that the pinch sheet is separated from the carrying roller 110. When the release lever 119 is climbed over the click 114d of the folded portion 114c, it is stopped at the click 114d, thereby maintaining the state in which the pinch sheet 117 is separated from the carrying roller 110.

A guide shaft 122, a guide shaft 123, a carrier 124 and a recording head 125 correspond the guide shaft 26, the guide shaft 27, the carrier 28 and the recording head 21, respectively, described with reference to Fig. 1.

In the recording apparatus constructed as described above, the pinch sheet 117 is wound around the carrying roller 110 at a given pressure by virtue of the tension of the spring 120. The support plate 115 is also pulled to come in touch with the carrying roller 110 via the pinch sheet 117. Thus, when the print paper 23 is inserted from the rear of the carrying roller 110 and the carrying roller 110 is rotated, the print paper 23 is carried while being held between the roller 110 and the pinch sheet 117, is passed over the support plate 115, and is sent upwards. The print paper 23 is carried while being always in close contact with the carrying roller 110, and hence it can be carried in a good precision.

On the other hand, when the release lever 119 is rotated and hooked on the click 114d, the tension shaft 118 is, as shown in Fig. 9, rotated in the direction of the arrow B, and the tension to the pinch sheet 117 is released, so that a clearance is made between the carrying roller 110 and the pinch sheet 117. The tension to the support 115 is also released, and hence a clearance is similarly made between the carrying roller 110 and the support plate 115, so that the print paper is brought into a free state.

Figs. 10 and 11 illustrate still another embodiments of the present invention. The same members as those in the recording apparatus shown in Fig. 7 are denoted by the same reference numerals.

In the embodiment shown in Fig. 10, a tension plate 126 is secured to a tension shaft 118, and one end of a pinch sheet 117 is fixed to the tension plate 126.

In the recording apparatus shown in Fig. 10, the recording material 23 can be set and released in the same manner as the recording apparatus shown in Fig. 7.

In the embodiment shown in Fig. 11, a release shaft 127 is rotatably supported on a left side plate 114a and a right side plate 114b, and arms 128 are fixed to both ends of the release shaft 127. A release lever 119 is fixed to one of the arm 128. On the end portions 128a of the arms 128, a support plate 115 is held and also springs 129 are provided. The end portions 128a of the arms 128 are pushed upward by the action of the springs 129. One end of the pinch sheet 117 is secured to the support plate 115, and the other end of the pinch sheet is secured to another support plate 130. The support plate 130 is secured to the side plates 114a and 114b.

Thus, the pinch sheet 117 is pressed against the roller 110 by the action of the springs 129.

As described above, the recording apparatus of the present invention comprises the carrying roller having on its surface the electro-deposition coating film containing the filler. Hence, a stable paper carrying precision can be maintained even in an environment of low temperature.

EXAMPLES

Example 1

Using an electro-deposition coating composition containing 5 parts by weight of alumina (Al_2O_3) filler with an average particle diameter of 0.5 μm , based on 100 parts by weight of acryl-melamine resin (trade name: HONEYBRIGHT CL-1; available from Honey Chemical Co., Ltd.), an electro-deposition coating film was formed on the periphery of a cylindrical substrate made of an aluminum alloy. Thus a paper carrying roller used in the recording apparatus of the present invention was produced.

The cylindrical substrate was 30 mm in outer diameter, 230 mm in length and 1 mm in thickness. Electro-deposition coating was carried out using the cylindrical substrate as the anode under conditions of an applied voltage of 90 V and a current density of 4.3 A/dm² for 150 seconds. At this time, the electro-deposition coating composition had a liquid temperature of 20 $\pm$ 0.5°C and a pH of 8. After the electro-deposition coating was com-

pleted, the cylindrical substrate on which a coating had been formed was put in an oven of a temperature 120°C for 30 minutes to cure the coating.

The electro-deposition coating film thus formed had an average thickness of 17 μm (minimum thickness: 5 μm). The quantity of the filler deposited in the electro-deposition coating composition was 18% by weight. The electro-deposition coating film had a ten-point average roughness R_z (JIS B0601) within the range of from 3 μm to 8 μm , which was different little by little according to positions.

On the paper carrying roller produced in this way, the coefficient of static friction against a copy paper was measured while varying environmental temperature. The coefficient of static friction was measured using the surface property tester as shown in Fig. 12.

The coefficient of static friction was measured in the following way: Using the surface property tester shown in Fig. 12, the paper carrying roller 210 on which the electro-deposition coating film had been formed was rotated at an angular speed ω of 1.5 rad/sec and a copy paper 213 was brought into contact with the periphery of this paper carrying roller 210. The copy paper 213 was fixed to a fixed plate 212 and a load of 1.5 kg was applied to the fixed plate 212 in the direction of the roller 210. Thus the coefficient of static friction was measured using a sensor 215 and a recorder 217. Results of measurement are shown in Table 1

Next, a paper carrying roller produced in the same manner as the roller 210 was set on the recording apparatus of Fig. 1 as the main roller 10 to carry out recording. As a result, the paper was carried in a good precision, and a recorded image thus obtained was on a good quality level.

Finally, a paper carrying roller prepared in the same manner as the roller 210 was cut perpendicularly to its rotating shaft to observe a cross section of the electro-deposition coating film by the use of an electron microscope.

Enlarged photographs of the cross section of the electro-deposition coating film are shown in Figs. 13, 14 and 15. Fig. 13 is an enlarged perspective photograph of 1,275 magnifications, Fig. 14 is an enlarged side view photograph of 1,700 magnifications, and Fig. 15 is an enlarged side view photograph of 850 magnifications. In Figs. 13, 14 and 15, reference numeral 601 denotes the substrate, and 602, the electro-deposition coating film.

Comparative Example 1

A paper carrying roller used in the recording apparatus was produced in the same manner as in Example 1 except that no alumina filler was contained in the electro-deposition coating film. The electro-deposition coating film of this paper carrying roller had a ten-point average roughness R_z (JIS B0601) within the range of from 0.1 μm to 0.8 μm , which was different little by little according to positions.

On this paper carrying roller, the coefficient of static friction against a copy paper was measured in the same manner as in Example 1.

Results of measurement are shown in Table 1.

Table 1

Environmental temperature	Example 1	Comparative Example 1
25°C	2.0	1.2
10°C	2.0	1.1
5°C	1.9	0.8

In Example 1, there was little decrease in the frictional force even in the environment of low temperature. This is presumed to be due to the frictional force produced by engagement of surface irregularities of the electro-deposition coating film with minute surface irregularities of the paper.

In Comparative Example 1, on the other hand, the coefficient of friction became lower with a lowering of temperature. This is presumed to be due to the loss of viscosity of resin because of its rigidification at low temperatures since the roller of Comparative Example 1 carries the paper by the aid of the viscosity of resin.

Example 2

Using an electro-deposition coating composition containing 5 parts by weight of silicon oxide (SiO_2) filler with an average particle diameter of 0.5 μm , based on 100 parts by weight of cationic acrylic resin (trade name: ELECOAT CMEX; available from Shimizu Co.), an electro-deposition coating film was formed on the periphery

of a cylindrical substrate made of an aluminum alloy. Thus a paper carrying roller used in the recording apparatus of the present invention was thus produced.

The cylindrical substrate was 30 mm in outer diameter, 230 mm in length and 1 mm in thickness. Electro-deposition coating was carried out using the cylindrical substrate as the cathode under conditions of an applied voltage of 100 V and a current density of 5.0 A/dm² for 150 seconds. At this time, the electro-deposition coating composition had a liquid temperature of 20±0.5°C and a pH of 3. After the electro-deposition coating was completed, the cylindrical substrate on which a coating had been formed was put in an oven of a temperature 130°C for 30 minutes to cure the coating.

The electro-deposition coating film thus formed had an average thickness of 17 µm (minimum thickness: 5 µm). The quantity of the filler deposited in the electro-deposition coating composition was 15% by weight.

On the paper carrying roller produced in this way, the coefficient of static friction against a copy paper was measured in the same manner as in Example 1.

Results of measurement are shown in Table 2.

Next, a paper carrying roller produced in this Example 2 was set on the recording apparatus of Fig. 7 as the main roller 10 to carry out recording. As a result, the paper was carried in a good precision, and a recorded image thus obtained was on a good quality level.

Comparative Example 2

A paper carrying roller used in the recording apparatus was produced in the same manner as in Example 2 except that no silicon oxide filler was contained in the electro-deposition coating film.

On this paper carrying roller, the coefficient of static friction against a copy paper was measured in the same manner as in Example 1.

Results of measurement are shown in Table 2.

Table 2

Environmental temperature	Example 2	Comparative Example 2
25°C	1.9	1.0
10°C	1.9	0.9
5°C	1.8	0.6

Example 3

Using an electro-deposition coating composition containing 3 parts by weight of silicon carbide (SiC) filler with an average particle diameter of 0.7 µm, based on 100 parts by weight of urethane resin, an electro-deposition coating film was formed on the periphery of a cylindrical substrate made of an aluminum alloy. Thus a paper carrying roller used in the recording apparatus of the present invention was thus produced.

The cylindrical substrate was 30 mm in outer diameter, 230 mm in length and 1 mm in thickness. Electro-deposition coating was carried out using the cylindrical substrate as the anode under conditions of an applied voltage of 80 V and a current density of 4.0 A/dm² for 150 seconds. At this time, the electro-deposition coating composition had a liquid temperature of 20±0.5°C and a pH of 8. After the electro-deposition coating was completed, the cylindrical substrate on which a coating had been formed was put in an oven of a temperature 120°C for 30 minutes to cure the coating.

The electro-deposition coating film thus formed had an average thickness of 17 µm (minimum thickness: 5 µm). The quantity of the filler deposited in the electro-deposition coating composition was 20% by weight.

On the paper carrying roller produced in this way, the coefficient of static friction against a copy paper was measured in the same manner as in Example 1.

Results of measurement are shown in Table 3.

Next, a paper carrying roller produced in this Example 3 was set on the recording apparatus of Fig. 1 as the main roller 10 to carry out recording. As a result, the paper was carried in a good precision, and a recorded image thus obtained was on a good quality level.

Comparative Example 3

A paper carrying roller used in the recording apparatus was produced in the same manner as in Example 3 except that no silicon carbide filler was contained in the electro-deposition coating film.

On this paper carrying roller, the coefficient of static friction against a copy paper was measured in the same manner as in Example 1.

Results of measurement are shown in Table 3.

Table 3

Environmental temperature	Example 3	Comparative Example 3
25°C	2.2	1.5
10°C	2.2	0.8
5°C	1.9	0.5

Claims

1. A recording apparatus comprising a carrying roller that carries a recording material to make a record on said recording material, wherein said carrying roller has on its periphery an electro-deposition coating film containing a filler.
2. The recording apparatus according to claim 1, wherein said recording apparatus is an ink-jet recording apparatus.
3. The recording apparatus according to claim 1, wherein said filler is selected from the group consisting of a ceramic powder, a metal powder and a metallized ceramic powder.
4. The recording apparatus according to claim 1, wherein said filler has an average particle diameter of from 0.05 μm to 5 μm .
5. The recording apparatus according to claim 4, wherein said average particle diameter is from 0.1 μm to 2.0 μm .
6. The recording apparatus according to claim 1, wherein said filler in said electro-deposition coating film is in a deposition quantity of from 3% by weight to 40% by weight.
7. The recording apparatus according to claim 6, wherein said deposition quantity is from 4.5% by weight to 30% by weight.
8. A recording apparatus comprising a carrying roller that carries a recording material to make a record on said recording material, wherein said carrying roller has on its periphery an electro-deposition coating film containing a filler and a pinch sheet is provided in the vicinity of the periphery of said carrying roller in such a manner that said pinch sheet can be pressed against the periphery of said carrying roller.
9. The recording apparatus according to claim 8, wherein said recording apparatus is an ink-jet recording apparatus.
10. The recording apparatus according to claim 8, wherein said filler is selected from the group consisting of a ceramic powder, a metal powder and a metallized ceramic powder.
11. The recording apparatus according to claim 8, wherein said filler has an average particle diameter of from 0.05 μm to 5 μm .
12. The recording apparatus according to claim 11, wherein said average particle diameter is from 0.1 μm to 2.0 μm .

13. The recording apparatus according to claim 8, wherein said filler in said electro-deposition coating film is in a deposition quantity of from 3% by weight to 40% by weight.

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14. The recording apparatus according to claim 13, wherein said deposition quantity is from 4.5% by weight to 30% by weight.

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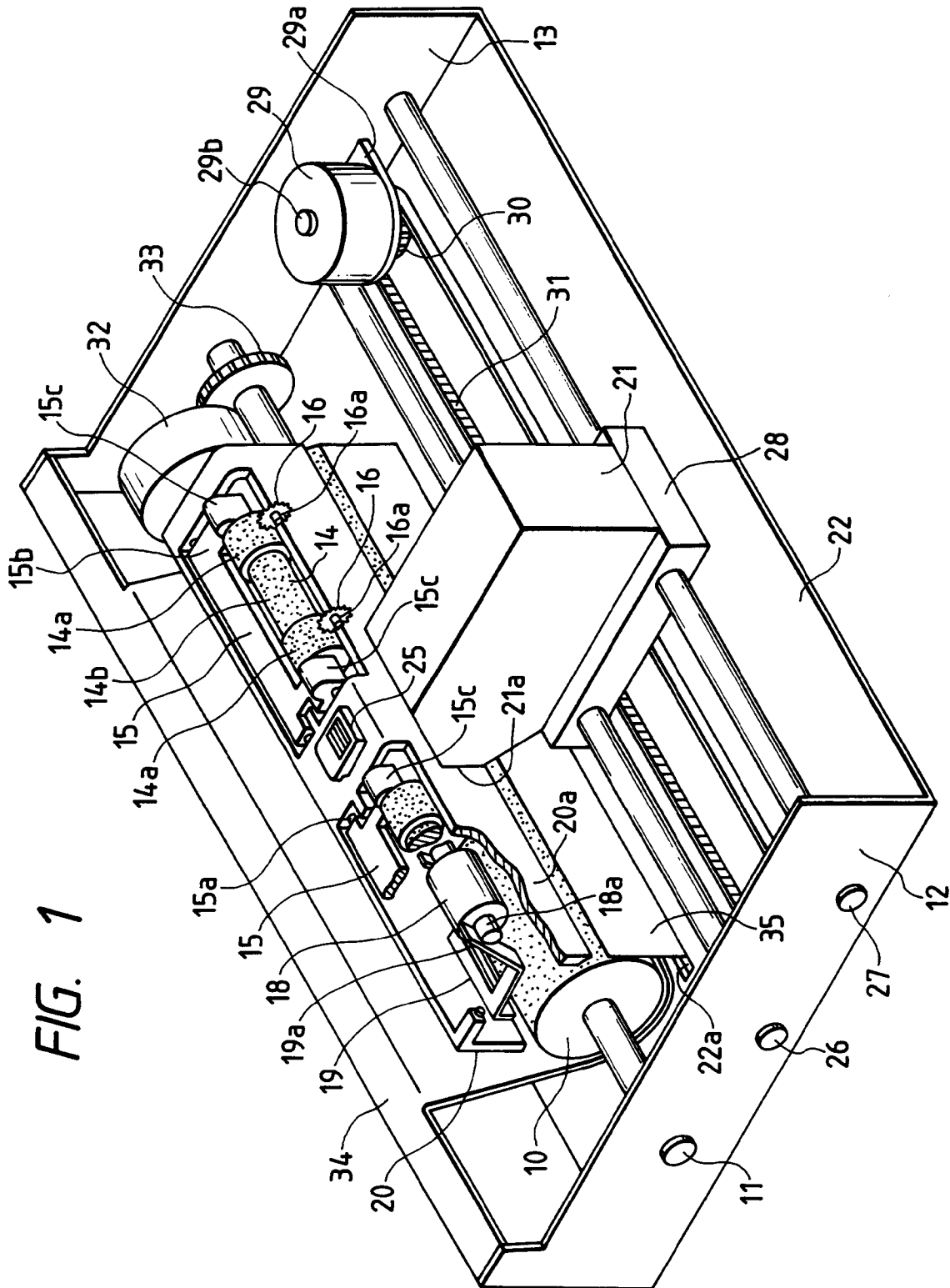
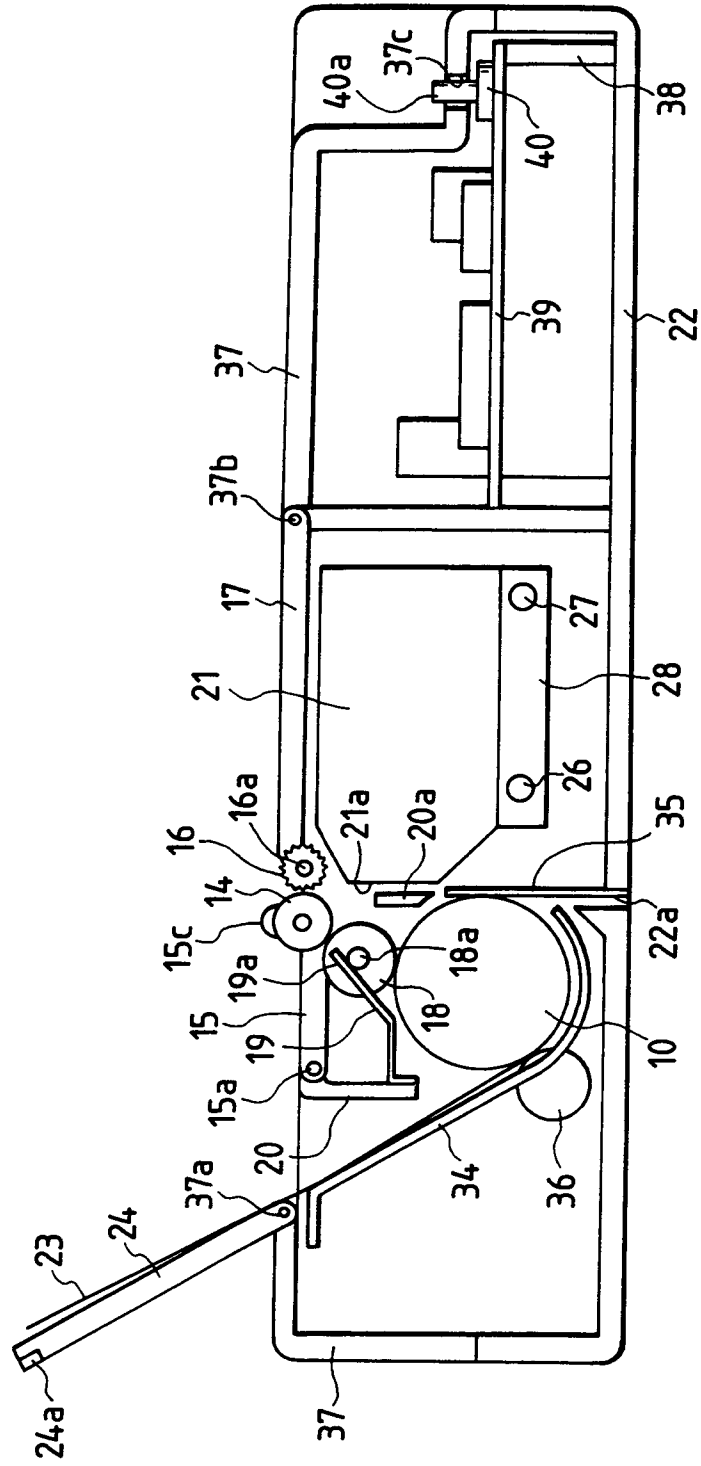
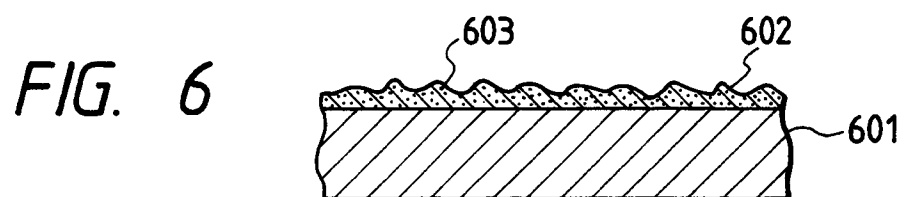
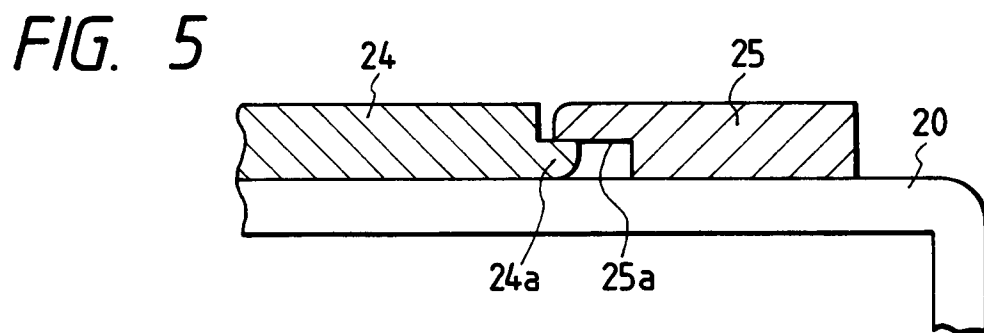
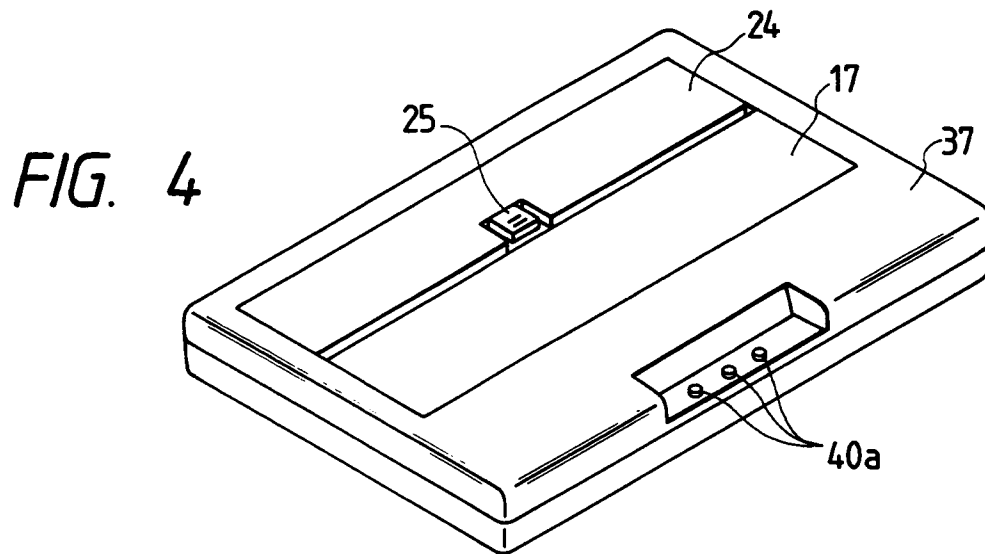
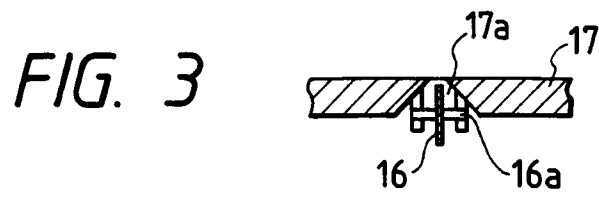


FIG. 1

FIG. 2





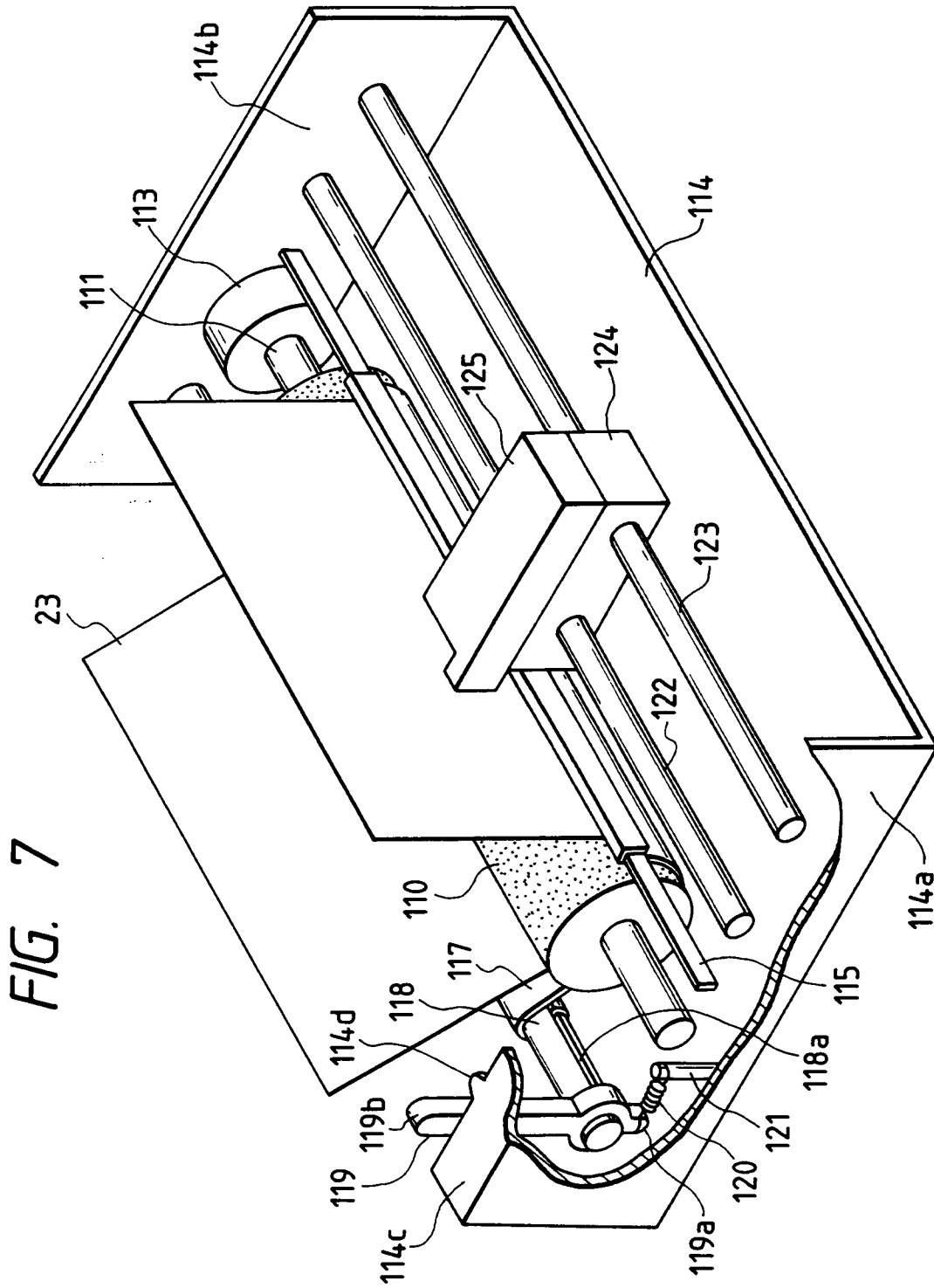


FIG. 8

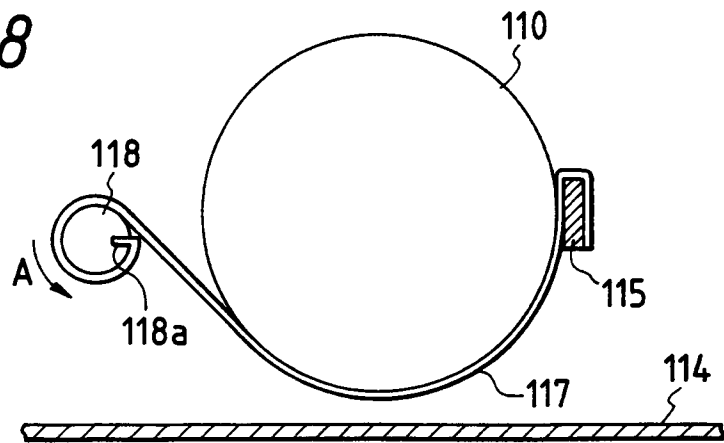


FIG. 9

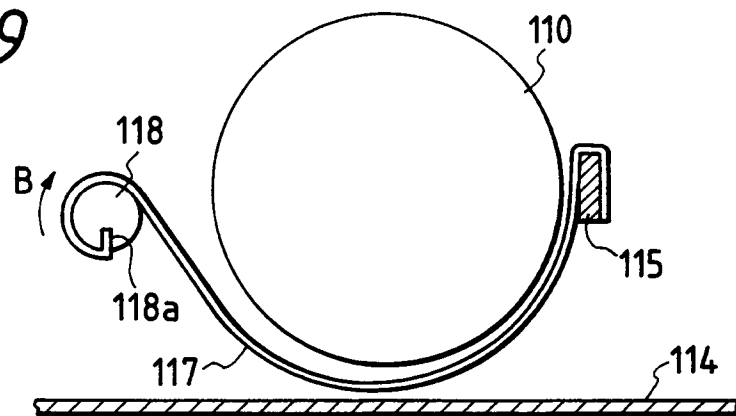


FIG. 12

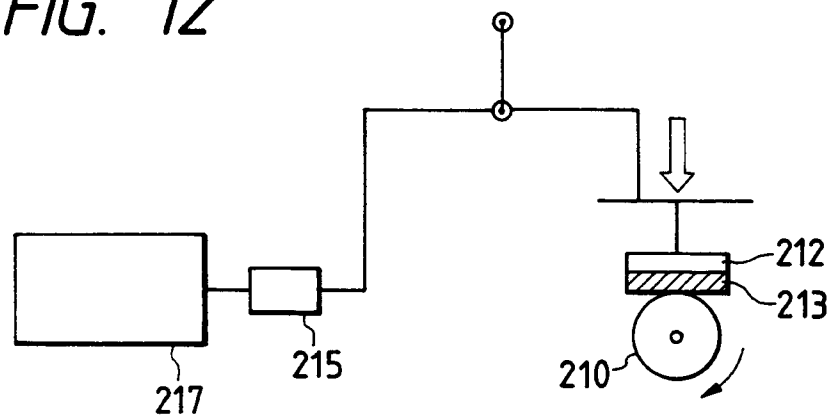
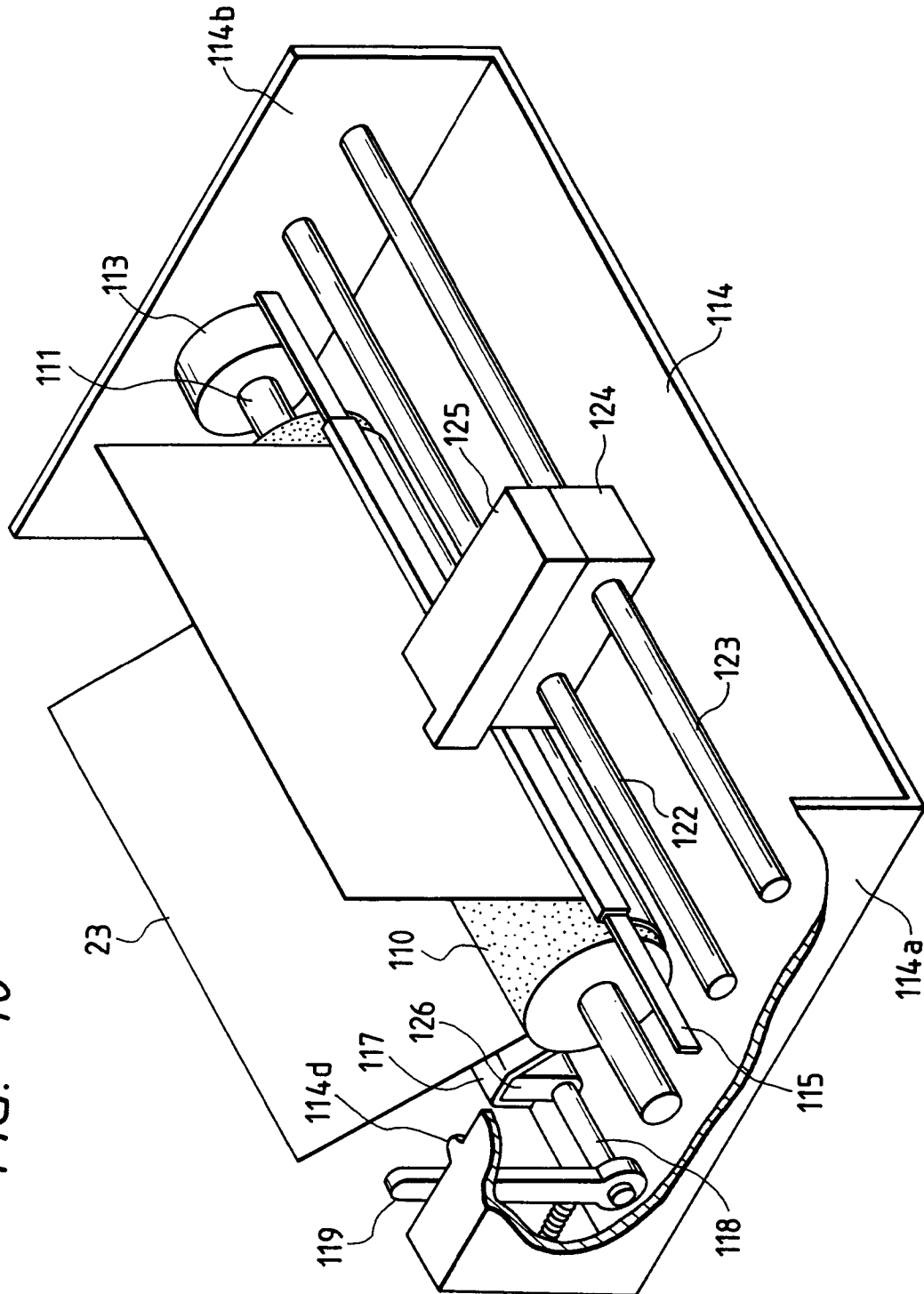


FIG. 10



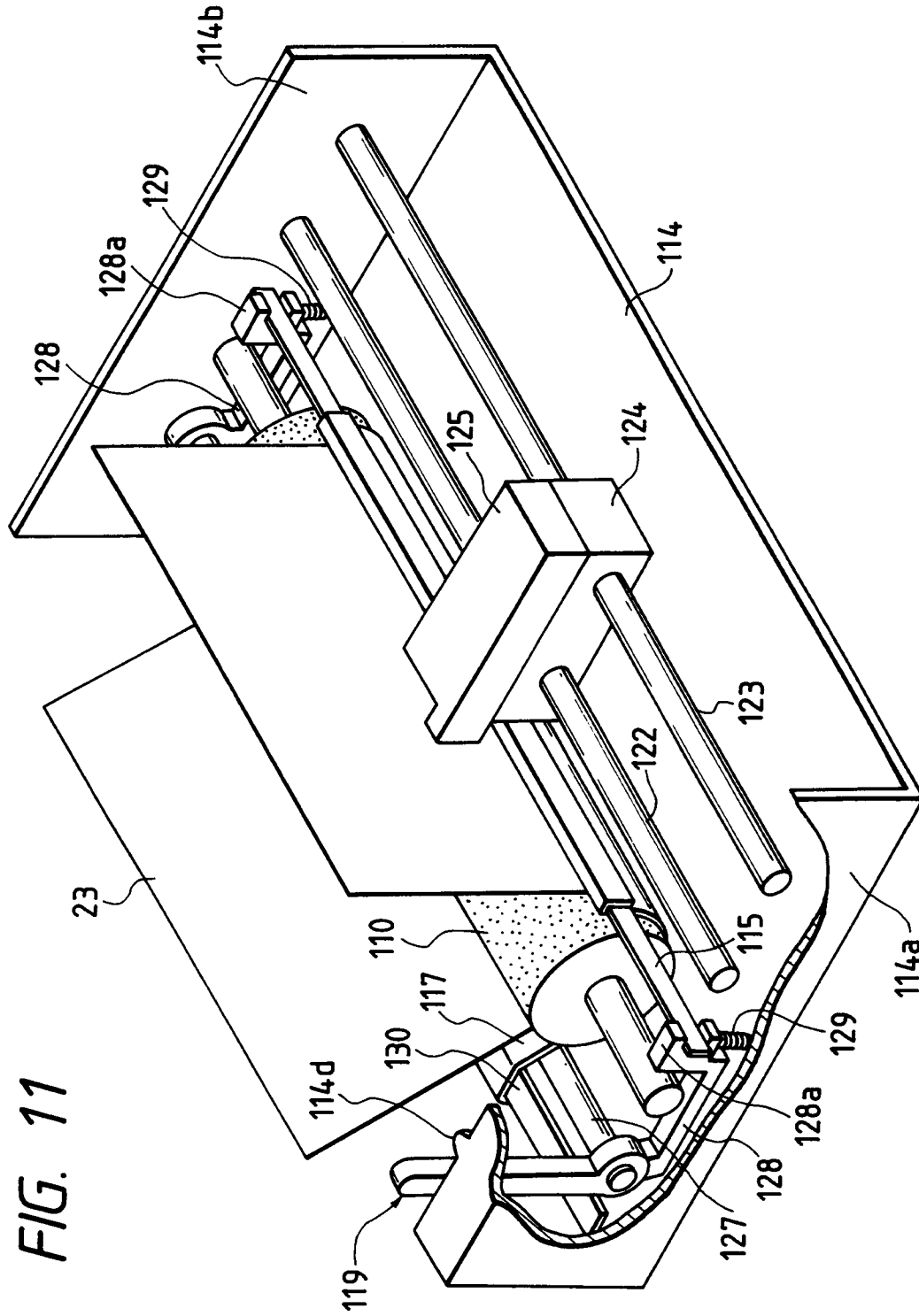


FIG. 11

FIG. 13

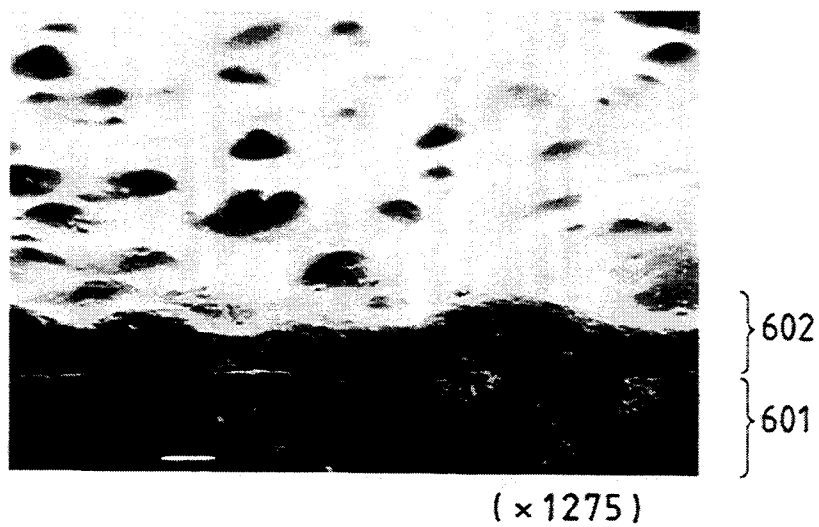


FIG. 14

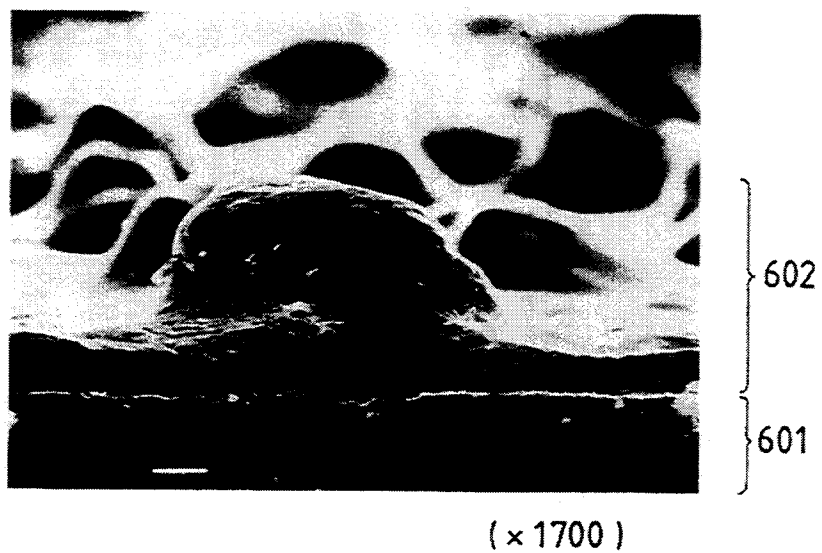


FIG. 15

