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Yamamoto et al.

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[54] **DEVICE FOR DEVELOPING TWO-COMPONENT DIAZO PHOTOSENSITIVE MATERIAL**

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[52] **U.S. Cl.** ..... **95/94 G**, 95/89 G, 118/260, 118/268, 355/100, 355/106

[51] **Int. Cl.** **G03d 3/12**

[58] **Field of Search** ...95/89 G, 89 A, 94 G; 355/106, 355/107, 100; 118/260, 268

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[57] **ABSTRACT**

A dry developing device for two-component diazo photosensitive material, comprising a heating chamber and a developing roller disposed therein. Liquid developer is applied to the inner peripheral surface of the developing roller gradually, so that it is gasified by the heat from the heating chamber for producing a gaseous developer layer on the outer peripheral surface of the developing roller where the photosensitive material is delivered and developed.

7 Claims, 7 Drawing Figures

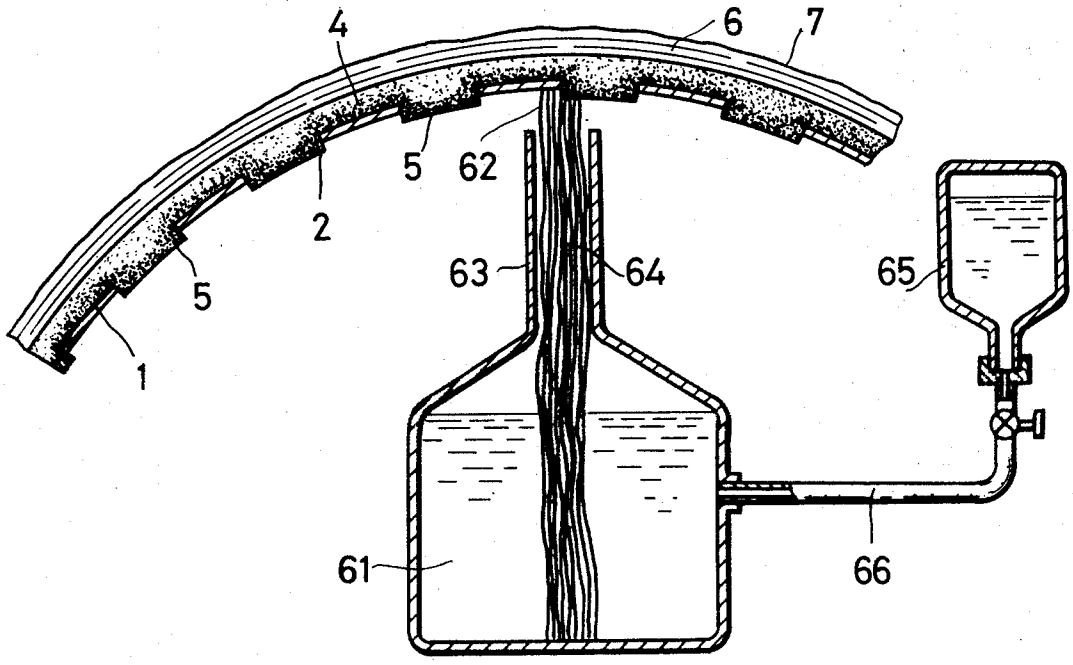

Fig. 1

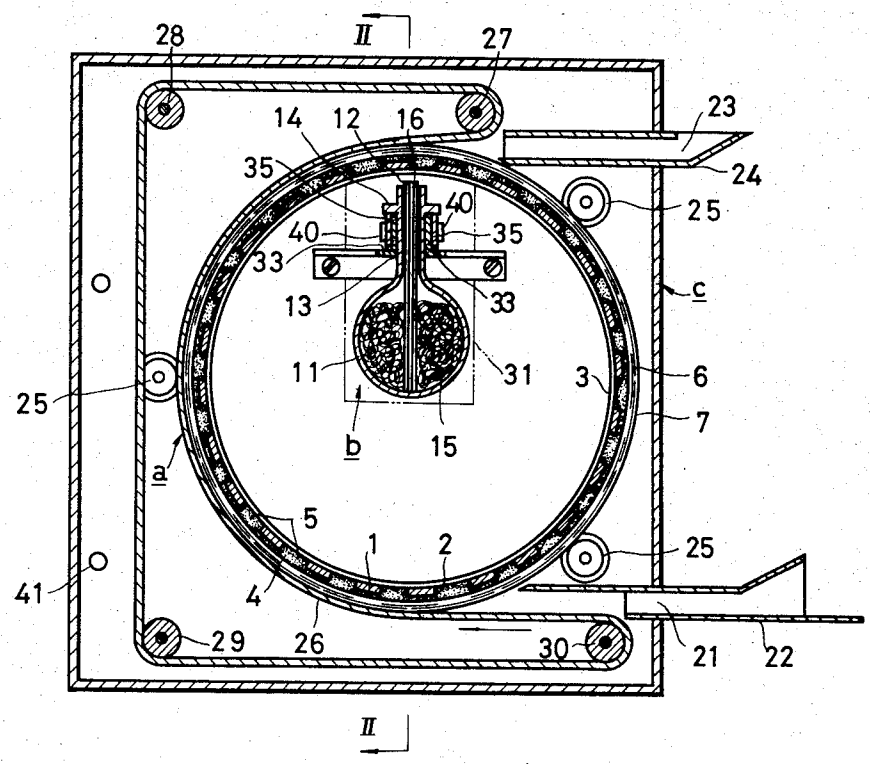
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Fig. 2

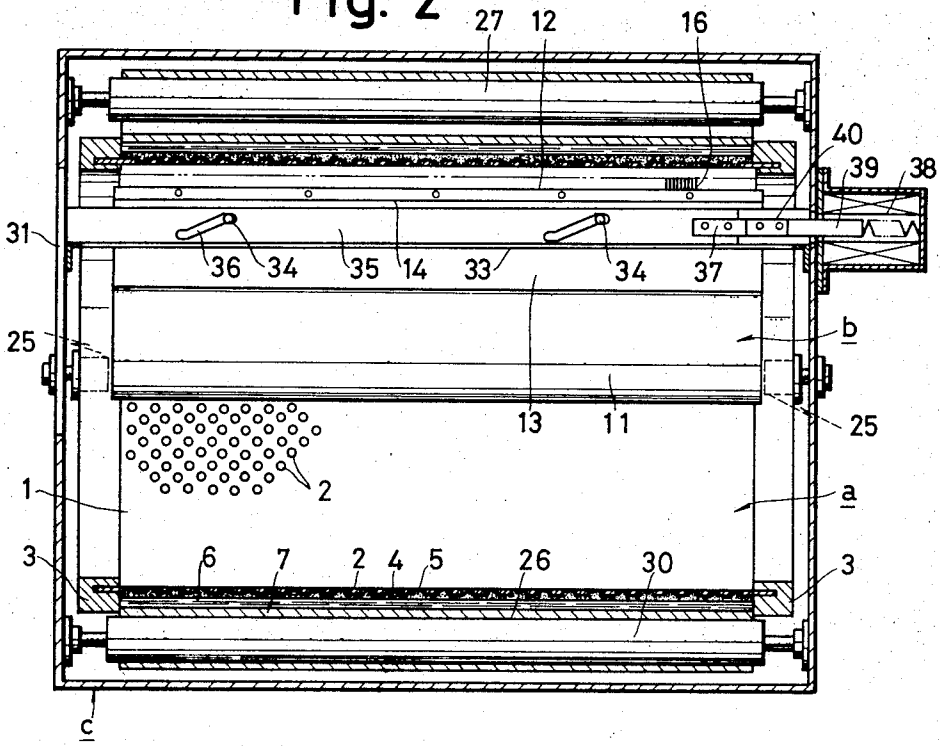
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Fig. 3

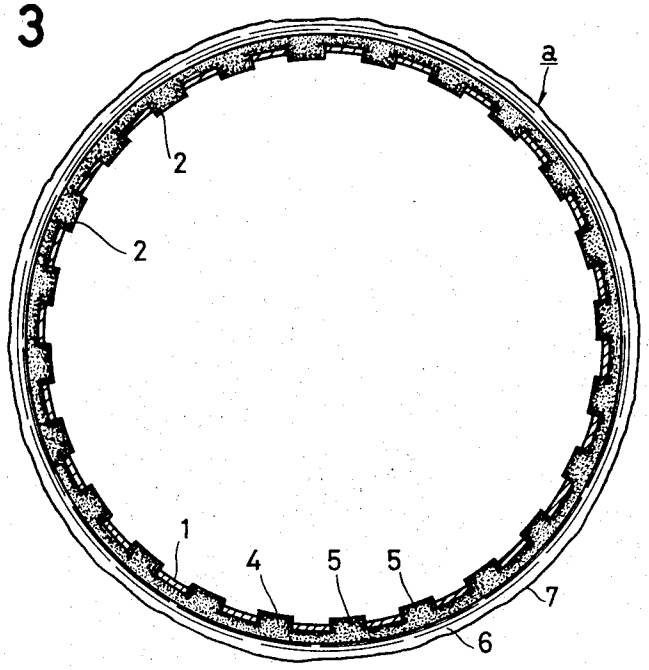
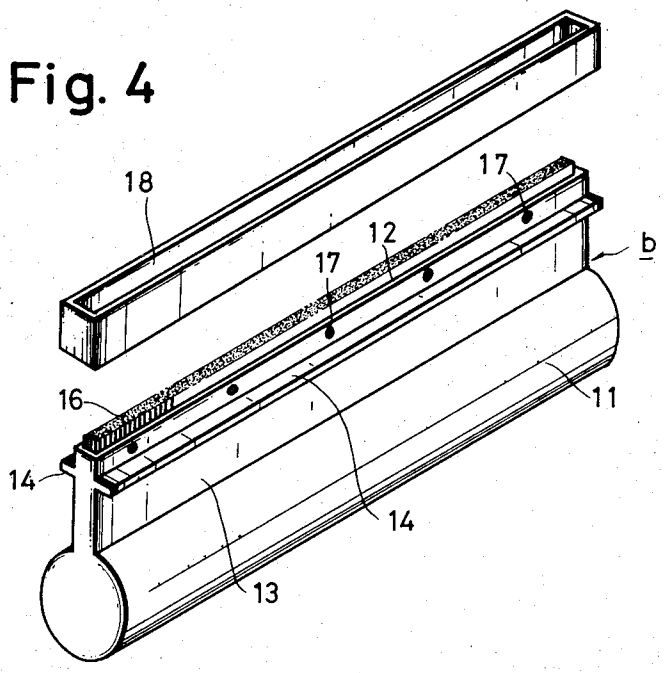


Fig. 4



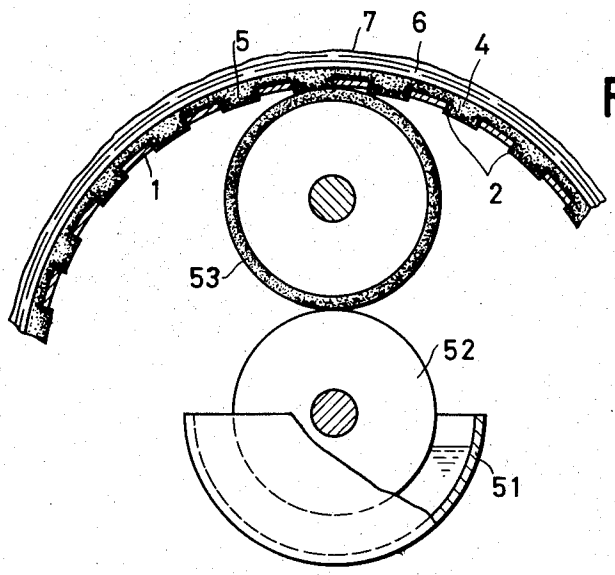


Fig. 6

Fig. 5

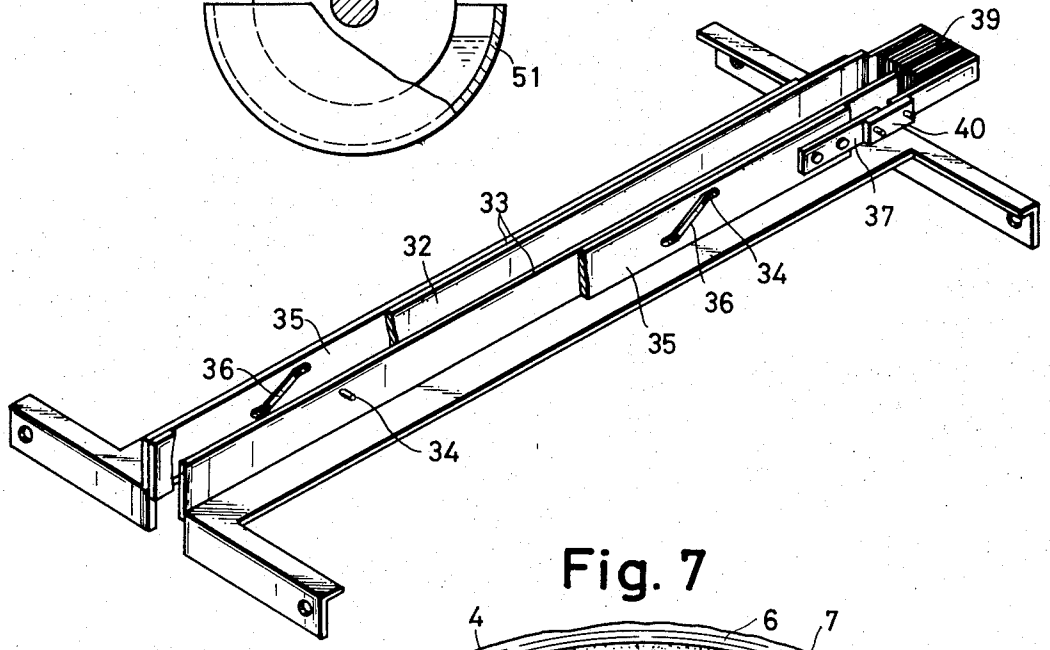
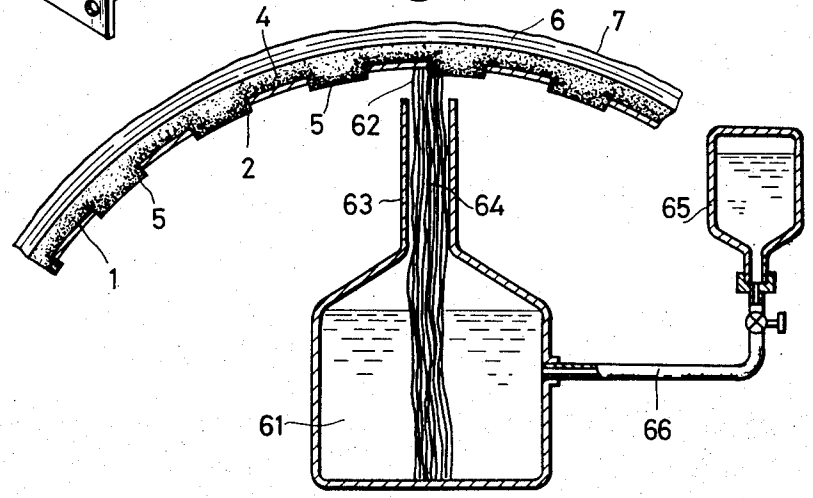


Fig. 7



DEVICE FOR DEVELOPING TWO-COMPONENT DIAZO PHOTOSENSITIVE MATERIAL

This invention relates to a device for developing two-component diazo photosensitive material,

An object of the invention is to provide a dry developing device for developing the latent image of a two-component diazo photosensitive material layer by applying a gaseous developer thereto, which device includes a heating chamber, and a developing roller having a peripheral impregnable portion impregnated with the developer and being rotatably mounted within the heating chamber, so as to generate a gaseous layer of the developer on the outer peripheral surface of the developing roller upon heating by the heating chamber, characterized in that the developing roller is hollow and the developer in liquid phase is applied to the inner peripheral surface of the developing roller gradually while causing the developer to transfer to the outer peripheral surface thereof, so that the liquid developer can continuously be delivered to the outer peripheral surface of the developing roller and the gaseous developer layer is continuously formed on the outer surface of the developing roller upon heating by the heating chamber.

Another object of the invention is to simplify the feeding of the liquid developer to the developing roller of the aforesaid device, by detachably inserting a disposable cartridge type developer tank through the heating chamber wall to the inside of the hollow developing roller, which developer tank has a developer spreading member engageable with the inner peripheral surface of the developing roller over the entire effective developing width of the developing roller. The developer tank may separately be manufactured as a sealed tank. Such developer tank is particularly suitable for office use.

Other objects and advantages of the present invention may be appreciated by referring to the following description, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a vertical sectional view of a developing device, according to the present invention;

FIG. 2 is a sectional view, taken along line II—II of FIG.1;

FIG. 3 is an enlarged sectionalview of a developing roller in the device of FIG.1, according to the present invention;

FIG. 4 is a schematic perspective view of a cartridge type developer tank and a developer spreader, according to the present invention;

FIG. 5 is a partially cut away perspective view of a framework for seating the developer tank, which framework includes holding bars and vertically reciprocating boards; and

FIGS.6 and 7 are lateral sectional views of different embodiments of the developer tank with a developer spreader to be used in the device according to the present invention.

Like part are designated by like numerals and symbols throughout the drawings.

Referring to FIG.3, a developing roller *a* includes a cylindrical rotary drum 1, preferably made of stainless steel, and a plurality of holes 2 are drilled through the peripheral wall of the drum 1. A pair of tire rings 3 (FIG. 1) are secured to the opposite ends of the cylindrical rotary drum 1. A substrate layer or an inner impregnable sheet 4 is tightly wound on the outer peripheral surface of the drum 1. The inner impregnable sheet 4 is preferably made of a spongy synthetic resin member. A plurality of wart-like projections 5 are formed on the inner surface of the sheet 4 in register with the holes 2 of the drum, so as to cause the projections 5 to extend through the holes 2 and slightly protrude to the inside of the drum 1 relative to the inner surface thereof. An outer impregnable sheet 6 is tightly wound on the inner impregnable sheet 4, which outer sheet is preferably made of a paper-like blotting material. For instance, the outer impregnable sheet 6 is made by overlaying four to six filter papers, each being 0.3 mm thick and having a capillary constant of 8 per square centimeter. A cover layer 7 is wound on the outer impregnable sheet 6, which layer 7 can be preferably made of a thin woven cloth. For instance, the cover layer 7 is made of a tricot fabric of non-impregnable synthetic fibers with a comparatively rough texture. The diameter of each hole 2 on the rotary drum 1 should preferably by four to five millimeters, and the area ratio between the holes 2 and the non-perforated drum portion should preferably be about 45:55.

FIG.4 shows a perspective view of a cartridge type developer tank-spreader assembly *b*. The assembly *b* includes an elongated cylindrical developer tank 11, whose length substantially corresponds to an effective developing width of the aforesaid developing roller *a* between the tire rings 3. The opposite ends of the cylindrical tank 11 are sealingly closed. A rectilinear elongated opening 12 is connected to the cylindrical tank through a similarly shaped neck passage defined by planar walls 13, so that the opening 12 extends in parallel with the longitudinal axis of the tank over the entire length thereof. A pair of mounting flanges 14 extend outwardly from the wide sides of the walls 13, on the opposite sides thereof. A suitable liquid-holding member 15 (FIG. 1) such as for example, fibers or sponge, is lightly stuffed into the hollow space within the developer tank 11, and then a liquid developer is poured into the tank 11 so as to fill it up. A spreading member 16 having capillary action is inserted into the opening 12, until its lower end comes in contact with the liquid-holding member 15 while its top edge protrudes upwardly from the upper end of the opening 12. A rectangular cap 18 is sealingly fitted on the top edges of the planar side walls 13, so as to facilitate the storage and transportation of the developer tank 11. A few adjusting screws 17 are threadably mounted on the side walls 13 so as to enable the control of the cross sectional area of the opening 12 for fine adjustment of the flow rate of the liquid developer through the spreading member 16.

FIGS. 1 and 2 show the structure of a developing device according to the present invention, which comprises the aforesaid developing roller *a* and the developer tank-spreader assembly *b*, both mounted within a heating chamber *c*. An inlet opening 21 for receiving a sheet of photosensitive paper and an outlet opening 23 for delivering the photosensitive paper after development are provided on the front wall of the heating chamber *c*, at the lower and upper portions thereof, respectively, as shown in FIG. 1. Suitable guide pieces 22 and 24 are associated with the inlet opening 21 and

the outlet opening **23**, respectively. Each of the tire rings **3** secured to the drum **1** of the developing roller *a* are rotatably held by bearing rollers **25**, which are disposed on the inner surface of the side wall of the chamber *c* at suitable angular intervals, for instance, three bearing rollers **25** spaced by 120°. By disposing similar bearing rollers **25** on the opposite side wall of the chamber *c*, the developing roller *a* is rotatably held in the hollow space within the heating chamber *c*. An endless conveyor belt **26** engages at least one half of the peripheral surface of the developing roller *a* and extends in proximity of the inlet opening **21** and in proximity of the outlet opening **23**. The conveyor belt **26** is driven by a driving roller **27** in the direction as shown by the arrow of FIG.1. The rotation of the endless belt **26** is guided by guide rollers **28** to **30**. A covered loading opening **31** is formed on one of the side walls of the heating chamber *c*, in register with the side opening of the developing roller *a* disposed within the heating chamber *c*, for purposes of loading the developer tank-spreader assembly *b* in the chamber *c*.

FIG. **5** shows a perspective view of holding framework to be secured to the inside of the heating chamber *c* for holding the developer tank-spreader assembly *b*. The framework comprises a pair of L-shaped holder bars **33** spaced by a gap **32**. The magnitude of the gap **32** is just wide enough for receiving the outer surfaces of the opposing wider side walls **13** of the opening **12** of the developer tank-spreader assembly *b*. The two holder bars **33** are at positioned directly above the axial center line of the developing roller *a*, by securing the longitudinally opposite ends of the bars **33** to the corresponding side walls of the heating chamber *c*. Each of the holder bars **33** has a plurality of outwardly projecting guide pins **34**, as shown in FIG.**5**. The guide pins **34** fit in the corresponding ones of slanted guide grooves or slots **36** drilled into each of a pair of vertically reciprocating boards **35**. The two vertically reciprocating boards **35** engage the outer surfaces of the vertical portions of the L-shaped holder bars **33**, respectively, and are connected to the movable iron core **39** of a solenoid **38** (FIG. **2**) through connecting pieces **37** and pivotal links **40**. The solenoid **38** is secured to the side wall of the heating chamber *c*. A suitable heater **41** FIG. **1**) is provided in the heating chamber c.

To mount the developer tank-spreader assembly *b* in the heating chamber *c*, a cover or door provided for the loading opening **31** is opened, and the developer tank-spreader assembly *b* is inserted into the interior chamber of the developing roller *a* rotatably mounted in the heating chamber *c*, while fitting the neck walls **13** of the opening **12** of the developer tank-spreader assembly *b* in the gap **32** between the holder bars **33**, so as to cause the lower surfaces of the mounting flanges **14** of the developer tank-spreader assembly *b* to rest on the upper edges of the vertically reciprocating boards **35**. The mounting flanges **14** may be secured to the vertically reciprocating boards **35**, if so desired. When the solenoid **38** is not energized, the top edge of the spreading member **16** of the developer tank-spreader *b* faces the inner surface of the developing roller *a* with a very small spacing therefrom.

The electric circuit of the solenoid **38** is interconnected with the circuit of a driving motor for the driving roller **27** in such a manner that, upon actuation of the driving motor, the solenoid **28** is energized. Accordingly, the moving iron core **39** is pulled by the solenoid, so as to pull the vertically reciprocating boards **35** toward the solenoid **38** through the links **40** and the connecting pieces **37**. At this moment, the engagement between the guide pins **34** of the stationary holder bars **33** and the slanted guide grooves or slots **36** of the vertically reciprocating boards **35** causes the latter boards **35** to rise upwards as they move toward the solenoid **38**. As a result, the developer tank-spreader assembly *b* is raised, and the top edge of the spreading member **16** comes into contact of the projections **5** of the inner impregnable sheet **4** at the inner surface of the developing roller *a*. As the conveyor belt **26** travels in response to the rotation of the driving roller **27**, the developing roller *a* rotates due to its contact with the conveyor belt **26**, so that the liquid developer sucked from the developer tank **11** by the spreading member **16** by capillary action is gradually spread on the projections **5**.

In the developing roller *a*, the liquid developer applied on the inner impregnable sheet **4** is transferred to the outer impregnable sheet **6**, and then gasified at 40° C to 60° C so as to permeate through the cover layer **7** and form a gaseous developer layer on the outer peripheral surface of the developing roller *a*. The rough texture of the cover layer **7** acts to keep the gaseous developer layer on its surface. The aforesaid temperature for gasifying the liquid developer is established by the heater **41** disposed within the heating chamber *c*.

A sheet of photosensitive paper (not shown) to be developed is delivered to the aforesaid gaseous developer layer on the outer periphery of the developing roller *a* by the conveyor belt **26** through the inlet opening **21**, so that a latent image produced in the photosensitive coating (i.e., two-component diazo materials in this case) is developed by the coupling action thereof.

A heating roller (not shown) may be disposed adjacent to the outlet opening **23** of the heating chamber *c*, so as to receive the developed photosensitive paper from the outlet opening **23** for heating it at 110° C to 130° C for a very short period of time. The heating at such a high temperature acts to decompose the molecules of the residual developer in the photosensitive paper and insures the complete coupling reaction of the diazo photosensitive material.

FIG. **6** shows another embodiment of the developer tank-spreader assembly. In this figure, an elongated developer tank **51** is disposed within the hollow space of the developing roller *a*. A horizontal developer feeding roller **52** rotates while dipping its lower portion in the liquid developer in the tank **51**. A spreading roller **53** is so disposed as to engage both the inner surface of the developing roller *a* and the upper portion of the feeding roller **52**. Thereby, the liquid developer is transferred from the tank **51** to the projections **5** of the inner impregnable sheet **4** of the developing roller *a*, through the peripheral surfaces of the feeding roller **52** and the spreading roller **53**.

FIG. **7** illustrates a different form of the developer tank-spreader assembly *b*. In this figure, a storage tank **65** is disposed outside the heating chamber *c* (FIG.1) and connected to a developer tank **61** located within

the inner hollow space of a developing roller *a* similar to that of FIG.1. A feeding conduit **66** serves for the connection. The developer tank has an upright opening **62** formed by neck walls **63**, and a spreader member **64** having capillary action extends from the bottom of the developer tank **61** through the opening **62**, so that the upper end of the spreading member **64** protrudes above the top edge of the opening **62**. The upper end of the spreading member **64** engages the inner peripheral surface of a drum **1** of the developing roller *a*, for applying the developer to the projections **5** of an inner impregnable sheet **4** of the developing roller *a*. The storage tank **65** may be of dripping type adapted for feeding the liquid developer as it is transferred from the tank **61** to the developing roller *a*.

The embodiments of FIGS. **6** and **7** are suitable for industrial use, where a large amount of the two-component diazo photosensitive material is dealt with.

The liquid developer to be used in the developing device, according to the present invention, consists of an odorless aqueous solution of ethanol amine or other amines with equivalent properties. Some of the examples of the liquid developer composition are as follows.

Example 1: 40 parts of monoethanol amine, 60 parts of water,

Example 2: 35 parts of monoethanol amine, 5 parts of diethanol amine, 60 parts of water,

Example 3: 30 parts of monoethanol amine, 10 parts of triethanol amine, 60 parts of water,

With conventional developing devices of two-component diazo photosensitive material, a spreading roller engages on the outer peripheral surface of a developing roller, which developing roller is disposed within a heating chamber and has an impregnable sheet wound thereon. The spreading roller spreads a liquid developer, such as ammonia water and aqueous solution of ethanol amine, onto the peripheral surface of the developing roller, in a comparatively simple manner. The conventional developing devices, however, have a shortcoming in that developer is transferred to the surface of the photosensitive material in liquid phase, so that the developer tends to wet the photosensitive material and makes it difficult to achieve satisfactory dry developing effect.

On the other hand, with the developing device of the present invention, as described in the foregoing disclosure, the liquid developer is applied on the inner peripheral surface of a developing roller and transferred to the outer peripheral surface where it is gasified by the heat from the heating chamber for ensuring the dry developing effect. To this end, the present invention uses a perforated drum for making the developing roller, and an impregnable sheet is tightly wound on the outer peripheral surface of the drum so as to cause partial projection of the impregnable sheet toward the inside of the drum through the perforations thereof. The liquid developer is applied to the projections of the impregnable sheet thus formed on the inner peripheral surface of the drum. Accordingly, it is an important feature of the present invention that a concentrated gaseous layer of the developer be provided on the outer peripheral surface of the developing roller for effecting satisfactory dry developing operation without wetting the photosensitive material at all. The developer tank-spreader assembly of the present invention is normally held invisible within the developing roller, but it can easily be inspected simply by opening the door or cover of a loading opening, so as to allow the adjustment of the application of the liquid developer and the supplement of the liquid developer. Thus, with the present invention, excellent development can be ensured.

Furthermore, with the developing device according to the present invention, the aforesaid advantages and effect can be achieved by using a disposable cartridge type developer tank-spreader assembly, so that reliable excellent developing effect can be insured without requiring any skilled operator. Accordingly, the developing device of the present invention is particularly suitable for office use.

Although the present invention has been described with a certain degree of particularlity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A device for developing a photosensitive print, comprising:

a casing having an inlet for the print to be developed and an outlet for the developed print;

a cylindrical roll mounted in said casing for rotation which comprises a rigid cylindrical drum having a plurality of perforations formed in the drum wall over the total circumferential surface thereof, a basic layer of elastic and porous material including a plurality of protrusions and wound around said drum so that each of said protrusions is inserted corresponding of said perforations, an intermediate layer of fibrous sheet material wound around said porous material layer, and a loose fabric cover layer of substantially non-hygroscopic material;

an applicator means arranged within said cylindrical rool and extending along the effective axial length thereof for supplying liquid developer onto the surface of the porous material evenly as said cylindrical roll rotates;

a heating means arranged outside of said cylindrical roll to evaporate developer liquid to form gas layer around the cylindrical roll; and

an endless belt means engaging with said cylindrical roll for rotating said roll and feeding the print from said inlet through the outer surface of said roll to said outlet.

2. A device as claimed in claim **1**, in which said rigid cylindrical drum has perforations arranged in even distribution, each being of dimension in the order of about 4–5 milimeters and the area ratio of the total perforations to the imperforate area being substantially equal.

3. A device as claimed in claim **1**, in which said porous material for the basic layer is of foamed plastics or foamed rubber.

4. A device as claimed in claim **1**, in which said fibrous sheet material for the intermediate layer is a lamination of a thickness of the order up to several milimeters and the lamination is of a plurality of webs.

5. A device as claimed in claim **4**, in which said web is blotting paper, filter paper, felt or non-woven fabric.

6. A device as claimed in claim 1, in which said loose fabric is of synthetic yarn.

7. A device as claimed in claim 1, in which said applicator means is an elongated trough of the length substantially corresponding to the effective axial length of the cylindrical rool; having an upper opening of the narrow width with a wick member of which lower portion is dipped in developer liquid contained in said trough and the upper portion protrudes out of the opening to make contact with the surface of the cylindrical roll porous material.

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