United States Patent [19]

Saito et al.

[11] **3,830,199**

[45] **Aug. 20, 1974**

[54] **DEVICE FOR DEVELOPING AN ELECTROSTATIC IMAGE WITH A DEVELOPING FLUID**

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[73] Assignee: **Kabushiki Kaisha Ricoh**, Tokyo, Japan

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[21] Appl. No.: **237,450**

[30] **Foreign Application Priority Data**

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Mar. 24, 1971	Japan	46-20033[U]
Dec. 15, 1971	Japan	46-101654
Dec. 15, 1971	Japan	46-101655
Dec. 15, 1971	Japan	46-101656

[52] **U.S. Cl.** ..... **118/637,** 117/37 LE, 118/DIG. 23

[51] **Int. Cl.** **G03g 13/00**

[58] **Field of Search** ..... 118/DIG. 23, 637, 2, 7, 118/243, 244, 258, 262, 263, 264, 266; 117/37 LE, 93.4 A

[56] **References Cited**

UNITED STATES PATENTS

1,473,594	11/1923	Jenne	118/258
2,551,329	5/1951	Klemola	118/243
3,299,791	1/1967	Susumu Fukuda	95/89
3,301,156	1/1967	Roeber	118/637 X
3,472,676	10/1969	Cassiers et al.	117/37
3,559,570	2/1971	Martel	101/170
3,566,786	3/1971	Kaufer et al.	101/150
3,626,833	12/1971	Koch	95/89 R
3,667,987	6/1972	Miller	117/37 LE
3,712,214	1/1973	Kaneko et al.	101/232
3,712,728	1/1973	Whittaker	355/10

Primary Examiner—Mervin Stein
Assistant Examiner—Leo Millstein
Attorney, Agent, or Firm—Cooper, Dunham, Clark, Griffin & Moran

[57] **ABSTRACT**

A device provided with a developing roller formed on its periphery with a multitude of valleys and valley, with the crests serving as fluid containing sections which are supplied with a developing fluid. The device is also provided with a doctor member made of a resilient, fluid absorbing material and adapted to adjust the level of the fluid contained in each fluid containing section such that the fluid is maintained at a level below the crests, or the maximum diameter portions of the developing roller. A recording sheet on which an electrostatic image is formed is brought into contact with the developing roller so that the fluid contained in the fluid containing sections selectively adheres to the electrostatic image to render the image visible. The visible images produced by this method may vary in density depending on the quantities of electricity carried by the charged regions of the electrostatic images.

10 Claims, 24 Drawing Figures

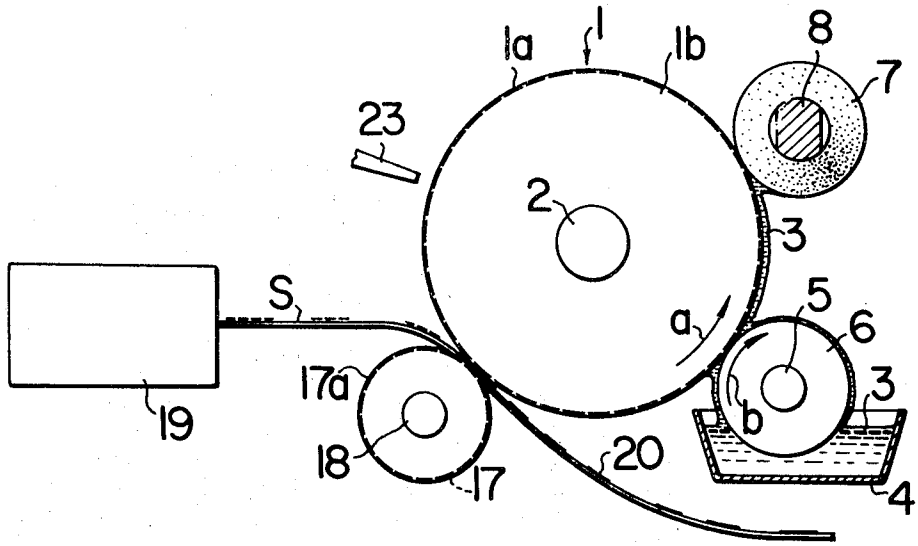


FIG. 1

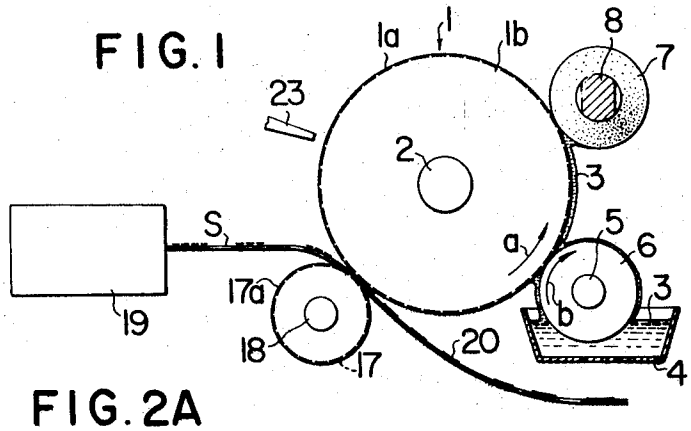


FIG. 2A

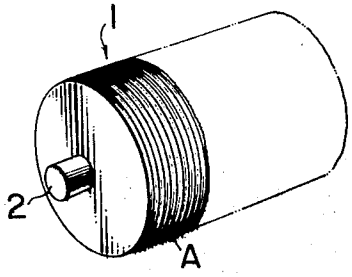


FIG. 2B

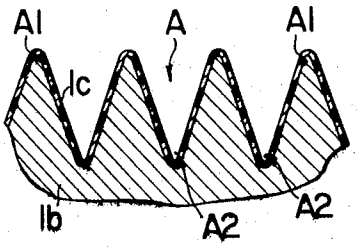


FIG. 3

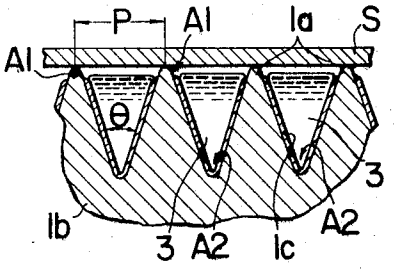


FIG. 4

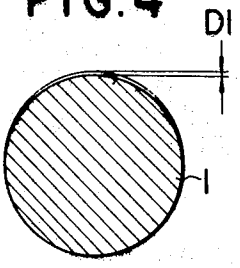


FIG. 5

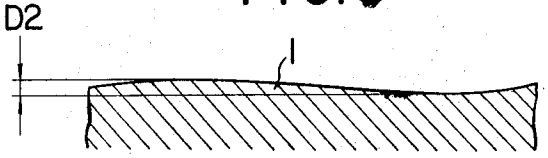


FIG. 6

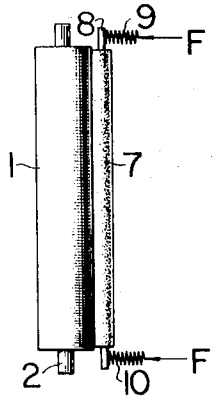


FIG. 7

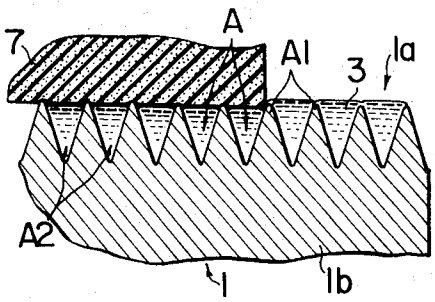


FIG. 8

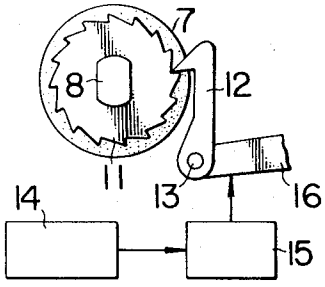


FIG. 9

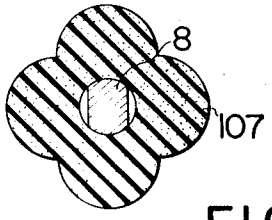


FIG. 10

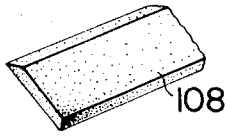


FIG. 11

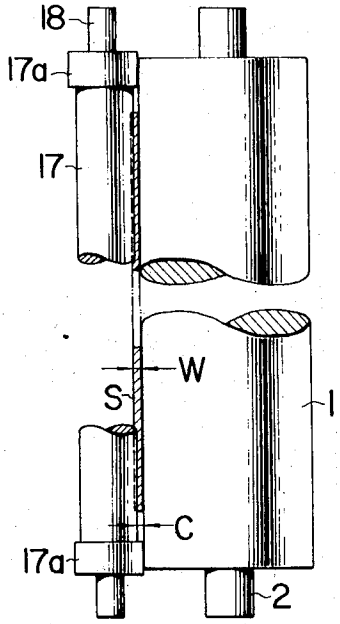


FIG. 12

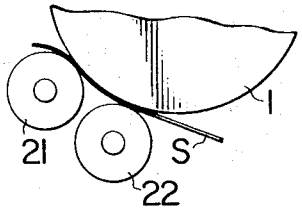


FIG. 13

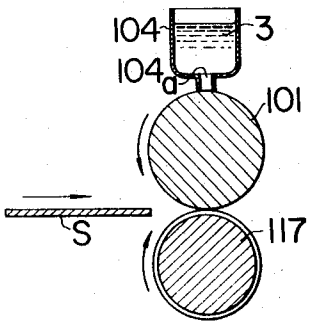


FIG. 16

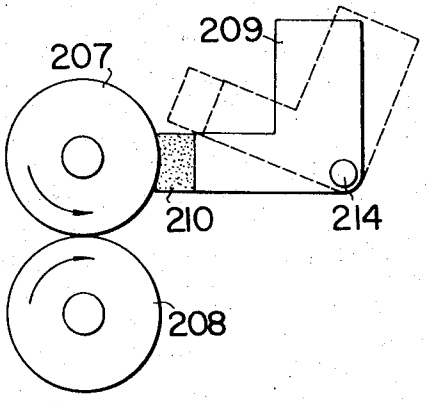


FIG. 14

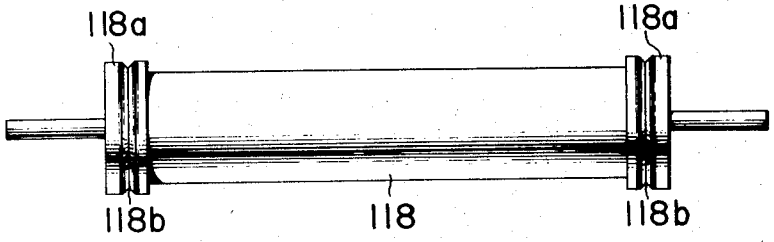


FIG. 15

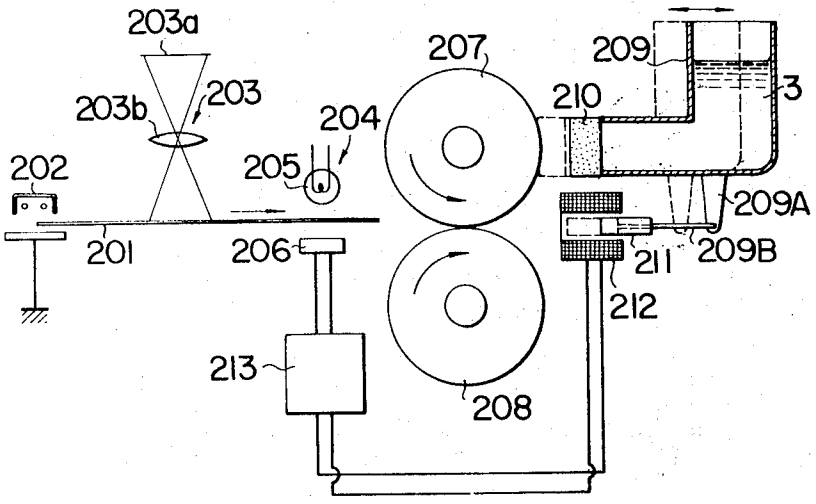


FIG. 17

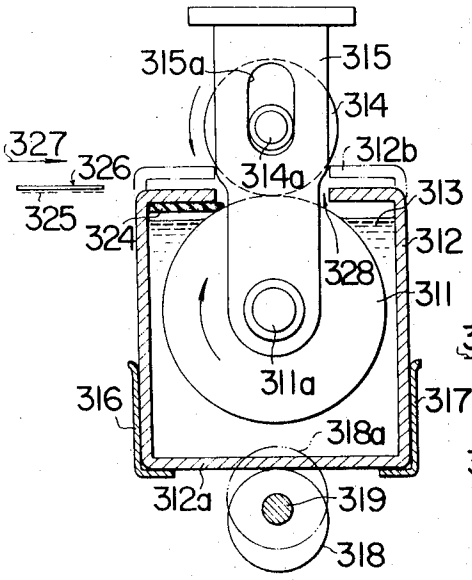


FIG. 19

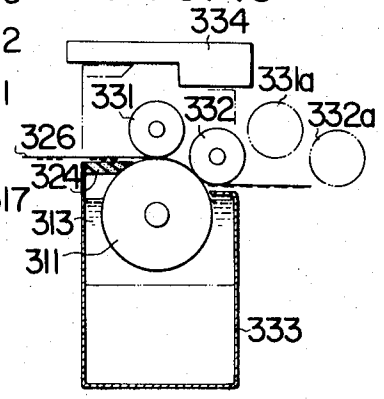


FIG. 18

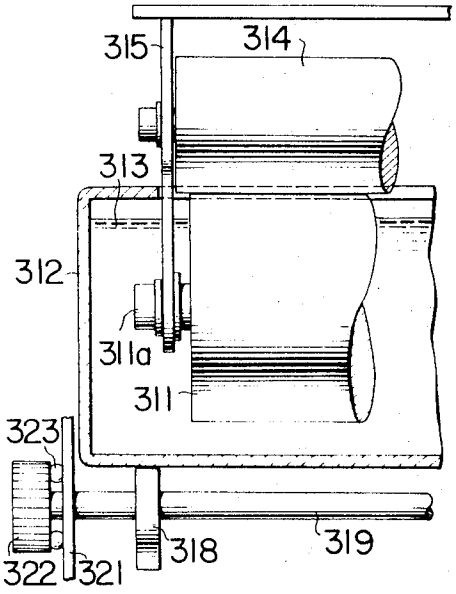


FIG. 20

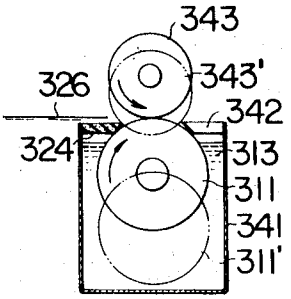


FIG. 21

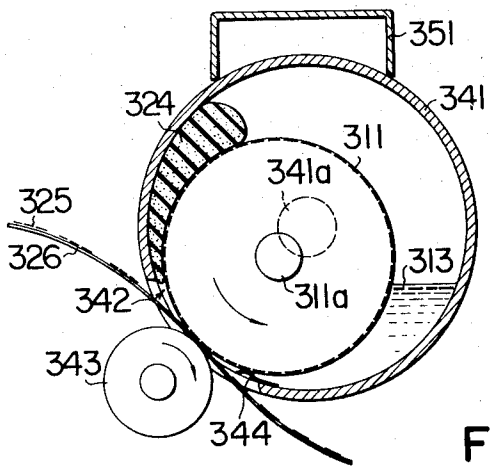


FIG. 23

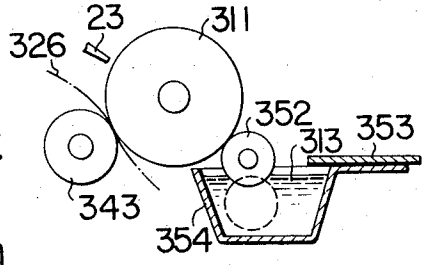
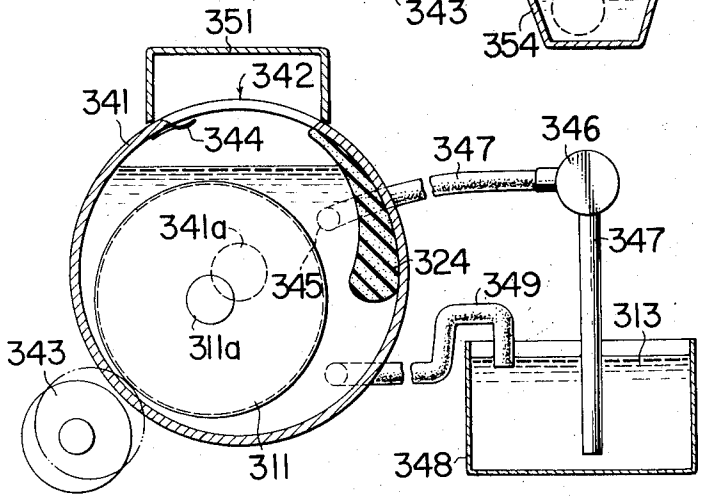


FIG. 22



DEVICE FOR DEVELOPING AN ELECTROSTATIC IMAGE WITH A DEVELOPING FLUID

BACKGROUND OF THE INVENTION

This invention relates to improvements in or relating to devices for developing an electrostatic image with a developing fluid.

A method of developing using a fluid according to the Electrofax system or a method of wet electrophotographing is known in which an electrostatic image is formed on a photoreceptor comprising an electrically conducting supporter, such for examples as paper subjected to an a treatment to render it electrically conducting, and a photoconductive material layer formed on such supporter by applying thereto a coat of selemium, zinc oxide or an organic semiconductor, by exposing the photoconductive material layer to an optical image of an original after being electrically charged. The electrostatic image formed in this way is developed and rendered visible by using a developing fluid comprising a toner dispersed in a fluid of high electric resistance, such toner being produced, for example, by treating carbon black or other colored material in minute powder form with a resin.

The wet electrophotographing method has advantages in that the density of the image formed can be readily controlled, it has a high resolving power and a high contrast reproducing capability, and the speed of developing is high. On the other hand, some disadvantages are associated inevitably with this method. For example, the composition of the developing fluid used in this method must meet strict standards, because the quantity of electricity carried by the colored powder in the carrier fluid, the degree of dispersion of the colored powder in the carrier fluid and the capacity of the colored powder to adhere to the electrostatic image or charged regions of the sheet should meet the requirements.

Proposals that have been made to obviate these disadvantages of the prior art include an invention entitled "Method of Developing Electrostatic Images" (hereinafter referred to as a fluid developing method) descrived in the Patent gazette of Japanese patent Publication No. Sho 44–9512.

In the aforementioned fluid developing method, a developing fluid is made by dissolving or dispersing a dye or pigment in water, an aqueous solution of an electrolyte or other fluid of high electric conductivity. The developing fluid is supplied to a recording sheet on which an electrostatic image is formed, so that the electrostatic image is developed as the charged regions are selectively moistened with the developing fluid and rendered visible by the dye or pigment while the non-charged regions are not moistened. Thus, the visible images produced by this method may vary in density depending on the quantities of electricity carried by the charged regions and the degree of wetness of the charged regions.

An advantage associated with this method is that water or other low cost fluid can be used as the fluid for carrying a dye or pigment because it is not required to use a highly insulating fluid for this purpose, since the dye or pigment in the fluid need not be electrically charged.

However, the problem of how to supply the developing fluid to the recording sheet formed with an electrostatic image thereon must be obviated in carrying this developing method into practical use. Technical difficulties are involved in obviating this problem. If the developing fluid is applied to the entire surface of the recording sheet, it will not be possible to produce a well-defined clear visible image and fog will be formed in the background of the image. Full realization of advantages from the use of this developing method has been hampered by inability to provide a suitable apparatus for carrying the method into practice. The use of a developing roller having a planar and smooth peripheral surface in combination with a doctor member is unable to produce visible images of high quality.

Proposals have been made to use a developing device comprising a developing roller formed on its periphery with a capillary surface as described in the patent gazettes of Japanese Patent Publication No. Sho 39–4299, Japanese Patent Publication No. Sho 40–18993 and Japanese Patent Publication No. Sho 41–6394. When the developing roller of this type is used, the resolving power can be increased and the continuity of the visible image produced can be improved if the dimension of each section of the periphery of capillary-tube-like shape is made as small as possible, since the total quantity of the developing fluid contained therein can be increased. However, the entire capillary surface on the periphery of the developing roller will be filled with the developing fluid and the entire surface of the recording sheet will be moistened unless the doctor member effectively functions in controlling the quantity of the developing liquid. This will cause irregularities to occur in the density of developed images and fog to be formed of the background.

In this developing device, a knife-shaped or plate-shaped scraping-off member, an air knife, or a wiping-off member made of felt or rubber is used as the doctor member. However, the use of such doctor member has hitherto been faced with considerable technical difficulties in preventing the filling of the entire capillary surface with a developing fluid and rendering uniform the quantities of the developing fluid contained in all the sections of the periphery of the capillary-tube-like shape.

On the other hand, special attention should be paid to means for bringing a recording sheet to a developing roller in this fluid developing method. Heretofore, it has been usual practice to merely bring the recording sheet into pressing engagement with the periphery of the developing roller. This has inevitably resulted in the entire surface of the recording sheet being moistened with the developing fluid, so that it has been unable to carry out developing in a satisfactory manner.

Besides if the developing roller to which the developing fluid is supplied is stored after use without having its peripheral surface cleaned, the developing fluid will get dry and solidity, thereby clogging the capillary surface on the periphery of the roller. It is thus necessary to use, in carrying this fluid developing method into practice, a developing device in which each component part is efficient in itself and all the components are well balanced to provide a useful apparatus for achieving good results.

SUMMARY OF THE INVENTION

Accordingly, an object of this invention is to provide a device for developing an electrostatic image with a developing fluid comprising a developing roller, a doc-

tor member made of a material capable of absorbing fluid and other peripheral equipment which each have an elaborate construction and which are well balanced to provide a useful apparatus for accomplishing the end of strictly regulating the supply of a developing fluid to a recording sheet so that only the charged regions of the recording sheet will receive a good supply of the developing fluid and a well-defined clar visible image can be produced.

The developing device provided by this invention is such that the use of the doctor member made of a suitable material capable of absorbing the developing fluid permits the supply of the developing fluid to be regulated and a suitable quantity of the developing fluid to be contained in each of the developing fluid containing sections provided in the form of minute valleys formed on the periphery of the developing roller. The developing fluid held in this manner by the developing roller selectively adheres to the charged regions of the recording sheet as the latter is brought into contact with the periphery of the developing roller, so that the electrostatic image on the recording sheet can receive a good supply of the developing fluid. The fluid absorbing property material of the doctor member permits it to come yieldingly into intimate contact with the irregular peripheral surface of the developing roller. This makes it possible to deliver a good supply of the developing fluid to the electrostatic image and to produce a good visible image of high contrast and quality without forming fog in the background, because the recording sheet is not wetted more than is necessary.

Another object of the invention is to provide a device for developing an electrostatic image with a developing fluid which further comprises at least one recording sheet keep roller which is juxtaposed to the developing roller with a suitable clearance being interposed therebetween so as to obtain good contact of the recording sheet with the periphery of the developing roller, such clearance being adjustable depending on the thickness of the recording sheet.

Another object of the invention is to provide a device for developing an electrostatic image with a developing fluid wherein the developing roller is immersed as a whole in the developing fluid when no developing operation is performed, so as to prevent the drying and solidifying of the developing fluid adhered to the developer roller and clogging of the valleys or the developing fluid containing sections formed on the periphery of the developing roller.

Additional and other objects, features and advantages are those inherent in the invention herein described, shown and claimed, and will become evident as the description proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of the developing device using a developing fluid comprising a first embodiment of this invention;

FIG. 2A is a fragmentary perspective view of the developing roller;

FIG. 2B is a fragmentary sectional view, on an enlarged scale, of the developing roller showing the manner in which developing fluid containing sections are formed on its periphery;

FIG. 3 is a fragmentary sectional view, on an enlarged scale, of the developing roller showing the manner in which the developing fluid is contained in the developing fluid containing sections formed on its perphery;

FIG. 4 is a transverse sectional view of the developing roller showing its construction;

FIG. 5 is a fragmentary vertical sectional view of the developing roller showing its construction;

FIG. 6 is a plan view of the developing roller and the doctor member, with the latter being maintained in pressing engagement with the former;

FIG. 7 is a fragmentary section view of the developing roller and the doctor member showing the manner in which the quantities of the developing fluid contained in the developing fluid containing sections on the periphery of the former are regulated by the latter;

FIG. 8 is a schematic view of the means for intermittently operating the doctor member;

FIG. 9 is a transverse sectional view of one form of the doctor member;

FIG. 10 is a fragmentary perspective view of the doctor member showing another form of its construction;

FIG. 11 is a schematic view of the developing roller and the recording sheet keep roller showing the manner in which they are juxtaposed to each other;

FIG. 12 is a fragmentary schematic view showing two recording sheet keep members used in this invention;

FIG. 13 is a schematic view of one form of the developing fluid supply means;

FIG. 14 is a front view of another form of the recording sheet keep roller;

FIG. 15 is a schematic view of the developing device comprising a second embodiment of the invention;

FIG. 16 is a sectional view of another form of the developing fluid supply means in relation to the developing roller;

FIG. 17 is a front sectional view of the developing device comprising a third embodiment of the invention;

FIG. 18 is a sectional side view of the developing device shown in FIG. 17;

FIG. 19 and FIG. 20 are schematic views of the developing device comprising fourth and fifth embodiments of the invention respectively;

FIG. 21 is a sectional front view of the developing device comprising a sixth embodiment of the invention;

FIG. 22 is a front sectional view of the developing device of FIG. 21 showing the development roller in an inoperative position; and

FIG. 23 is a schematic view of the developing device comprising a seventh embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

In FIG. 1, a developing roller 1 supported by a shaft 2 is formed on its periphery with a multitude of minute crests and valleys with the valleys serving as fluid containing sections 1a. Developing roller 1 is driven by suitable drive means to rotate in the direction of an arrow *a* at a constant rate.

Developing roller 1 comprises a main body 1b made of brass, stainless steel or other like material, and fluid containing sections 1a thereof are formed on main body 1*b* as by etching or machining.

Fluid containing portions 1*a* are in the form of valleys surrounded by crests formed on the periphery of devel-

oping roller 1. Such valleys may be conical, cylindrical, or semi-spherical in form. They may be in the form of a modification of any of the aforementioned forms or a mixture thereof. They may merely be in irregular concave form.

The main body 1*b* of developing roller 1 may be made, in its entirety or merely in an outer peripheral portion thereof, of a waterrepellent material, such for example as a silicon resin or fluorine resin. The outer peripheral portion made of such material can be worked on to provide fluid containing sections 1*a* described above.

The developing roller 1 shown in FIG. 2A and FIG. 2B comprises main body 1b made of a water-repellent material and formed on its outer peripheral surface with a spirally arranged peripheral groove or a number of discontinuous grooves A.

Developing roller 1 is also provided on its entire surface with a thin coat 1*c* of a metal, such for example as aluminum or copper, or other hydropholic coat forming material, which is formed as by vaporization deposition or spraying.

Portions of the developing roller 1 made in this way which correspond to tops of walls A1 surrounding grooves A are treated by etching or grinding to remove therefrom the coat of hydropholic material and expose the underlying water-repellent material. Then, finishing touches are given to the roller as by lapping to provide a developing roller of the construction shown in FIG. 4.

Grooves A may be formed on the outer peripheral surface of roller 1 as by spiral cutting by continuous feed of a lathe or by shaping by means of a form having female grooves on its inner peripheral surface. The pitch of the groove or the distance between the adjacent groove walls A1 and A1 or between the adjacent groove bottoms A2 and A2 is set to be in a range from 0.08 to 0.15 millimeters. The angle formed by che adjacent groove walls or the degree of opening of each groove is set to be in a range from 15° to 20°. The tolerance D1 in a radial direction is set at less than ±10 microns as shown in FIG. 4. The amplitude D2 of swell of the outer peripheral surface of roller 1 in an axial direction is set at less than 10 microns as shown in FIG. 5.

According to this invention, the grooves A of roller 1 serving as fluid containing sections 1*a* must meet the severe dimensional requirements as aforementioned. This dimensional tight tolerances permit a developing fluid 3 to be positively contained in fluid containing sections 1a when such fluid is supplied to the roller. When the quantity of fluid contained in each fluid containing portion is adjusted by a doctor member 7 shown in FIG. 1, the fluid 3 does not adhere to groove wall tops A1 as shown in FIG. 3 because the water-repellent material of roller main body 1b is exposed at the groove wall tops A1 as aforementioned.

Developing fluid 3 is held in a container 4 of a developing fluid supply device as shown in FIG. 1. A fluid supply roller 6 made as of sponge rubber or other fluid absorbing material and supported by a shaft 5 is disposed such that a portion of its periphery is immersed in the developing fluid 3 in container 4. Fluid supply roller 6 is maintained in light engagement with developing roller 1 and rotates in a direction of an arrow *b* to scoop up fluid 3 and supply the same to developing roller 1. Fluid roller 6 may be made to rotate in slaved relation to developing roller 1 or driven to rotate in a direction opposite to the direction of rotation of developing roller 1.

In place of using fluid supply roller 6, developing fluid 3 may be supplied to developing roller by any other known. For example, fluid 3 may be directly poured on to the periphery of developing roller 1, or developing roller 1 may be immersed directly in fluid 3 in container 4.

The developing fluid used in this invention may be black ink, blue ink, red ink or ink of any other color available at the market; it may be an aqueous solution of any known dye; or it may be a dispersion of ultramarine, red oxide, carbon black or other pigment in minute powder form in liquid. It may be added with a suitable additive or additives. The pigment used may be treated suitably with a resin so that its fixing by heating after adhering to charged regions may be facilitated.

When water is used as the solvent in making the developting fluid according to this invention, its amount is preferably over 60 percent by weight.

The developing fluid used in this invention may be a fluid including a colorless or slightly colored component which is converted into a coloring matter upon oxidization in the air, upon exposure to heat or light, or upon reaction with a compound contained in a recording sheet as subsequently to be described.

Referring to FIG. 1 again, doctor member 7 is disposed upwardly rightwardly of developing roller 1 and maintained in engagement therewith. Doctor member 7 is formed in roller form and rotatably supported by a shaft 8 as shown. When made in roller form, doctor member 7 can be brought into contact with the periphery of the developing roller at right angles thereto, the surface roughness of the doctor member can be made to conform to desired standards, and worming on the doctor member to give uniform finishes to its entire surface can be made possible.

Forces F are exerted on doctor member 7 by compression springs 9 and 10 through shaft 8 as shown in FIG. 6. Forces F exerted on doctor member 7 in this way act as a pressure applied to the interface between developing roller 1 and doctor member 7 at right angles thereto. Doctor member 7 may be rotated at any suitable time to effect control of the quantity of developing fluid 3 on the periphery of developing roller 1 in a proper manner.

As shown in FIG. 7, the doctor member 7 maintained in pressing contact with the periphery of developing roller 1 scrapes off a portion of developing fluid 3 contained in each fluid containing section 1a of developing roller 1 so as to reduce the level of developing fluid 3 in each fluid containing portion 1*a* below the maximum diameter portions of roller 1 or the groove tops A1. The level of developing fluid 3 in each fluid containing section 1*a* can be varied to obtain an optimum level for effecting development by varying the pressure applied by doctor member 7 to developing roller 1. It has been ascertained by experiments that the optimum force F exerted by the spring 9 (10) is about 900 g.

In the developing device according to this invention, it is essential that the quantity of developing fluid on the periphery of developing roller 1 be adjusted to a proper level by doctor member 7 to obtain satisfactory results in development. If the quantity is too great or too small, it will be impossible to consummate development; if the quantity of fluid in each fluid containing

portion is not uniform, the visible image produced by development will be unclear and ill defined.

In this invention, experiments have been carried out by using doctor members made of different materials. It has been found that the use of three types of materials of foamed polyethylene (Sunfoam, trade name of an article made by Sanwa Chemical Industry Company, Ltd.) permits well-defined and clear images to be obtained upon development. The particulars of the materials are as follows;

Sunfoam of Type 1

Grade:	L-2500
Size:	80×1000×1000 m/m
Standard Colors:	White, red, blue, yellow, green, gray, black
Density (g/cm3):	0.033–0.040
Tensile Strength (kg/cm3):	3.5–4.4
Extensibility (%):	320–440
25% Compression Hardness (kg/cm3):	0.5–0.59
25% Compression Permanent Strain (%):	1.3–2.3
Tear Strength (kg/cm2):	1.7–2.0
Heat Conductivity (Kcal/mhr℃):	0.035
Water Absorbing Capacity (g/m3 24 hr):	not more than 0.0001

Sunfoam of Type 2

Grade:	L-2500N
Size:	80×1000×1000 m/m
Standard Colors:	White, gray
Density (g/cm3):	0.033–0.040
Tensile Strength (kg/cm3):	3.5–4.4
Extensibility (%):	300–440
25% Compression Hardness (kg/cm3):	0.5–0.59
25% Compression Permanent Strain (%):	1.3–2.3
Tear Strength (kg/cm2):	1.0–1.5
Heat Conductivity (Kcal/mhr℃):	0.040
Water Absorbing Capacity (g/m3 24hr):	not more than 0,0001

Sunfoam of Type 3

Grade:	C-0600
Size:	30×1000×1000 m/m
Standard Colors:	White
Density (g/cm3):	0.210–0.240
Tensile Strength (kg/cm3):	21.0–28.0
Extensibility (%):	160–190
25% Compression Hardness (kg/cm3):	4.2–4.6
25% Compression Permanent Strain (%):	2–3
Tear Strength (kg/cm2):	9–11
Heat Conductivity (Kcal/mhr℃):	0.055
Water Absorbing Capacity (g/m3 24hr):	not more than 0.004

The results achieved in converting invisible images to visible images by using the aforementioned materials and other materials for making doctor member 7 are tabulated below.

Material	Quality of Image	Density of Image	Fog in Background
Foamed Polyethylene (Sunfoam of Type 1)	Good	1.8	None
Foamed Polyethylene (Sunfoam of Type 2)	Good	1.8	None
Foamed Polyethylene (Sunfoam of Type 3)	Good	1.8	None
Foamed Neoprene	Good	1.8	0.03
Nitrile Rubber (Hardness, 30°)	Slightly Poor	1.6	0.15
Nitrile Rubber (Hardness, 50°)	Slightly Poor (Small Letters Not Legible)	1.6	0.18
Nitrile Rubber (Hardness, 70°)	Poor (Small Letters Not Legible)	1.5	0.3
Silicone Rubber	Poor (Small Letters Not Legible)	1.5	0.5
Vinyl Chloride	Poor (Small Letters Not Legible)	1.5	0.5
Felt	Poor (Small Letters Not Legible)	1.5	0.5

When air knife was used as the doctor member, the quality of image was fairly good, with the density of image and the fog in background being 1.3 and 0.2 respectively.

The results of experiments show that the use of a doctor member made of a foamed resilient material of less than 0.5 in density permits images of high quality to be obtained. It is believed that a doctor member made of a material of low density and high resilience enables the doctor member to be yieldingly brought into intimate contact with the irregular outer peripheral surface of developing roller 1 to thereby satisfactorily effect adjustments of the quantity of developing fluid 3 on the periphery of developing roller 1. Preferably, the 25 percent compression hardness of the material of doctor member 7 is set at a level below 4.6 kg/cm2. If this is the case, the damage that might otherwise be caused to the periphery of developing roller 1 would be substantially eliminated and the doctor member would have a long service life.

In the embodiment shown and described, doctor member 7 is in cylindrical roller form. However, this invention is not limited to this shape of doctor member 7. A doctor member 107 of petal shape in cross-section as shown in FIG. 9 or a doctor member 108 of knife shape as shown in FIG. 10 may also be used.

Doctor member 7 may be rotatable in slaved relation to developing roller 1 or not rotatable. When not rotatable, it may be intermittently moved as by a ratchet wheel 11 and a pawl 12 as shown in FIG. 8. A shaft 13 supporting pawl 12 may be displaced downwardly as an arm 16 is moved in pivotal motion by means of a developed sheet number counter 14 and an electromagnet 15, so that doctor member 7 can be angularly rotated intermittently each time a suitable number of recording sheets have been developed. This permits discrete portions of the periphery of doctor member 7 to be successively brought into engagement with the periphery of developing roller 1 when a developing operation is performed.

A recording sheet keep roller 17 is disposed in a position in which its periphery is juxtaposed to the periphery of developing roller 1 to which a suitable quantity of fluid 3 has been applied. Recording sheet keep roller 17 may, as shown in FIG. 11, be provied with heads 17*a* on opposite ends of its periphery. Supported by a shaft 18, recording sheet keep roller 17 has its heads 17*a* maintained in pressing engagement with developing roller 1, leaving a clearance C between its periphery and the periphery of roller 1 as shown in FIG. 11. Good

results were achieved in this invention when the force with which recording sheet keep roller **17** presses against developing roller **1** was about 1 kg.

The clearance C between the two rollers **1** and **17** is slightly smaller than the thickness W of a recording sheet. For example, when the former is 70 microns, the latter is 80 microns, so that the surface of a recording sheet S can be brought into intimate contact with the periphery of developing roller **1.**

The recording sheet used in this invention may be an electrophotographic photoreceptor formed on its surface with a photoconductive material layer on which an electrostatic image is formed by electric charging and exposure to an optical image of an original to be duplicated, an electrostatic recording sheet such as the one used in facsimile which comprises a dielectric layer consisting of a copolymer of vinyle chloride and vinyl acetate or other high molecular substance and formed on electrically charged paper or other supporter for forming thereon an electrostatic image as by a contact electrode or electrodes, or a color developing sheet provided with a color developing material layer of a special composition.

A recording sheet S is formed on its surface with an electrostatic image (indicated by - - -) by means of an electrostatic image forming means **19** shown in FIG. **1** which may form an electrostatic image by a combination of electric charging and exposure to an optical image or by a contact electrode or electrodes. The recording sheet on which an electrostatic image is formed is fed between the two rollers **1** and **17** by suitable feed means. When the surface of recording sheet is brought into engagement with the periphery of developing roller **1,** the level of developing fluid **3** in each fluid containing section **1***a* is below the groove wall tops A1 as the result of developing fluid quantity control action of doctor member **7.** As the charged regions of the recording sheet come into contact with groove wall tops A1 or their neighborhood, the developing fluid in fluid containing sections **1***a* is excited and attracted by the electricity carried by the charged regions to adhere to such regions so that only the charged regions of the recording sheet are moistened. Excitation and attraction of developing fluid **3** are occasioned by the presence of electric charges, so that non-charged regions are not moistened with developing fluid **3.** Besides, since the recording sheet itself only comes into contact with the groove wall tops A1 which are free from the developing fluid, it is possible to form on the recording sheet a visible image **20** of good quality with no fog formation in the background.

Two rollers **21** and **22** may be used in place of roller **17** for keeping a recording sheet in contact with the developing roller. If two rollers **21** and **22** are disposed continuously one after another as shown in FIG. **12** and maintained in contact with the developing roller **1,** the area of the recording sheet which comes into contact with the developing roller will increase and the density of the visible image formed will be increased. The use of two rollers **21** and **22** in this manner will permit the rate of development to increased.

The recording sheet developed by coming into contact with the development roller is dried as by exposure to an air stream or by heating, so as to permit the visible image to be fixed. In case it is necessary to ensure that a color is developed upon development, the recording sheet may be subjected to a further treatment.

If the developing roller used for performing a developing operation is left uncleaned upon completion of the operation, solids in minute powder form dispersed in the developing fluid which adhere to grooves A will get dry. The pressure of dry solids in the grooves may exert unfavorable influences on the results of a next following developing operation. To preclude the unfaborable influences, the developing roller may be cleaned upon completion of the developing operation as by a cleaning fluid sprayer **23** shown in FIG. **1.** Alternatively, the developing roller may be cleared of residual developing fluid by ejecting an air stream on to it by means of a blower. When the developing roller receives a supply of developing fluid by being partly immersed in developing fluid in a container, either the developing roller or the container may be moved relative to each other upon completion of the developing operation, so as to house the roller in its entirety in the container and seal the latter or to submerge the roller entirely in the developing fluid in the container. Means for cleaning the developing roller is subsequently to be described in detail.

When only one type of developing fluid is used, the developing device may comprise only one developing roller and one set of subsidiary means. However, when two types of developing fluid are used and the recording sheets are subjected to a preliminary developing treatment, two developing rollers and two sets of subsidiary means may be used. When color visual images are to be formed, the developing device according to this invention may comprise a number of developing rollers and a number of subsidiary means.

FIG. **13** shows one form of developing fluid supply means comprising a developing fluid container **104** formed at its bottom with an outlet port **104**a and disposed above the periphery of a developing roller **101** of the same construction as developing roller **1.** The outlet port **104**a of developing fluid container **104** is maintained at its lower end in intimate contact with the periphery of developing roller **101** so as to supply developing fluid **3** from container **104** to the periphery of developing roller **101.**

Disposed adjacent developing roller **101** on a side thereof opposite developing fluid container **104** is a recording sheet keep roller **117** of the same construction as recording sheet keep roller **17** which is maintained in pressing engagement with developing roller **101.** Recording sheet S moves on a path between the two rollers **101** and **117** to be developed.

A doctor member similar to the aforementioned doctor member **7** may be maintained in contact with the periphery of developing roller **101** to control the quantity of developing fluid thereon. Alternatively, a fluid permeable plug or a perforated plug which is made of a material similar to the material of the aforementioned doctor member may be fitted in the outlet port **104***a* of fluid container **104** and maintained at its lower end in contact with the periphery of roller **101,** so that the plug may perform the function of adjusting the quantity of developing fluid on the periphery of the developing roller.

The recording sheet keep roller may be in the form of a roller **118** shown in FIG. **14** which is formed on opposite end portions of its periphery with head **118***a* each formed thereon with a fluid guide groove **118***b.*

The use of this type of recording sheet keep roller permits the downward flow of developing fluid to be regulated as desired without permitting the developing fluid to flow outwardly of the roller 118.

A second embodiment of this invention will now be described with reference to FIG. 15 and FIG. 16. In FIG. 15, a recording sheet 201 formed thereon with a photoconductive material layer is first uniformly charged by electric charging means 202, and then exposed to an optical image of an original 203*a* by exposing means 203.

After exposure, recording sheet 201 moves through a detector 204 comprising, for example, a lamp 205 and a cadmium sulfide cell or other light receiving element 206. The detector may be in the form of a microswitch having its actuator disposed on the path of movement of the recording sheet.

After passing through detector 204, recording sheet 201 is nipped by a developing roller 207 and a recording sheet keep roller 208 pressing against roller 207.

A developing fluid container 209 formed with an outlet opening having a developing fluid impregnable sponge-like member 210 fitted therein is disposed in the vicinity of developing roller 207, with sponge-like member 210 being juxtaposed to the periphery of developing roller 207. Developing roller 207 may be of the same construction as the aforementioned developing roller 1 or 101. Sponge-like member 210 may be made of a material capable of being impregnated with developing fluid, such for example as sponge, urethane rubber, felt, cloth, cotton or filter paper.

A support 209A projects downwardly from the bottom of container 209. A rod 209B connected to support 209A at one end thereof supports an iron core 211 of a solenoid 212 at the other end thereof. Iron core 211 serves as a plunger for solenoid 212 which is controlled by a control circuit 213 actuated by a signal from light receiving element 206.

When no recording sheet passes through detector 204, the light of lamp 205 is incident on light receiving element 206 and solenoid 212 remains inoperative. However, when a recording sheet passes through detector 204, the light of lamp 205 is not incident on light receiving element 206, so that solenoid 212 is energized through control circuit 213. Upon energization, solenoid 212 pulls and moves iron core 211 leftwardly in FIG. 15. This moves container 209 to left into a broken line position through rod 209B and support 209A, so that developing fluid impregnable member 210 is brought into contact with the periphery of rotating developing roller 207 to supply developing fluid thereto.

The aforementioned construction permits the developing fluid to be uniformly supplied from the container to the periphery of the developing roller in a suitable quantity only when a developing operation is carried out. The quantity of supplied fluid can be limited to an essential minimum and no excess fluid is supplied to the developing roller. This is conducive to prevention of uneven developing of an electrostatic image and fog formation in the background. When the device remains idle for a long period of time, the developing fluid does not remain adhering to the developing roller or it does not solidify on the developing roller, because no developing fluid is supplied to the developing roller so long as the device remains idle and member 210 serves as a doctor. Thus, the developing roller can be maintained in good condition at all times.

FIG. 16 shows another form of developing fluid supply means in which container 209 provided with developing fluid impregnable member 210 is pivotally mounted on a shaft 214. When no signal is supplied from detector 204, container 209 is disposed in a non-operative position shown in broken lines. When a signal is supplied, container 209 pivots to an operative position shown in solid lines in which the member 210 of container 209 is maintained in engagement with the periphery of developing roller 207 to supply the developing fluid thereto.

The aforementioned recording sheet 201 may be an electrophotographic photosensitive sheet, electrostatic recording sheet or any other color developing sheet. Means for forming an electrostatic image thereon may vary depending on the type of recording sheet used.

Other embodiments of this invention in which the developing roller is submerged entirely in the developing fluid will now be described with reference to FIG. 17 to FIG. 22.

In FIG. 17, a developing roller 311 is shown as being disposed in a container 312 for rotation in the direction of an arrow with the major portion of the periphery thereof being immersed in a developing fluid 313 contained in container 312. The periphery of developing roller 311 is formed with the fluid containing sections as is the developing roller 1 shown in FIG. 1, and the composition of developing fluid 313 is similar to that of developing fluid 3.

A recording sheet keep roller 314 is mounted above developing roller 311 and presses against the periphery thereof by its own weight while rotating in the direction of an arrow as shown. Recording sheet keep roller 314 is of the same construction as the aforementioned recording sheet keep roller 7 shown in FIG. 1.

Developing roller 311 is rotatably supported by a shaft 311*a* connected at opposite ends to support plates 315 (only one of such plates is shown) which are each formed therein with a vertical slot 315*a* for loosely receiving therein a shaft 314*a* for supporting recording sheet keep roller 314 so that roller 314 may be moved vertically as presently to be described.

Container 312 is loosely held at opposite sides thereof by guide plates 316 and 317 as shown in FIG. 17. A plurality of eccentric cams 318 (only one of them is shown in FIG. 18) are maintained in engagement with the underside of a bottom 312*a* of container 312. Eccentric cams 318 are supported by a shaft 319 connected at opposite ends thereof to immovable members 312. A knob 322 is attached to each of the opposite ends 312 with click means comprising a plurality of steel balls 323 being mounted between each knob 323 and each movable member 321 so that the knob 322 may be held in a position to which it is turned.

In FIG. 17, a doctor member 324 is maintained at its end in pressing engagement with a portion of the periphery of developing roller 311 which extends above the level of developing fluid 313 in container 312 so as to control the quantity of fluid 313 adhering to the periphery of developing roller 311. Doctor member 324 may be of the same construction as the aformentioned doctor member 108 shown in FIG. 10.

A recording sheet 326 on which an electrostatic image 325 is formed is transported in the direction of an arrow 327 and brought by roller 314 into pressing

engagement with the periphery of developing roller **311**, so that the electrostatic image is developed in the same manner as the embodiment shown in FIG. **1**.

When the developing device is kept out of service for a long interval of time, one of the knobs **322** is turned to move eccentric cams **318** to a phantom line position **318***a* shown in FIG. **17** so as to move container **312** to a phantom line position **312***b*. A top plate of container **312** is formed therein with a slot **328** through which the two rollers **311** and **314** are maintained in engagement with each other.

The aforementioned upward movement off container **312** brings end edges of slot **328** into engagement with the periphery of roller **314** as shown at phantom line **312***b* in FIG. **17** to raise roller **314**, so that the periphery of roller **314** is brought out of engagement with the periphery of developing roller **311**. The end edges of slot **328** are brought into engagement with greater width portions of support plates **315**, so that longitudinal opposite end edges (disposed perpendicularly to the plane of FIG. **17**) of slot **328** are sealed.

Upward movement of container **312** leaves the entire periphery of developing roller **311** immersed in the developing fluid **313** in container **312**, thereby precluding drying and solidifying of fluid on the periphery of developing roller **311**. Since the slot **328** formed in the top plate of container **312** is closed and sealed by roller **314** and support plates **315**, vaporization of the developing fluid **313** in container **312** is prevented.

When the developing device with the developing roller in its inoperative position as aforementioned is put to service again, each eccentric cam **318** is moved from the phantom line position shown in FIG. **17** to the solid line position to bring roller **314** into engagement with developing roller **311** again. Thus, the developing device is ready for operation.

FIG. **19** to FIG. **23** show other embodiments of this invention. In these figures, like reference characters designate similar parts in all the drawings. The developing roller, doctor member, recording sheet keep roller and developing fluid in these figures may be of the same construction and composition as the corresponding parts of the embodiments described above.

In FIG. **19**, a plurality of recording sheet keep rollers **331** and **332** are arranged in close proximity to the periphery of developing roller **311**. A cover **334** for closing container **333** is disposed above rollers **331** and **332**. When the developing device is inoperative, rollers **331** and **332** are withdrawn to phantom line positions **331***a* and **332***a* respectively and container **333** is moved upwardly. The upward movement of container **333** brings the top of container **333** into engagement with the underside of cover **334**, so that the container is closed and the periphery of recording roller **311** is immersed in its entirety in the developing fluid **313** in container **333**.

Developing roller **311** itself may be moved downwardly to bring the same to a position in which its periphery is entirely immersed in developing fluid **313**. In FIG. **20**, an upper opening of container **341** is partly covered with a lid **342** and a doctor member **324** which define therebetween a slot through which an upper portion of developing roller **311** extends. A roller **343** is maintained at its lower portion in pressing engagement with the upper portion of developing roller **311** by its own weight. The two rollers **311** and **343** are supported for relative vertical movement by support means (not shown).

When the developing device constructed as aforementioned is not in operation, developing roller **311** can be moved downwardly to an inoperative position shown at **311'** by phantom lines so that its periphery may be immersed in its entirety in the developing fluid in container **341**. In its downward movement, roller **343** is brought into engagement with end edges of lid **342** and doctor member **324** as shown at **343'** in phantom lines to close and provide a seal to container **341**, thereby precluding vaporization of the developing fluid in container **341**.

In FIG. **21**, a cylindrical container **341** are supported at opposite ends thereof by shafts **341***a* for rotation when necessary. A developing roller **311** is mounted within container **341** for rotation in the direction of an arrow as shown. Formed in one portion of the periphery of container **341** is a rectangular opening **342** which is disposed such that its longitudinal extnetion is disposed perpendicular to the plane of FIG. **21**. A roller **343** is arranged with its periphery being juxtaposed to a portion of the periphery of developing roller **311** which is exposed through rectangular opening **342**. A seal **344** made of rubber or other resilient material is secured at its base to one side edge of opening **342** and presses at its free end against the periphery of developing roller **311** for preventing outflow of developing fluid **313**. An arcuate doctor member **324** increasing in thickness in going from one end to the other is interposed between the inner wall of container and the periphery of roller **311** with its smallest thickness end being disposed at the otherside edge of opening **342** so as to adjust the quantity of developing fluid on the periphery of developing roller **311**.

Formed in one side plate of container **341** is a developing fluid supply port **345** which is connected to a pump **346** through a flexible line **347** as shown in FIG. **22**. A line **347** connected at an upper end thereof to pump **346** is immersed at a lower end thereof in a developing fluid **313** in an auxiliary developing fluid container **348**. Container **341** and auxiliary container **348** are connected to each other by another flexible line **349** for discharging the fluid in container **341** into auxiliary container **348**. A cover **341** is disposed over container **341** for providing a seal thereto.

A recording sheet **326** on which an electrostatic image **325** is formed is brought with a light force into engagement with the periphery of developing roller **311** by a recording sheet keep roller **343**, so that the image can be developed into a visible image. When the developing device is inoperative, roller **343** is moved away from developing roller **311** as shown in FIG. **22** and container **341** is angularly rotated clockwise in the figure so that opening **342** may be closed by cover **351**. Then, pump **346** is operated to deliver an additional supply of fluid **313** to container **341** from auxiliary container **348**. Thus, developing roller **311** is immersed entirely in the fluid **313** in container **341**, so that drying and solidifying of the developing fluid in fluid containing portions on the periphery of developing roller **311**. Since container **341** is sealed by cover **351**, vaporization and degradation of the developing fluid in container can be precluded.

When the developing device is placed in service, a substantial quantity of the developing fluid **313** in container **341** is returned to auxiliary container **348** and

container 341 is angularly rotated counter clockwise in FIG. 22 into a position in which developing roller 311 is juxtaposed to recording sheet keep roller 343 as shown in FIG. 21.

In FIG. 23, a doctor member 352 of the same construction as the aforementioned doctor member 7 which serves concurrently as a developing fluid supply roller and a recording sheet keep roller 343 are maintained in pressing engagement with developing roller 311. Roller 352 has a portion of its periphery immersed in the developing fluid 313 in a container 354 and delivers a supply of developing fluid in suitable quantity to the periphery of developing roller 311, thereby eliminating the need to provide an additional doctor member.

Roller 352 may be moved downwardly as is the case with developing roller 311 of FIG. 20 when the developing device is put out of service so that roller 352 may be immersed entirely in the developing fluid 313 in container 354. Container 354 is closed and sealed by a lid 353 when roller 352 is in its lower inoperative position. According to this invention, the developing fluid supply roller may be immersed in its entirety in the developing fluid in place of the developing roller when the developing device is inoperative. When this is the case, the developing fluid adhering to the periphery of roller 352 can be prevented from solidifying when put out of service. However, it is required to clean developing roller 311 by some cleaning means after the developing operation is terminated.

What we claim is:

1. A device for developing an electrostatic image with a developing fluid comprising a developing roller formed on its periphery with a multitude of minute valleys and crests, with the valleys serving as developing fluid containing sections, developing fluid supply means comprising a container for containing therein a developing fluid and a developing fluid supply member for delivering a supply of the developing fluid from said container to said developing roller, means for rotating said developing roller, a doctor member made of a material capable of suitably absorbing fluid, means for bringing the doctor member into intimate pressing engagement with the periphery of said developing roller so as to adjust the fluid level of developing fluid in each developing fluid containing section and keep it below the crests or maximum diameter portions of the developing roller, and means comprising at least one recording sheet keep roller juxtaposed to said developing roller for bringing a recording sheet fed between the peripheries of said developing roller and said recording sheet keep roller into intimate contact with the periphery of said developing roller so that the developing fluid in said developing fluid containing sections on the periphery of the developing roller may be attracted to an electrostatic image formed on the recording sheet and adhere thereto so that the image can be developed into a visible image while no developing fluid adheres to non-charged regions of the recording sheet, wherein said developing fluid containing sections are formed around the periphery of the developing roller by providing adjacent grooves each having a groove bottom and groove walls, the pitch of the groove defined as the distance between adjacent groove wall tops being in the range from 0.08 to 0.15 millimeters and the angle formed by adjacent groove walls defining the degree of opening of each groove being in the range from 15° to 20°, said groove walls having smooth tops.

2. A device as claimed in claim 1 wherein said grooves for providing the developing fluid containing sections are continuous with one another and form a continuous spiral around the circumference of the developing roller.

3. A device as claimed in claim 1 wherein said tops of said groove walls are made of material having water repellent surface.

4. A device for developing an electrostatic image with a developing fluid, comprising: a developing roller formed on its periphery with a multitude of minute valleys and crests, with the valleys serving as developing fluid containing sections, developing fluid supply means comprising a container for containing therein a developing fluid and a developing fluid supply member for deliverying a supply of the developing fluid from said container to said developing roller, means for rotating said developing roller, a doctor member made of a material capable of suitably absorbing fluid, means for bringing the doctor member into intimate pressing engagement with the periphery of said developing roller so as to adjust the fluid level of developing fluid in each developing fluid containing section and keep it below the crests or maximum diameter portions of the developing roller, and means comprising at least one recording sheet keep roller juxtaposed to said developing roller for bringing a recording sheet fed between the peripheries of said developing roller snd said recording sheet keep roller into intimate contact with the periphery of said developing roller so that the developing fluid in said developing fluid containing sections on the periphery of the developing roller may be attracted to an electrostatic image formed on the recording sheet and adhere thereto so that the image can be developed into a visible image while no developing fluid adheres to non-charged regions of the recording sheet, and cylindrical end pieces of greater diameter than the keep roller fixed to the axial ends of the keep roller coaxially therewith to maintain the keep roller spaced apart from the developing roller by a clearance which is slightly less than the thickness of the recording sheet, so that a surface of the recording sheet on which the electrostatic image is formed is brought into contact with at least the crests formed on the periphery of the developing roller when the recording sheet is fed between the peripheries of the developing roller and the recording sheet keep roller, but the developing roller and the recording sheet keep roller are spaced from each other and out of contact of each other when no recording sheet is present between them to avoid staining the sheet keep roller with developing fluid from the developing roller.

5. A device for developing an electrostatic image with a developing fluid comprising a developing roller formed on its periphery with a multitude of minute valleys and crests, with the valleys serving as developing fluid containing sections, developing fluid supply means comprising a container for containing therein a developing fluid and a developing fluid supply member for delivering a supply of the developing fluid from said container to said developing roller, means for rotating said developing roller, a doctor member made of a material capable of suitably absorbing fluid, means for bringing the doctor member into intimate pressing engagement with the periphery of said developing roller

so as to adjust the fluid level of developing fluid in each developing fluid containing section and keep it below the crests or maximum diameter portions of the developing roller, and means comprising at least one recording sheet keep roller juxtaposed to said developing roller for bringing a recording sheet fed between the peripheries of said developing roller and said recording sheet keep roller into intimate contact with the periphery of said developing roller so that the developing fluid in said developing fluid containing sections on the periphery of the developing roller may be attracted to an electrostatic image formed on the recording sheet and adhere thereto so that the image can be developed into a visible image while no developing fluid adheres to non-charged resions of the recording sheet, wherein said container and said developing roller are movable relative to each other before and after a developing operation, and including means for bringing the developing roller to a position in which its periphery is partly immersed in the developing fluid in the container before initiation of the developing operation and to a position in which its periphery is entirely immersed in the developing fluid in the container after termination of the developing operation.

6. A device as claimed in claim **5** wherein said container is provided with a cover which is movable relative to the container, so that the cover can be removed from the container before initiation of the developing operation to open the container and applied to the container after termination of the developing operation to close and seal the container.

7. A device for developing an electrostatic image with a developing fluid comprising a developing roller formed on its periphery with a multitude of minute valleys and crests, with the valleys serving as developing fluid containing sections, developing fluid supply means comprising a container for containing therein a developing fluid and a developing fluid supply member for delivering a supply of the developing fluid from said container to sad developing roller, means for rotating said developing roller, a doctor member made of a material capable of suitably absorbing fluid, means for bringing the doctor member into intimate pressing engagement with the periphery of said developing roller so as to adjust the fluid level of developing fluid in each developing fluid containing section and keep it below the crests or maximum diameter portions of the developing roller, and means comprising at least one recording sheet keep roller juxtaposed to said developing roller for bringing a recording sheet fed between the peripheries of said developing roller and said recording sheet keep roller into intimate contact with the periphery of said developing roller so that the developing fluid in said developing fluid containing sections on the periphery of the developing roller may be attracted to an electrostatic image formed on the recording sheet and adhere thereto so that the image can be developed into a visible image while no developing fluid adheres to non-charged regions of the recording sheet, wherein said container is provided with a cover, said container being opened as a result of relative movements of the cover and the developing roller before initiation of a developing operation to bring the developing roller to a position in which its periphery is partly immersed in the developing fluid in the container and closed as a result of relative movements of the cover and the developing roller after termination of the developing operation to bring the developing roller to a position in which its periphery is entirely immersed in the developing fluid in the container.

8. A device for developing an electrostatic image with a developing fluid comprising a developing roller formed on its periphery with a multitude of minute valleys and crests, with the valleys serving as developing fluid containing sections, developing fluid supply means comprising a container for containing therein a developing fluid and a developing fluid supply memeber for delivering a supply of the developing fluid from said container to said developing roller, means for rotating said developing roller, a doctor member made of a material capable of suitably absorbing fluid, means for bringing the doctor member into intimate pressing engagement with the periphery of said developing roller so as to adjust the fluid level of developing fluid in each developing fluid containing section and keep it below the crests or maximum diameter portions of the developing roller, and means comprising at least one recording sheet keep roller juxtaposed to said developing roller for bringing a recording sheet fed between the peripheries of said developing roller and said recording sheet keep roller into intimate contact with the periphery of said developing roller so that the developing fluid in said developing fluid containing sections on the periphery of the developing roller may be attracted to an electrostatic image formed on the recording sheet and adhere thereto so that the image can be developed into a visible image while no developing fluid adheres to non-charged regions of the recording sheet, wherein said developing fluid supply means comprises a developing fluid supply roller and means for immersing said developing fluid supply roller in its entirely in the developing fluid in the container when no developing operation is being carried out.

9. A device for developing an electrostatic image with a developing fluid comprising a developing roller formed on its periphery with a multitude of minute valleys and crests, with the valleys serving as developing fluid containing sections, developing fluid supply means comprising a container for containing therein a developing fluid and a developing fluid supply member for delivering a supply of the developing fluid from said container to said developing roller, means for rotating said developing roller, a doctor member made of a material capable of suitably absorbing fluid, means for bringing the doctor member into intimate pressing engagement with the periphery of said developing roller so as to adjust the fluid level of developing fluid in each developing fluid containing section and keep it below the crests or maximum diameter portions of the developing roller, and means comprising at least one recording sheet keep roller juxtaposed to said developing roller for bringing a recording sheet fed between the peripheries of said developing roller and said recording sheet keep roller into intimate contact with the periphery of said developing roller so that the developing fluid in said developing fluid containing sections on the periphery of the developing roller may be attracted to an electrostatic image formed on the recording sheet and adhere thereto so that the image can be developed into a visible image while no developing fluid adheres to non-charged regions of the recording sheet, wherein said doctor member is a roller, and including means for intermittently rotating the doctor member roller around its longitudinal axis.

10. A device for developing an electrostatic image with a developing fluid comprising a developing roller formed on its periphery with a multitude of minute valleys and crests, with the valleys serving as developing fluid containing sections, developing fluid supply means comprising a container for containing therein a developing fluid and a developing fluid supply member for delivering a supply of the developing fluid from said container to said developing roller, means for rotating said developing roller, a doctor member made of a material capable of suitably absorbing fluid, means for bringing the doctor member into intimate pressing engagement with the periphery of said developing roller so as to adjust the fluid level of developing fluid in each developing fluid containing section and keep it below the crests or maximum diameter portions of the developing roller, and means comprising at least one recording sheet keep roller juxtaposed to said developing roller for bringing a recording sheet fed between the peripheries of said developing roller and said recording sheet keep roller into intimate contact with the periphery of said developing roller so that the developing fluid in said developing fluid containing sections on the periphery of the developing roller may be attracted to an electrostatic image formed on the recording sheet and adhere thereto so that the image can be developed into a visible image while no developing fluid adheres to non-charged regions of the recording sheet, wherein said doctor member is a roller of irregular cross-section.

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