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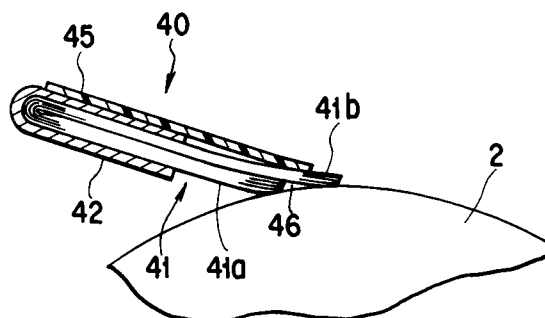
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W-8000 München 60(DE)(54) **Image forming apparatus.**

(57) An image forming apparatus includes an image distributing device (40) for distributing a developing agent remaining on a photoconductive drum (2) after a image transfer. The distributing device has a holding member (42), and a brush (41) extending from the holding member and in sliding contact with the drum. The brush includes a first brush section (41a) having a distal end portion in contact with the drum, and a second brush section (41b) having a distal end portion extending beyond that of the first brush section and in contact with the drum. The drum and the distal end portions of the first and second brush sections define a cavity (46) for temporarily storing the residual developing agent on the drum.

**FIG. 7****EP 0 501 151 A2**

The present invention relates to an image forming apparatus, such as an electrophotographic apparatus, electrostatic printer, etc., and more particularly, to an image forming apparatus which forms a developing agent image on an image carrier, such as a photoconductive drum, and transfer the developing agent image to a paper sheet or other transfer medium, and which is provided with an image distributing member adapted to come into sliding contact with the image carrier on the downstream side of a transfer region for the transferred material so that a developing agent remaining on the image carrier after passage through the transfer region is made nonpatterned.

Recently, there has been a demand for the miniaturization of image forming apparatuses of this type. Disclosed in Published Unexamined Japanese Patent Application No. 47-11538, for example, is an apparatus in which a single unit serves both as a developing device and a cleaning device so that the whole apparatus size is relatively small. According to this apparatus, an electrostatic latent image is developed by means of a developing device during a first turn of a photoconductive drum, and a residual image remaining on the drum after transfer is removed by the developing device during a second turn of the drum. In this conventional apparatus, however, the residual image is removed as the photoconductive drum passes through the developing device during its second turn, so that the recording speed is half that of an apparatus which is provided with a developing device and a cleaning device independent of each other. Also, it is impossible to obtain a recording area which is greater than the area of the whole circumferential surface of the drum. Naturally, therefore, the photoreceptor drum must have a relatively great size, so that the apparatus cannot be fully reduced in size.

Disclosed in U.S. Pat. No. 3,649,262, on the other hand, is a method for solving the problem on the recording speed by the use of a developing device which can simultaneously develop an electrostatic latent image and clean a residual developing agent, remaining after a preceding transfer cycle, during a first passage of the latent image. In this conventional apparatus, however, charging, formation of another electrostatic latent image, and development for the next cycle are carried out with the residual image remaining on the photoconductive drum. Inevitably, therefore, the latent image and toner image remaining on the drum are charged in a superposed manner, and this toner image is further exposed to another image, so that uniform charging and latent image formation cannot be achieved. Thus, a so-called memory image, which remains after a preceding image forming process, appears superposed on the next image,

so that the resulting image is not clear.

The above problem is liable to arise particularly when a solid portion (region where the developing agent covers a wide area) of a latent image is superposed on a residual image, such as characters, formed in the preceding process. It is often impossible to fully remove the developing agent as well as the latent image in the preceding process, so that a developing agent image also remains a memory image on the photoconductive drum and is transferred directly to a paper sheet. Thus, the conventional image forming apparatuses cannot provide satisfactory reliability, and often cannot produce clear images.

Thereupon, as disclosed in Published Unexamined Japanese Patent Applications Nos. 64-20585 and 1-118878, for example, an improved image forming apparatus has been developed and started to be practically used to bring a solution to these problems. This apparatus comprises an image distributing member which is arranged in sliding contact with an image carrier, on the downstream side of a transfer region where a developing agent image is transferred to a paper sheet, and is used to make a residual developing agent, remaining on the image carrier after passage through the transfer region, nonpatterned.

A brush-shaped structure is generally used as the image distributing member. Conventionally, the brush-type image distributing member is formed in the following manner. First, a brush member composed of two overlapping brush materials is folded double so that the respective distal ends of the materials are trued up. Then, the bent end portion of the brush member is fitted into a doubled aluminum plate, and the aluminum plate is caulked. The brush is located so that the distal end side of its flank is in sliding contact with the circumferential surface of the photoconductive drum. The developing agent remaining on the drum is temporarily attracted to the brush and discharged therefrom so that the developing agent image remaining after the passage through the transfer region is distributed or made non-patterned.

If the diameter of the photoconductive drum is as small as 40 mm or less, however, it is difficult to bring the brush fully into contact with the outer circumferential surface of the drum, and a satisfactory distributing effect cannot be obtained with use of one brush alone. If a plurality of independent brushes are arranged around the drum, as disclosed in Published Unexamined Japanese Patent Application No. 2-211487, in order to avoid this problem, the manufacturing cost increases, and a wide setting space is required. This constitutes a substantial hindrance to the miniaturization of the apparatus.

The present invention has been contrived in

consideration of these circumstances, and its object is to provide an image forming apparatus in which a single image distributing member can provide the same distributing effect as the conventional combination of two independent distributing members produces, and which enjoys simpler construction and lower cost.

In order to achieve the above object, an image forming apparatus according to the present invention comprises means for forming a developing agent image on an image carrier by using a developing agent, means for transferring the developing agent image to a transfer medium, and an image distributing member arranged in sliding contact with the image carrier on the downstream side of the transferring means, for making a residual developing agent, remaining on the image carrier after passage through the transferring means, nonpatterned. The image distributing member includes a holding member and a brush extending from the holding member. The brush includes a first brush section, which has a distal end portion in contact with the image carrier, and a second brush section which has a distal end portion extending beyond that of the first brush section and in contact with the image carrier.

Thus, according to the apparatus of the present invention, the brush of the image distributing member is arranged so that the positions of the respective distal ends of the first and second brush sections are offset to form a stepped portion at the distal end of the brush. The stepped portion defines a cavity in the contact region between the image carrier and the brush. This cavity serves substantially as a buffer for storing some of the developing agent. In this manner, the same distributing effect as the conventional combination of two independent distributing members produces can be obtained, and the residual developing agent on the image carrier can be satisfactorily distributed even after solid printing or removal of a jam. Moreover, the apparatus can enjoy simpler construction and lower cost.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Figs. 1 to 7 show an image forming apparatus according to an embodiment of the present invention, in which:

Fig. 1 is a sectional view showing an outline of the apparatus,

Fig. 2 is an enlarged sectional view of an image forming process unit,

Fig. 3 is a perspective view of an image distributing member,

Fig. 4 is an enlarged side view of the image distributing member,

Figs. 5 and 6 are schematic views showing processes for manufacturing the image distributing member, and

Fig. 7 is a schematic view showing the way the image distributing member and a photoconductive drum are in contact with each other; and

Figs. 8 and 9 are side views individually showing modifications of the image distributing member.

An embodiment of the present invention will now be described in detail with reference to the accompanying drawings.

Fig. 1 shows an image forming apparatus according to the present embodiment. A photoconductive drum 2 for use as an image carrier is arranged substantially in the central portion of a body 1 of the apparatus so as to be rotatable in the direction of arrow A. The drum 2, which is formed of a photoconductive material based on an organic photoconductor (OPC), has a recording area smaller than the area of an image to be recorded. In this embodiment, the drum diameter is as small as 40 mm.

As shown in Figs. 1 and 2, the photoconductive drum 2 is surrounded by a discharger 3 having the function mentioned later, developer distributing device 4, charger 5, electrostatic latent image forming device 6, developing/cleaning device 7, and transfer device 8, which are arranged successively in the rotating direction A of the drum. These elements constitute an image forming process unit 9 which forms a toner image T' as a developing agent image on the circumferential surface of the drum 2 and transfers the image to a paper sheet.

Defined in the apparatus body 1, moreover, is a paper conveying path 13 which guides a paper sheet P as a transferred material taken out from a paper cassette 10, which is disposed in the lower right-hand portion of the body 1, to a receiving tray 12 on the left-hand side of the body 1, via an image transfer section 11 between the photoconductive drum 2 and the transfer device 8 of the process unit 9.

Aligning rollers 15 are arranged on the upstream side of the image transfer section 11 with respect to the paper conveying path 13. The rollers 15 serve to align the leading end of the paper sheet P delivered thereto from the paper cassette 10 by means of a paper-supply roller 14, and then feed the sheet to the transfer section 11 with predetermined timing. Further, a fixing device 16 and a discharge roller pair 17 are arranged on the downstream side of the image transfer section 11. The fixing device 16 fixes the toner image T' transferred to the paper sheet P. The roller pair 17 discharges the sheet P, having the image fixed thereon, onto the receiving tray 12.

A gate 19 is arranged between the fixing de-

vice 16 and the exit roller pair 17. It guides the paper sheet P, fixed by means of the fixing device 16, to a reverse conveying path 18 as required. The sheet P guided to the transportation path 18 is discharged, with its image forming surface downward, into a recessed paper receiving portion 21, which is formed on the top side of the body 1, by means of an exit roller pair 20.

The following is a description of an image forming operation of the apparatus described above.

First, with the photoconductive drum 2 rotating in the direction of arrow A, the circumferential surface of the drum 2 is electrically charged to about -500 to -800V by means of the charger 5, which is formed of a Scorotron charger. Then, a light beam 25 from the electrostatic latent image forming device, formed of an edge emitter array (EL), is applied to the charged region of the drum 2, in accordance with image information, to expose the same, thereby forming an electrostatic latent image on the drum surface.

The electrostatic latent image is then transported to a developing/cleaning position opposite to the developing/cleaning device 7. The device 7 comprises a hopper 26 which contains a toner T for use as a so-called one-component developing agent having frictional chargeability. Arranged in the hopper 26 is a developing roller 27, which transports the toner T to a position opposite to the photoconductive drum 2, and returns the toner T remaining on the drum 2 to the hopper 26.

The developing roller 27 includes an electrically conductive surface layer 28, having electric resistance of 10^2 to $10^8 \Omega$, and an elastic layer 29 of urethane foam, silicone rubber, or EPDM located inside the layer 28. Thus, the roller 27 is an elastic roller as a whole. An elastic blade 30 is pressed against the roller 27. The blade 30, which is formed of phosphor bronze or urethane or silicone resin, serves to form a thin toner layer on the roller 27 while frictionally charging the toner T. The toner T transported past the blade 30 is frictionally charged for negative polarity, the same polarity of the photoconductive drum 2, thereby forming one to three toner layers on the circumferential surface of the drum.

The surface layer 28 is formed by applying a mixture of urethane resin and 10 to 30% by weight of conductive carbon, for example. The developing roller 27 is connected with a bias power source (not shown) so that the surface layer 28 conducts. Thus, a predetermined developing bias is applied to the roller 27 during developing and cleaning operations.

A spongy developer transportation roller 31, which is arranged in the hopper 26, serves to prevent the particles of the toner T in the hopper

from cohering and to transport the toner.

The toner T supplied from developing roller 27 is brought elastically into contact with the photoconductive drum 2 with a nip attributable to deformation, so that it is adhered to the electrostatic latent image, thereby forming the toner image T'. In this case, the toner T adheres to the exposed region of the drum 2, thereby effecting the so-called reversal development. The toner T is charged to about -5 to -30 $\mu\text{C/g}$ (micro-coulomb/gram) by friction between the blade 30 and the surface layer 28 of the developing roller 27, and a voltage of about -150 to -450V is applied to the roller 27. After the development, the toner image T' is transported to a region where it faces the transfer device 8 including a transfer roller 22, that is, the image transfer section 11, as the drum 2 rotates.

In synchronism with the rotation of the photoconductive drum 2, on the other hand, the image transfer section 11 is supplied with a paper sheet P which is delivered from the paper cassette 10 as the paper-supply roller 14 rotates.

A positive bias is applied to the reverse side of the paper sheet P by means of the transfer roller 22, so that the toner image T' on the circumferential surface of the photoconductive drum 2 is electrostatically attracted to the paper sheet P to be transferred thereto. In this case, a positive AC bias from a power source (not shown) is applied to the rotational shaft of the transfer roller 22, and a voltage is applied through a conducting portion to a conductive surface portion of electrical resistance 10^5 to $10^9 \Omega\text{cm}$ on the surface of the roller 22. The conducting portion, which is provided on either end portion of the roller 22, is formed of a mixture of silicone resin and 5 to 0% by weight of conductive carbon.

Preferably, the surface of the transfer roller 22 should be formed from a low-friction material having surface smoothness, in order to facilitate the removal of contaminants, such as the adhering toner T, paper dust, etc. In this embodiment, conductive polyfluoride resin or conductive polyester is used as the material of the surface of the roller 22. The surface of the roller 22 is satisfactorily cleaned by means of a cleaning blade 32. A high degree of allowance for the force of pressure on the photoconductive drum 2 was able to be obtained when soft rubber having general hardness of 25 to 50° (based on the JIS (Japanese Industrial Standard) relative measurement method) was used for the transfer roller 22.

After the transfer, the paper sheet P is delivered to the fixing device 16, whereupon the toner image T' is fused and fixed on the sheet P. Thereafter, the sheet P is alternatively discharged to the receiving tray 12 or the paper receiving portion 21.

When the residual toner T, remaining on the photoconductive drum 2 after the transfer, is transported past the discharger 3, on the other hand, it is substantially de-electrified together with the electrostatic latent image on the drum 2.

Subsequently, the surface of the drum 2 passes through the developer distributing device 4. The device 4 comprises a brush-type image distributing member 40. As the photoconductive drum 2 rotates, the member 40 slides on the circumferential surface of the drum, so that the residual toner T on the drum surface is fully distributed and made nonpatterned by the member 40.

After the electrostatic latent image is erased and the residual toner is made nonpatterned in this manner, the photoconductive drum 2 is charged again to a predetermined potential by means of the charger 5. In doing this, the scattered nonpatterned toner T on the drum 2 is also negatively charged, and is removed in the developing/cleaning device 7. Thereafter, desired images can be formed by repeating the above-described processes.

The arrangement of the image distributing member 40 will now be described in detail.

As shown in Figs. 3 and 4, the image distributing member 40 comprises a brush 41, which is twice-folded with a stepped portion at the distal end, and a holding member 42 for holding the brush. A power source 48 (see Fig. 2) is connected to the brush 41 so that a predetermined voltage is applied to the brush.

More specifically, the brush 41 includes first and second brush sections 41a and 41b extending from the holding member 42. The respective proximal end portions of these brush sections are clamped on both sides by means of the holding member 42 so that the brush sections are intimately in contact with each other. The distal end portion of the second brush section 41b extends longer by a length e than that of the first brush section 41a. The width of the brush 41 is equal to or greater than that of the effective image forming area of the photoconductive drum 2. The holding member 42 is fixedly fitted with a backup plate 45 which serves to press the brush 41 against the drum 2 and shield the brush from the charger 5. The backup plate 45, which is opposed to that lateral face of the second brush section 41b on the opposite side to the first brush section 41a, is formed of an insulating elastic material, e.g., polyethylene phthalate and urethane.

The image distributing member 40 is manufactured in the following manner.

First, a brush material 41' formed of a bundle of electrically conductive fibers (trademark: TORAYKA) having electric resistance of 10^3 to 10^9 Ω cm (preferably 10^4 to 10^5 Ω cm) is folded double to form the first and second brush sections 41a

and 41b, as shown in Fig. 5. In doing this, the material 41' is doubled so that the distal end portion of the second brush section 41b extends beyond that of the first brush section 41a by the length e . Thereafter, the bent portion of the brush material 41' is inserted into an aluminum plate 42', which is previously bent V-shaped and used as the holding member 42, as indicated by two-dot chain line in Fig. 5. Then, the aluminum plate 42' is caulked inward so as to hold the bent portion of the material 41', that is, the respective proximal end portions of the brush sections 41a and 41b, from both sides, as shown in Fig. 6, thus forming the image distributing member 40.

As shown in Fig. 7, the image distributing member 40 is arranged so that the first brush section 41a faces the outer circumferential surface of the photoconductive drum 2 and that a lateral face or flank portion of the distal end portion of the each brush section is in contact with the outer circumferential surface of the drum. Further, the distributing member 40 is arranged so that a certain spot on the circumferential surface of the drum 2 is brought into contact with the second brush section 41b after it is brought into contact with the first brush section 41a. The respective distal end portions of the brush sections 41a and 41b are pressed against the circumferential surface of the drum 2 under a desired pressure by the agency of its own elasticity and the backup plate 45.

Since the distal end portion of the second brush section 41b extends beyond that of the first brush section 41a, as mentioned before, the distal end portion of the brush 41 is stepped. When the distal end portion of the brush 41 is in contact with the outer circumferential surface of the photoconductive drum 2, therefore, a cavity 46 is defined by the respective distal end portions of the first and second brush sections and the outer circumferential surface of the drum.

The cavity 46 serves substantially as a buffer for storing some of the toner T. Thus, if plenty of untransferred toner exists on the photoconductive drum 2, e.g., in case the paper sheet p is jammed in a manner such that the toner image on the drum 2 remains thereon without having been transferred at all or after high-density pattern printing, the untransferred toner is temporarily stored in the cavity 46 as it is leveled by means of the brush 41 of the image distributing member 40, and is gradually discharged from the cavity as the drum rotates. Even if plenty of untransferred toner remains on the drum 2, therefore, the drum can be cleaned satisfactorily.

An experiment was conducted changing the length e of projection of the second brush section 41b compared with the first brush section 41a. Thereupon, it was found that if the length e is not

less than 1 mm, the image distributing member 40 can fulfill its distributing function even though the untransferred toner remains in abundance after solid printing or removal of a jam, etc.

According to the image forming apparatus constructed in this manner, the image distributing member 40, which makes the residual developing agent on the photoconductive drum 2 nonpatterned after the transfer section 11 is passed, is provided with the brush 41 whose distal end portion contacting the drum is stepped. When the distal end portion of the brush is brought into contact with the drum, therefore, the cavity 46 is formed substantially having the function of a buffer capable of temporarily storing some of the toner T. Thus, the single image distributing member 40 can provide the same distributing effect as the conventional combination of two independent distributing members produces, and can adequately cope with the situation after solid printing or removal of a jam. Since the image distributing means is composed of the single distributing member 40 only, moreover, it does not require a wide setting space, thus ensuring simple construction and low-cost production of the apparatus, as well as reduced apparatus size.

It is to be understood that the present invention is not limited to the embodiment described above, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention.

As shown in Fig. 8, for example, the holding member 42 may be doubled so that a second plate section 42b in contact with the second brush section 41b is longer than a first plate section 42a in contact with the first brush section 41a. In this case, the first and second brush sections 41a and 41b can be satisfactorily pressed against the photoconductive drum 2 through the medium of the plate section 42b.

As shown in Fig. 9, moreover, the first and second brush sections 41a and 41b may be formed individually of two fiber bundles with different lengths.

Claims

1. An image forming apparatus comprising:
 - means (5, 6, 7) for forming a developing agent image on an image carrier (2);
 - means (8) for transferring the developing agent image to a transfer medium in a transfer section (11); and
 - distributing means (40) having a brush (41), for distributing a developing agent remaining on the image carrier after the developing agent image is transferred to the transfer medium;

characterized in that:

said distributing means (40) includes a holding member (42), and said brush (41) extends from the holding member and has a stepped distal end portion which is in sliding contact with the image carrier on a downstream side of the transferring means.

2. An apparatus according to claim 1, characterized in that said brush (41) includes first and second brush sections (41a, 41b) extending from the holding member (42) and having distal end portions which are offset to form the stepped distal end portion.
3. An apparatus according to claim 2, characterized in that said distributing means (40) is arranged so that the first brush section (41a) faces the image carrier (2), and the distal end portion of the second brush section (41b) extends beyond the distal end portion of the first brush section.
4. An apparatus according to claim 3, characterized in that said distributing means (40) is arranged so that a lateral face of the distal end portion of the first brush section (41a) and a lateral face of the distal end portion of the second brush section (41b) are in contact with the image carrier (2), and the respective distal end portions of the first and second brush sections and the image carrier define a cavity (46) for temporarily storing the residual developing agent on the image carrier.
5. An apparatus according to claim 1, characterized in that said brush (41) includes an electrically conductive fiber bundle having a pair of end portions and doubled so that the end portions are offset for a predetermined length, and a bent portion of the doubled fiber bundle is held by the holding member (42).
6. An apparatus according to claim 2, characterized in that said first brush section (41a) is formed of a first electrically conductive fiber bundle having first and second ends, and said second brush section (41b) is formed of a second electrically conductive fiber bundle which is longer than the first fiber bundle and has first and second ends, the first and second fiber bundles being arranged so that the first ends are joined together with an offset of a predetermined length and the second ends are held by the holding member (42).
7. An apparatus according to claim 2, characterized in that said holding member (42) includes

first and second plate sections (42a, 42b) facing each other, and a bent portion connecting the respective one ends of the plate sections, and said brush (41) is held by the holding member while that end portion of the brush which is spaced from the image carrier is sandwiched between the first and second plate sections.

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8. An apparatus according to claim 7, characterized in that said first and second plate sections (42a, 42b) are in contact with the first and second brush sections (41a, 41b), respectively, and said second plate section is longer than the first plate section.

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9. An apparatus according to claim 2, characterized in that said distributing means (40) includes a backup member (45) attached to the holding member (42) so as to face the first brush section (41a) and pressing the brush against the image carrier (2), the backup member being formed of an electrically insulating elastic member.

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10. An image forming apparatus comprising:
 means (5, 6, 7) for forming a developing agent image on an image carrier (2);
 means (8) for transferring the developing agent image to a transfer medium in a transfer section (11); and
 distributing means (40) having a brush (41), for distributing a developing agent remaining on the image carrier after the developing agent image is passed the transfer section;
 characterized in that:
 said brush (41) is formed by doubling an electrically conductive fiber bundle having a pair of end portions so that the end portions are offset for a predetermined length, and said distributing means includes a holding member (42) for holding a bent portion of the fiber bundle, the end portions of the fiber bundle being in sliding contact with the image carrier (2) on a downstream side of the transfer section (11), the end portions of the fiber bundle and the image carrier defining a cavity (46) for temporarily storing the residual developing agent on the image carrier.

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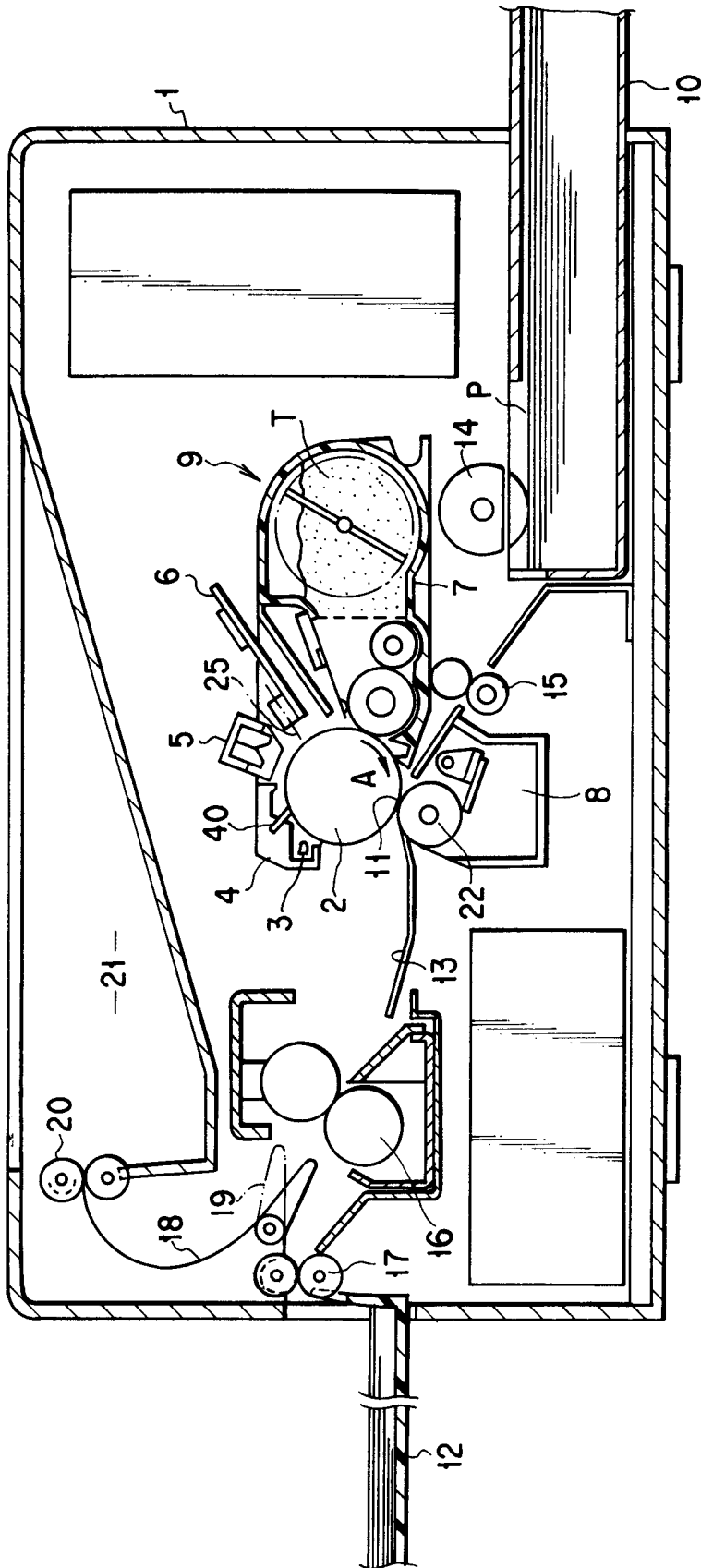


FIG. 1

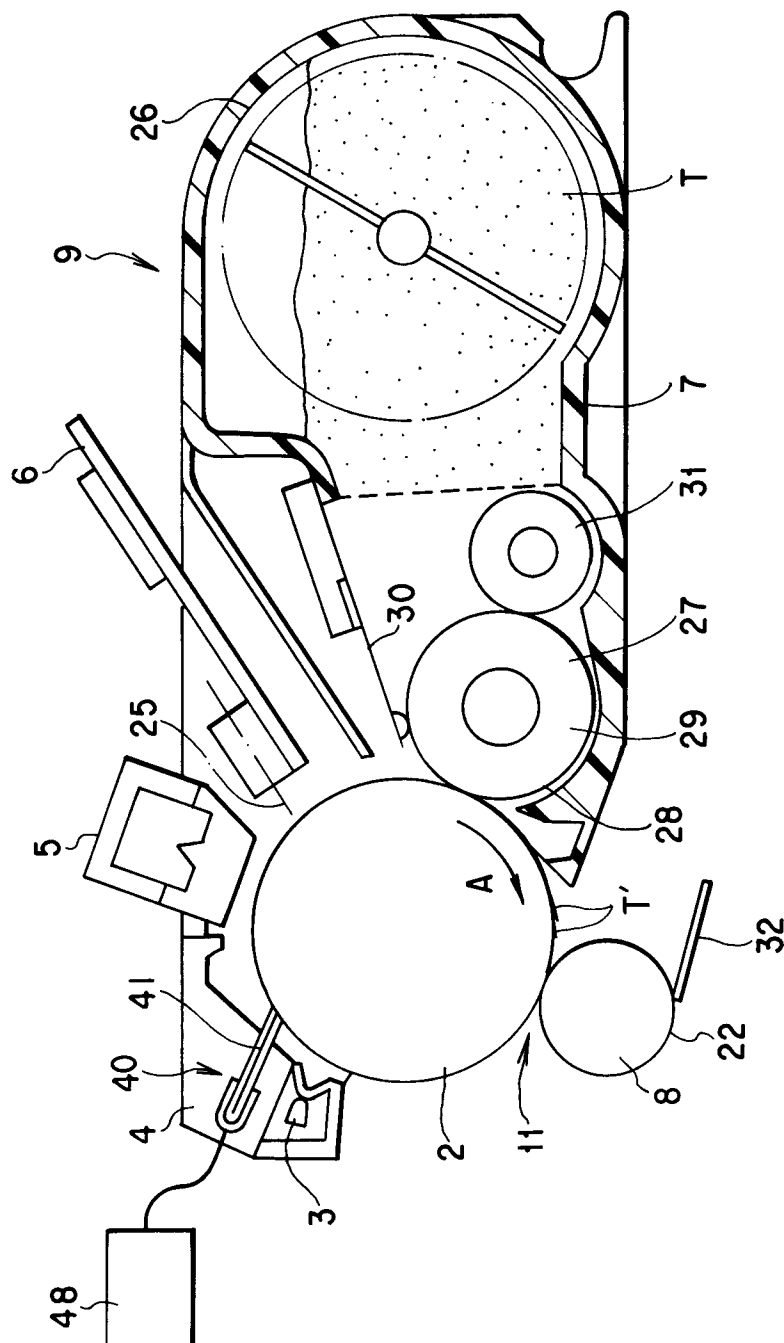


FIG. 2

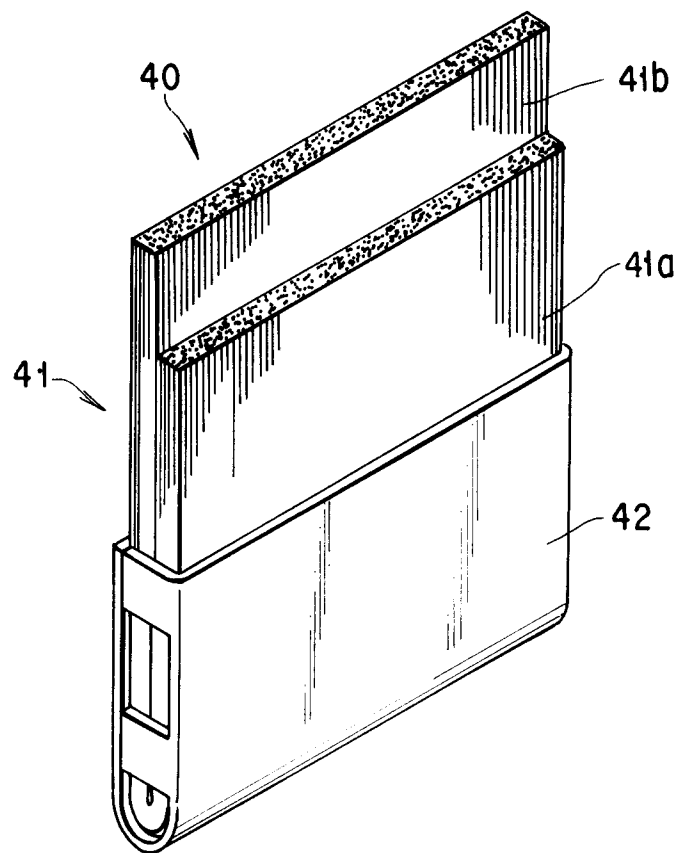


FIG. 3

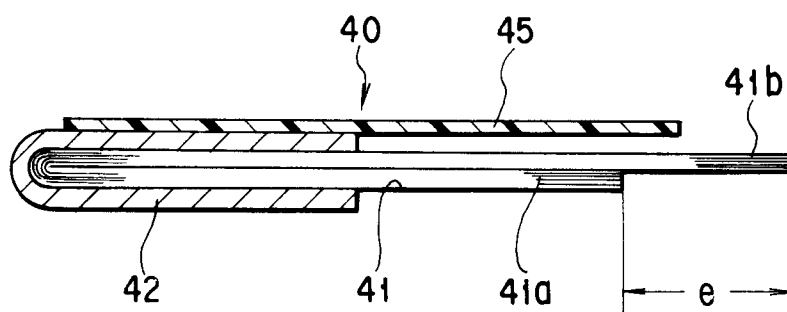


FIG. 4

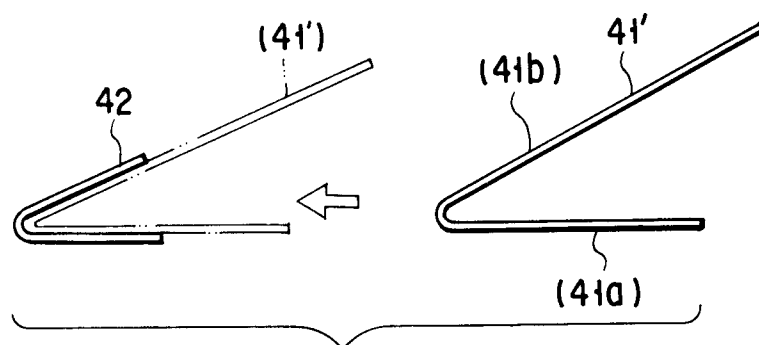


FIG. 5

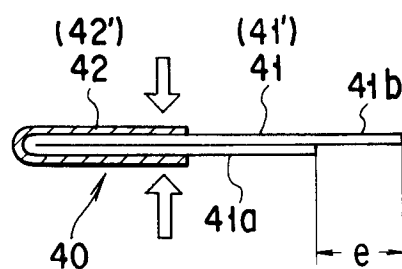


FIG. 6

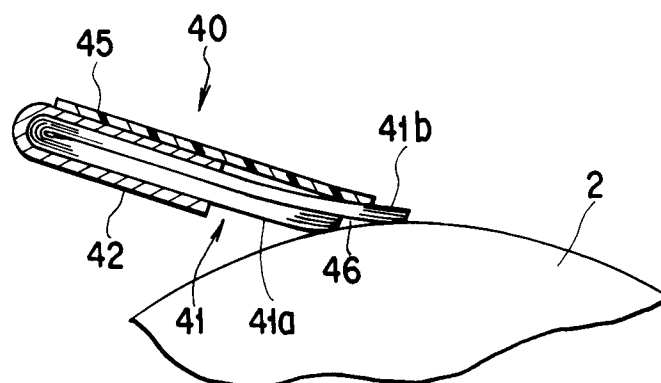


FIG. 7

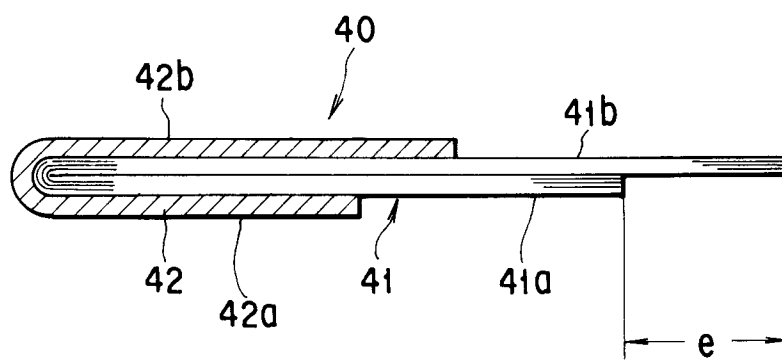


FIG. 8

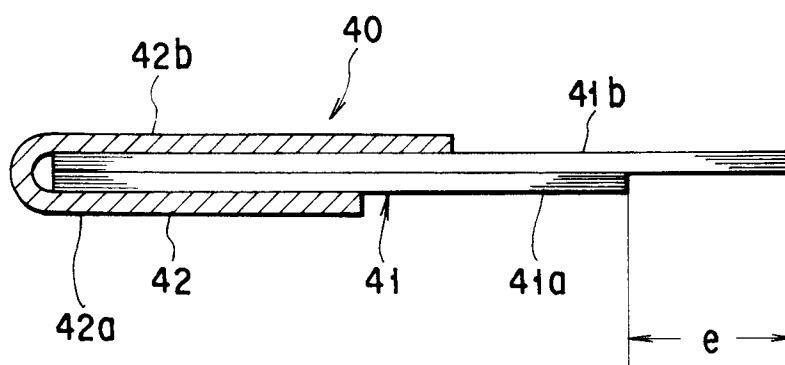


FIG. 9