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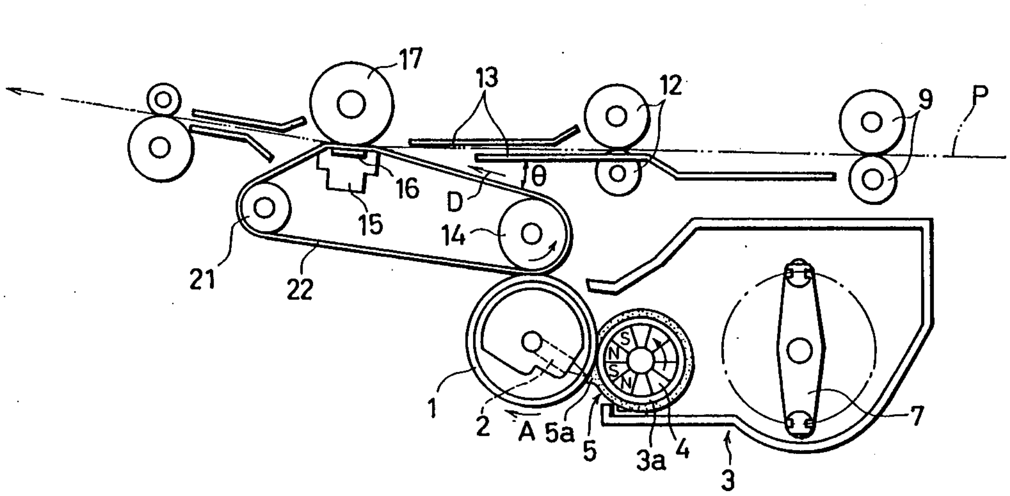
(54) **Electrophotographic printing machine.**

(57) An electrophotographic printing machine includes a photoreceptor drum, and a dielectric transfer belt. The transfer belt moves in contact with a surface of the photoreceptor drum. A toner image formed on the surface of the photoreceptor drum is temporally transferred to the transfer belt, and is then transferred to and fixed on a recording material by a transfer and fusing unit. The transfer and fusing unit includes a heater and a pressure roller mounted to face each other with the transfer belt therebetween. The recording material is transported onto the transfer belt moving toward the heater, and then to the transfer and fusing unit by the transfer belt. The transfer belt stably applies a transport force evenly to the recording material without interruption so that the recording material is carried stably to the transfer and fusing unit. Consequently, the toner image is transferred to and fixed on the recording material without distortion.

FIG.1



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FIELD OF THE INVENTION

The present invention relates to an electrophotographic printing machine which forms an image on a recording material by forming a toner image on a surface of a photoreceptor and then transferring and fixing the toner image onto the recording material.

BACKGROUND OF THE INVENTION

Conventionally, electrophotography adapting the Carlson process is widely used for the formation of an image with toner. For example, as shown in Fig. 8, an electrophotographic printer using the Carson process includes a charger 52 such as a corona discharger, an exposure unit 53, a developer unit 54, a transfer unit 55 such as a corona discharger, and a cleaner 56. These devices are disposed in this sequence on the periphery of a photoreceptor drum 31 having a photoconductive layer formed on the surface thereof.

With this arrangement, first, the surface of the photoreceptor drum 31 is uniformly charged by the charger 52 in a dark place. Next, an image on an original document is projected onto the surface of the photoreceptor drum 31 by the exposure unit 53 to remove the electric charges on the portion exposed to light. As a result, an electrostatic latent image is formed on the surface of the photoreceptor drum 31. Thereafter, toner 39, which has been charged to a polarity opposite to the electric charges on the photoreceptor drum 31, is caused to adhere to the electrostatic latent image to form a visible image.

Meanwhile, a recording material 41 fed by a feed roller 39 is sent between the photoreceptor drum 31 carrying the toner image on its surface and the transfer unit 55 by transport rollers 42, thereby transferring the toner image to the recording material 41.

The transport rollers 42 feed the recording material 41 carrying thereon the transferred toner image through a transport guide plate 36 to a fusing unit 45 having a pressure roller 37 and an in-plane heater 40. When the toner image is heated by the heater 40, the toner image is fixed to the recording material 41. Then, the recording material 41 with the toner image fixed thereon is discharged outside of the printer by discharge rollers 43.

On the other hand, residual toner 35 remaining on the photoreceptor drum 31 after the transfer of the image is removed by the cleaner 56. After erasing the latent image on the photoreceptor drum 31 with light projected by an eraser (not shown), a cycle of the above-mentioned process starting with charging by the charger 52 is repeated to form the image on the next recording material successively.

In the fixing process, sometimes toner heated to a melting point by the heater 40 adheres to the heating surface, making the heater 40 dirty. When such a trouble occurs, the heating operation of the heater 40 becomes unstable and the toner adhering to the heated surface spoils the appearance of the recording material 41.

To prevent such problems, a sheet 44 which is easily separated from the toner 35 is sandwiched between the recording material 41 and the heater 40. The sheet 44 is wound around a roller 57, and unrolled from the roller 57 and then wound around a roller 58 in accordance with a need.

The above-mentioned configuration requires a clean sheet 44 every fixing operation. However, it is difficult to circulate and reuse the sheet 44, thereby resulting in an increase in the costs.

To avoid such a problem, for instance, as shown in Fig. 9, a heat roller system is proposed. With this system, a fusing unit 59 having a heater 46a therein, a heat roller 46 made from a material which is easily separated form the toner 35, and a pressure roller 47 is used for fixing.

With this system, the transport of the recording material 41 to the fusing unit 59 is executed by the transport rollers 42 and a transport guide plate 36. The transport rollers 42 apply a transport force to the recording material 41, while the transport guide plate 36 guides the recording material 41 to the fusing unit 59.

With this configuration, before the recording material 41 reaches the fusing unit 59, the transport rollers 42 apply the transport force only to the rear edge of the recording material 41. This causes the leading edge of the recording material 41 fed past the transport guide plate 36 to be curled, resulting in unstable transport of the recording material 41. Moreover, when the transport force is applied only to a certain portion of the recording material 41, the recording material 41 tends to be creased. Therefore, the configuration induces a distorted image on the recording material 41.

In order to solve the problem, the fusing unit 59 needs to provide a transport force sufficient to achieve stable transport of the recording material 41. To apply the transport force to the recording material 41 as long as possible, for example, an endless transport belt 48 is proposed to be installed between the transport roller 42 and the fusing unit 59 as illustrated in Fig. 10.

With such a conventional configuration, however, there is a restriction on the size of a roller 48a which gives a tensile force and a driving force to the transport belt 48. Consequently, there is a need to place between the leading end of the transport belt 48 and the fusing unit 59 a guide plate, not shown, which gives no transport force to the recording material 41 because there is a gap therebetween.

With this configuration, the transport force is not effected on the leading edge of the recording paper 41 just before the recording material 41 reaches the fusing unit 59, preventing the recording material 41 from reaching the fusing unit 59 in a stable manner. It is thus difficult to surely prevent the distorted image from being formed on the recording material 41.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an electrophotographic printing machine capable of fixing a toner image on recording material without distortion.

In order to achieve the above object, the electrophotographic printing machine of the present invention includes:

photoreceptor means having a photoconductive layer;

toner-image forming means for forming a toner image on a surface of the photoreceptor means;

moving means which moves while making contact with the surface of the photoreceptor means, the moving means having at least a dielectric surface in contact with the photoreceptor means;

transfer means for transferring the toner image formed on the surface of the photoreceptor means to the moving means;

transfer and fusing means, mounted in contact with the moving means, for transferring the toner image on the moving means to a recording material and fixing it thereon; and

recording material transport means for transporting the recording material onto the moving means moving toward the transfer and fusing means.

With this configuration, the toner image formed on the surface of the photoreceptor means by the toner-image forming means is temporally transferred to the moving means by the transfer means, and is then transferred to and fixed on the recording material by the transfer and fusing means.

More specifically, the recording material is first transported onto the moving means moving toward the transfer and fusing means by the recording material transport means and is then transported to the transfer and fusing means by the moving means. The moving means stably applies a continuous transport force to the recording material evenly until the recording material reaches the transfer and fusing means. Consequently, the recording material is stably transported to the transfer and fusing means. Accordingly, the electrophotographic printing machine is capable of fixing the toner image on the recording material without distortion.

The electrophotographic printing machine of the present invention may have, in addition to the above-mentioned structure, a support member for supporting the moving means to be flat, the support member being disposed underneath the moving means at a contacting position of the moving means and the recording material so that the moving means slides over the support member.

With this configuration, since the surface of the moving means onto which the recording material has been transported by the recording material transport means is always supported to be flat by the support member, it is possible to reduce the change in the area of the contact region of the recording material and the moving means. Namely, if the support member does not exists, when the leading edge of the recording material comes into contact with the moving means, the surface of the moving means undulates, causing a change in the area of the contact region. However, such a problem is solved by the installation of the support member. Moreover, since the moving means is charged when the moving means slides along the support member, the adhesiveness between the recording material and the moving means is intensified.

Consequently, the transport force is applied to the recording material in a highly stable manner by the moving means, and the recording material is accurately transported to the transfer and fusing means. Thus, the electrophotographic printing machine with this configuration achieves more stable image formation.

For a fuller understanding of the nature and advantages of the invention, reference should be made to the ensuing detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 through 7 show the present invention in detail.

Fig. 1 is a view showing the structure of the essential components of an electrophotographic printing machine according to a first embodiment of the present invention.

Fig. 2 is a schematic view showing the structure of the electrophotographic printing machine of Fig. 1.

Fig. 3 is an enlarged cross sectional view of the essential components, explaining the principle of the formation of a toner image in the electrophotographic printing machine.

Fig. 4 is an enlarged cross sectional view of the essential components, explaining a change in the state of the essential components when an exposure is conducted in the state of Fig. 3.

Fig. 5 is an enlarged cross sectional view of the essential components, explaining a change in the state of an exposed portion of the photoreceptor drum when it is moved away from toner held by the development sleeve.

Figs. 6 is a schematic view showing the structure of an electrophotographic printing machine according to a second embodiment of the present invention.

Fig. 7 shows a view showing the essential structure of the electrophotographic printing machine of Fig. 6.

Figs. 8 through 10 show a prior art.

Figs. 8 is a schematic view showing the structure of a conventional electrophotographic printing machine.

Fig. 9 is a view showing the structure of essential components of another conventional electrophotographic printing machine.

Figs. 10 is a view showing the structure of essential components of still another conventional electrophotographic printing machine.

DETAILED DESCRIPTION OF THE EMBODIMENTS

A first embodiment of the present invention is discussed below with reference to Figs. 1 through 5.

As shown in Fig. 2, an electrophotographic printing machine of this embodiment is provided with a cylindrical photoreceptor drum 1 (photoreceptor means) that is rotatable in a clockwise direction within the machine. In the figure, a developer sleeve 3a is located on the right side of the photoreceptor drum 1 in which an exposure unit 2 (toner-image forming means, and exposure means) is installed. A transfer belt 22 (moving means) is placed above and in contact with the photoreceptor drum 1 so that it moves over the surface of the photoreceptor drum 1.

As shown in Fig. 3, the photoreceptor drum 1 is constituted by a cylindrical transparent base 103 having a transparent electrically conductive layer 102 and a photoconductive layer 101 made of photoconductive material, laminated in this order on the surface thereof. In this embodiment, an In_2O_3 layer with a thickness of about 0.5 μm formed by sputtering In_2O_3 is used as the transparent electrically conductive layer 102. As for the photoconductive layer 101, an amorphous Si layer with a thickness of about 3 μm is formed. However, the transparent electrically conductive layer 102 is not limited to the In_2O_3 layer, and, for example, an SnO_2 layer is preferable for use. Similarly, the photoconductive layer 101 is not limited to the amorphous Si layer, and, for example, an Se layer, a ZnO layer or a CdS layer can also be used.

As shown in Fig. 2, the developer 3 includes a toner vessel 8 for storing electrically conductive magnetic toner 5 as a developer; a mixing roller 7 for mixing the toner 5, the mixing roller 7 being pivotally mounted in the toner vessel 8; a substantially cylindrical developer sleeve 3a (toner-image forming means, and toner holding means) which is placed at an opening 8a of the toner vessel 8 so that it faces the photoreceptor drum 1 and a doctor blade 6 fixed under the developer sleeve 3a at the opening 8a.

As illustrated in Fig. 1, the developer sleeve 3a extends in an axis direction of the photoreceptor drum 1 and has therein a substantially cylindrical magnetic roller 4 mounted around the axis of the developer sleeve 3a. The magnetic roller 4 has N polarity magnets and S polarity magnets that are alternately disposed along the internal surface of the developer sleeve 3a. The developer sleeve 3a is made of a non-magnetic electrically conductive material such as aluminum or martensite series stainless steel.

The developer sleeve 3a holds the toner 5 on the surface thereof with the use of an alternating field generated by the counterclockwise rotation of the magnetic roller 4 and transports the toner 5 in the reverse direction, i.e., a clockwise direction. As illustrated in Fig. 2, the doctor blade 6 adjusts the amount of the toner 5 to be held on the surface of the developer sleeve 3a and transported in the clockwise direction to a predetermined amount.

The toner 5 is produced in the following manner. First, powdered magnetic material such as powdered iron or ferrite and powder color such as carbon black are mixed into a resin made from styrene-acrylic copolymer by kneading. The mixture is then ground into particles ranging from several μm to several tens μm, to obtain the toner 5. In order to have the toner 5 with high electric conductivity, it is desirable to use an electrically conductive color.

The exposure unit 2 includes a light emitting diode (LED) array wherein a plurality of lens having a short focal distance and LEDs are combined. The exposure unit 2 projects a light beam toward the developer 3 in response to an image pattern signal from an exposure control unit (not shown). As illustrated in Fig. 4, the light beam projected is converged on the photoconductive layer 101 through the transparent base 103 and the transparent electrically conductive layer 102 of the photoreceptor drum 1.

A power supply 29 (toner-image forming means, and voltage application means) applies a predetermined voltage to the transparent electrically conductive layer 102 and the developer sleeve 3a.

As illustrated in Fig. 1. the transfer belt 22 is produced by shaping into an endless belt a film material including mainly polyimide having good dielectric and heat-resistant properties, and mechanical strength. The transfer belt 22 is attached around a transfer roller 14, a heater 15 (to be described later) and a tension roller 21. The transfer roller 14 is made of an electrically conductive resilient member and mounted above the photoreceptor drum 1. The heater 15 is placed on the left side and slightly upper side of the transfer roller 14. And the tension roller 21 is located on the left side and slightly lower side of the heater 15. The transfer belt 22 is sandwiched between the photoreceptor drum 1 and the transfer roller 14.

As for the material of the transfer belt 22, a film-shaped polyimide resin is used in this embodiment. However, the material is not particularly limited to this material, and it is possible to use other material if that film is dielectric, has suitable mechanical strength, and is formed into an endless belt. For instance, other than the polyimide resin, polyamide resin is a suitable material for the transfer belt 22.

Additionally, a material for the transfer belt 22 needs to meet the following three requirements. First, the surface on which the toner 5 is transferred (i.e., the surface in contact with the photoreceptor drum 1) is dielectric. Second, the material is resistant to heat applied by the heater 15. And, third, the material is separated from the toner 5 fused by the heat more easily in comparison to the recording material P. It is especially desirable to form the transfer belt 22 by a metal belt having a dielectric layer formed on its surface in contact with the photoreceptor drum 1. An electric cast nickel belt is preferable for the metal belt, and the dielectric layer is preferably formed by coating the surface of the metal belt with fluorocarbon polymers.

Although it is not necessary to limit the thickness of the transfer belt 22, considering its thermal conductivity and mechanical strength, a desirable thickness is in the range of about 10 μm to 200 μm. Moreover, by making the transfer belt 22 with a rough surface, the image with appropriate gloss is formed on the recording material P. This causes friction between the recording material P transported by the transfer belt 22 and the surface of the transfer belt 22, ensuring proper transport of the recording material P by the transfer belt 22.

As will be described later, the heater 15 is provided for heat-fusing the toner 5 transferred to the surface of the transfer belt 22. The heater 15 is a ceramic heater produced by printing a plane-shaped Mo series resistance heater 16 on an alumina ceramic substrate and laminating a glass coat thereon by printing. Further, the heater 15 is designed such that the temperature of the heating surface thereof is rapidly raised up to a predetermined heating temperature by conducting electricity through the resistance heater 16. The heater 15 is disposed such that the heating surface thereof is in direct contact with the inner surface of the transfer belt 22.

Disposed above the heater 15 is a pressure roller 17 which rotates while pressing the heater 15 through the transfer belt 22. The pressure roller 17 is arranged so as to sandwich the recording material P fed between opposing transport guide plates 13 (recording material transport means, and guide members, to be described later) at the pressurized portion between the transfer belt 22 and the pressure roller 17.

As shown in Fig. 2, the electrophotographic printing machine of this embodiment has a cooling fan 24, located under the transfer belt 22, for cooling down the transfer belt 22 which has been heated by the heater 15, a main motor 23 as a drive source of the machine, and discharge means 25 for discharging the recording material P from the machine.

The transport guide plates 13 are located above the photoreceptor drum 1, developer 3, and the transfer belt 22 to form a transport path running almost horizontally from register rollers 12, to be described later, to the transfer belt 22.

As illustrated in Fig. 1, an angle θ formed by the transfer belt 22, which runs upwardly from the transfer roller 14 to the heater 15, and the lower transport guide plate 13 is arranged 15° in this embodiment. However the angle θ is not limited to 15°. In fact, it is desirable to arrange

$$0^\circ \leq \theta \leq 40^\circ,$$

and more desirably to

$0° \leqq \theta \leqq 20°$

When the angle θ is smaller than 0°, i.e, takes a negative value, installation of other members, for example, of the photoreceptor drum 1 becomes difficult. On the other hand, when the angle θ exceeds 40°, a force exerted by the weight of the recording material P becomes stronger than frictional resistance between the transfer belt 22 and the recording material P. Therefore, there is a possibility that the recording material P slides down the transfer belt 22, causing instability in transporting the recording material P to the heater 15.

Such a range of the angle θ is determined through an experiment. In this experiment, the angle θ was set within the following four ranges, $0° \leqq \theta \leqq 20°$, $20° < \theta \leqq 40°$, $40° < \theta \leqq 60°$, and $60° < \theta$, and an image was formed on 100 sheets of recording material P, respectively, to observe the occurrence of crease and jam of the recording material P.

Table 1 gives the results. When the angle θ was set within the range $20° < \theta \leqq 40°$, jam was not observed, and the recording material P got a crease to a degree that did not practically affect the operation. When the angle $\theta$was set within the range $0° \leqq \theta \leqq 20°$, jam and crease were not observed, forming an image of favorable quality.

TABLE 1

	$0°\leqq\theta\leqq20°$	$20°<\theta\leqq40°$	$40°<\theta\leqq60°$	$60°<40°$
crease	0/100	3/100	7/100	7/100
jam	0/100	0/100	3/100	3/100

In Table 1, θ is indicated by degree, and the occurrence of crease or jam is shown by a ratio of the number of sheets got a crease or jammed to the total number of sheets tested.

As shown in Fig. 2, the electrophotographic printing machine includes a feed actuator 10, feed rollers 9, the register rollers 12 in the course of the transport path formed by the transport guide plates 13, and a feed solenoid 11 for controlling the rotation of the register rollers 12.

The discharge means 25 is located on the left side of the pressurized portion between the transfer belt 22 and the pressure roller 17. The discharge means 25 includes a discharge guide plates 19, a discharge actuator 18, and transport rollers 20. The discharge guide plates 19 form a discharge path linking the pressurized portion and a recording material discharge opening, not shown. The discharge actuator 18 is placed in the vicinity of the pressurized portion. The transport rollers 20 are placed near the end of the discharge guide plates 19.

The following description discusses the operation of the above-mentioned electrophotographic printing machine.

First, a sheet of recording material P is fed into the machine by the recording material supply means (not shown) through a recording material supply opening. Here, as the leading edge of the recording material P lifts the feed actuator 10, a feed detection switch, not shown, detects the feeding of the recording material P and then transmits a feed detection signal to the main motor 23. Upon receiving the signal, the main mother 23 starts rotating.

The rotation of the main motor 23 is transmitted to the feed rollers 9 through a rotation transmission mechanism (not shown), thereby rotating the feed rollers 9. The rotation of the feed rollers 9 transports the recording material P to the register rollers 12.

The recording material P transported to the register rollers 12 is temporarily stopped when the register rollers 12 stop rotating under the control of the feed solenoid 11. At this time, a pair of the feed rollers 9 sandwich the trailing edge of the recording material P. Here, since the frictional resistance of the surfaces of the rollers 9 is small, when the recording material P is stopped from being transported, the feed rollers 9 slip on each side of the recording material P.

Then, the electrophotographic printing machine comes into a stand-by state, and the main motor 23 is suspended if a printing start signal is not generated within a predetermined time. On the other hand, in the stand-by state, if the printing start signal is generated, all of the rotating sections except the register rollers 12 are rotated by the rotation transmission mechanism.

The developing process using the toner 5 is described below with reference to Figs. 1 through 5.

First, as shown in Fig. 2, the toner 5 stored in the developer vessel 8 is held on the surface of the developer sleeve 3a by an alternating magnetic field generated by the clockwise rotation of the magnetic roller 4, and then transported in a counterclockwise direction, i.e., in a direction opposite to the rotating direction of the photoreceptor drum 1, over the surface of the developer sleeve 3a.

At this time, since the developer sleeve 3a and the photoreceptor drum 1 are very close to each other, the surface of the toner 5 slides along the surface of the photoreceptor drum 1, that is, the surface of the photoconductive layer 101. Therefore, the stack 5a of the toner 5 is formed in the vicinity of the photoreceptor drum 1 and the developer sleeve 3a (see Fig. 1).

Here, electric charges are injected by the developer sleeve 3a into the surface of the photoreceptor drum 1 through the electrically conductive toner 5 when the power supply 29 applies a voltage of several tens V to the developer sleeve 3a and the transparent electrically conductive layer 102. As a result, the surface of the photoreceptor drum 1 is charged at the stack 5a of the toner 5 to have substantially the same electric potential as the developer sleeve 3a.

The toner 5 in contact with the photoreceptor drum 1 does not adhere to the photoreceptor drum 1 because, when the surface of the photoreceptor drum 1 has the same electric potential as the developer sleeve 3a, the Coulomb force exerted between the toner 5 and the surface of the photoreceptor drum 1 becomes extremely weak and balances the magnetic force generated by the magnetic roller 4.

In this state, an exposing operation is carried out by the exposure unit 2. More specifically, as shown in Fig. 4, in the exposure unit 2, the LED corresponding to the image pattern is selected in order, and light is projected onto the area C just before a position where the photoreceptor drum 1 is separated from the toner 5 by the exposure unit 2. As a result, the resistance of the exposed portion of the photoconductive layer 101 is lowered and the surface potential of the photoconductive layer 101 at that portion and that of the electrically conductive layer 102 become substantially equal. This produces a difference in electric potential between the area C of the photoconductive layer 101 and the developer sleeve 3a. Due to the difference, the injection of electric charges from the developer sleeve 3a to the photoreceptor drum 1 through the toner 5 is performed.

However, since the photoreceptor drum 1 is rotating in the direction of A, when electric charges are injected into the photoconductive layer 101 by the toner 5, the exposed portion of the photoreceptor drum 1 is moved away from the position where the photoreceptor drum 1 comes into contact with the toner 5 as illustrated in Fig. 5. As a result, the toner 5 in contact with the exposed portion of the surface of the photoreceptor drum 1 keeps adhering to the surface of the photoreceptor drum 1 because an adhesive force, that is, the resultant force of the Coulomb force generated by an electric field between the developer sleeve 3a and the surface of the photoreceptor drum 1 and the van der Waals forces between the surface of the photoreceptor drum 1 and toner 5 becomes stronger than the magnetic force of the magnetic roller 4. Thus, a toner image corresponding to the image pattern is formed on the surface of the photoreceptor drum 1.

As described above, the toner image formed on the surface of the photoreceptor drum 1 is transported to a position where the transfer roller 14 is located by the rotation of the photoreceptor drum 1 in the direction of arrow A as shown in Fig. 1. Then, a voltage with a polarity opposite to that of the electric charges of the toner image is applied to the transfer roller 14. As a result, the toner image on the surface of the photoreceptor drum 1 is transferred to the surface of the transfer belt 22 moving at substantially the same speed as the peripheral speed of the photoreceptor drum 1. Then, the toner image is transported by the movement of the transfer belt 22 in the D direction to a position where the heater 15 and the pressure roller 17 are located.

Further, the CPU (Central Processing Unit) of the controller (not shown) sends out a signal to the feed solenoid 11 so that the toner image on the surface of the transfer belt 22 corresponds to the recording material P at the pressurized portion between the transfer belt 22 and the pressure roller 17 above the heater 15. Then, the register rollers 12 are released from the stop state. With the rotation of the register rollers 12, the recording material P is fed onto the transfer belt 22 through the transport path formed by the transport guides 13.

The recording material P is now transported to the pressurized portion between the transfer belt 22 and the pressure roller 17 by the transfer belt 22 moving toward the heater 15. Then, the recording material P overlaid on the toner image formed on the transfer belt 22 is fed to pass between the heater 15 and the pressure roller 17. As a result, the toner image is transferred to and fixed on the recording material P at the same time. Namely, when the recording material P is fed while being pressurized between the transfer belt 22 and the pressure roller 17, the toner 5 on the surface of the transfer belt 22 is fused by the heat of the heater 15. Since the fused toner 5 is separated from the surface of the transfer belt 22 more easily than from the surface of the recording material P, almost all of the toner 5 on the transfer belt 22 is transferred to and fixed on the recording material P.

Thereafter, as illustrated in Fig. 2. the recording material P carrying thereon the fixed toner image lifts the discharge actuator 18 and is discharged from the machine through the recording material discharge opening by the rotation of the transport rollers 20. After the elapse of a predetermined time, the conducting of electricity to the resistance heater 16 of the heater 15 and the driving of the main motor 23 are stopped, indicating the end of a cycle of the sequential process.

As described, with the electrophotographic printing machine of this embodiment, the recording material P is transported while being guided by the transport guide plates 13 to the moving transfer belt 22 attached around the transfer roller 14, the tension roller 21 and the heater 15. With this arrangement, the recording material P transported to the transfer belt 22 is stably transported to the transfer and fixing section as a stable transport force is evenly applied to the recording material P.

Meanwhile, when the recording material is moved on the transport guide while being pushed by the transport force of the transport roller (register roller) as is in a conventional machine, it is likely happen that the leading edge of the recording material is curled, bent or creased. When a toner image is transferred to and fixed on the recording material in such a condition in the transfer and fusing section, the resulting image has deteriorated quality.

However, with the configuration of this embodiment, since the tensile strength of the transfer belt 22 is applied even to the leading edge of the recording material P, it is possible to transport the recording material P stably to the transfer and fusing section. Consequently, problems familiar to a conventional machine, such as a crease in the recording material P is prevented, thereby enabling the recording material P to stably receive an image without distortion and dislocation.

With this configuration, the image is formed without using the charger 52 such as a corona discharger installed over the photoreceptor drum 31 in a conventional machine employing the Carlson process shown in Fig. 8. It is therefore possible to make the size of the machine smaller totally. Additionally, since the corona discharger is not used, a high voltage electric supply is not required, preventing ozone.

Moreover, when the recording material P is pressed against the toner 5 which is fused on the surface of the transfer belt 22, the image on the transfer belt 22 is transferred to and fixed on the recording material P. Thus, there is no need to have the transfer unit 55 (see Fig. 8) including a corona discharger used in the conventional machine. This arrangement allows a reduction in the size of the machine overall and the transfer and fixing operations to be performed simultaneously. Consequently, in comparison to a conventional process in which after transferring the image to the recording material such as paper, the recording material is transported to the fusing unit for fixing the image thereon, distortion of the toner image is restrained, and thereby forming a clear image.

In the case when electrically conductive toner is used in the conventional process where a corona discharge is performed or voltage application rollers are pressed against the back side of the paper as the recording material P to transfer the image to the paper, it is difficult when transferring the image to ordinary paper with relatively low resistance. Therefore special paper whereupon an insulating film is coated is used. On the other hand, with the configuration of this embodiment, since the transfer of the image to the recording material P is performed with the use of adhesiveness of the toner fused to the recording material P instead of electric Coulomb force, the image is easily transferred to and fixed on the ordinary paper even with the electrically conductive toner.

Furthermore, with the configuration of this embodiment, since the exposure unit 2 is located inside the photoreceptor drum 1, different from a conventional machine, no extra space is required for the installation of the exposure unit. This arrangement makes it possible to further reduce the size of the machine overall. Besides, since the exposure unit 2 is covered with the photoreceptor drum 1, the light emitting section of the exposure unit 2 is prevented from getting dirty. As a result, the amount of light irradiated by the exposure unit 2 is maintained stably over a long period of time, thereby maintaining the image of good quality.

As described above, an electrophotographic printing machine of this embodiment includes:

photoreceptor means having a photoconductive layer;

toner-image forming means for forming a toner image on a surface of the photoreceptor means;

moving means which moves while making contact with the surface of the photoreceptor means, the moving means having at least a dielectric surface in contact with the photoreceptor means;

transfer means for transferring the toner image formed on the surface of the photoreceptor means to the moving means;

transfer and fusing means, mounted in contact with the moving means, for transferring the toner image on the moving means to recording material and fixing it thereon; and

recording material transport means for transporting the recording material onto the moving means moving toward the transfer and fusing means.

With this configuration, the moving means stably applies a continuous transport force to the recording material evenly until the recording material reaches the transfer and fusing means. Namely, the recording material is stably transported to the transfer and fusing means. Thus, this electrophotographic printing machine is capable of fixing the toner image on the recording material without distortion.

A second embodiment of the present invention is now described with reference to Figs. 6 and 7. For components in this embodiment having the same functions as those in the above-mentioned embodiment, the same reference numerals are given and their description is omitted.

An electrophotographic printing machine of this embodiment is identical to that of the first embodiment, except for the additional incorporation of a support plate 26 (support member) installed underneath the transfer belt 22 at a position where the recording material P to be transported onto the transfer belt 22 comes into contact with the transfer belt 22.

The support plate 26 is placed along the cross direction of the transfer belt 22 and is attached thereto so as to keep the transfer belt 22 flat. When the transfer belt 22 moves, it slides over the support plate 26.

The support plate 26 can be an insulating or electrically conductive plate and its material is not restricted if it has a predetermined rigidity and if its surface which comes slidingly contact with the transfer belt 22 is flat.

With this configuration, the surface of the transfer belt 22 with which the recording material P transported through the transport guide plates 13 comes into contact, is kept flat by the support plate 26, thereby reducing the change in the area of the contact region of the recording material P and the transfer belt 22. In other words, if the support plate 26 does not exist, when the leading edge of the recording material P comes into contact with the transfer belt 22, the transfer belt 22 undulates. This causes a change in the area of the contact region of the recording material P and the transfer belt 22. However, such a change in the area of the contact region is avoided by the installation of the support plate 26.

Additionally, when the transfer belt 22 slides over the support plate 26, the transfer belt 22 is charged and the adhesiveness between the transfer belt 22 and recording material P is intensified because static electricity is generated between the transfer belt 22 and the recording material P.

This enables the transfer belt 22 to apply the transport force stably to the recording material P and the recording material P to be accurately transported to the pressurized portion between the heater 15 and the pressure roller 17. Thus, the configuration of this embodiment together with the effects of the present invention described in the first embodiment prevents the displacement of the image due to the deterioration of adhesiveness of the transfer belt 22 and the recording material P, and restrains the distortion and displacement of the image fixed on the recording material P by the heater 15, achieving stable image formation.

Further, as illustrated in Fig. 7, if the support plate 26 and members opposing the support plate 26 with the transfer belt 22 therebetween, for example, the transport guide plates 13 are made of conductive material such as metal, respectively, and if the support plate 26 is connected to a power supply 30 for applying a predetermined direct voltage, the formation of image is performed in a further stabilized manner.

In short, with the configuration, since an electric field is generated between the support plate 26 and the transport guide plates 13, it is possible to increase the charge of the dielectric transfer belt 22 as it is located in the electric field. This further intensifies the adhesiveness of the transfer belt 22 and the recording material P. Consequently, the transfer belt 22 stably applies the transport force to the recording material P and transports the recording material P accurately to the pressurized portion between the heater 15 and the pressure roller 17. It is therefore possible to restrain the displacement and distortion of the image fixed on the recording material P by the heater 15 and to achieve stable image formation.

As described above, an electrophotographic printing machine of this embodiment includes:

photoreceptor means having a photoconductive layer;

toner-image forming means for forming a toner image on a surface of the photoreceptor means;

moving means which moves while making contact with the surface of the photoreceptor means, the moving means having at least a dielectric surface in contact with the photoreceptor means;

transfer means for transferring the toner image formed on the surface of the photoreceptor means to the moving means;

transfer and fusing means, mounted in contact with the moving means, for transferring the toner image on the moving means to recording material and fixing it thereon;

recording material transport means for transporting the recording material onto the moving means moving toward the transfer and fusing means; and

a support member for supporting the moving means to be flat, the support member being disposed underneath the moving means at a contacting position of the moving means and the recording material so that the moving means slides over the support member.

With this configuration, the moving means stably applies a continuous transport force evenly to the recording material until the recording material reaches the transfer and fusing means. Moreover, the support member reduces the change in the area of the contact region of the recording material and the moving means. Further, since the moving means is charged when the moving means slides along the support member, the adhesiveness between the recording material and the moving means is intensified. With such a configuration, the moving means applies the transport force to the recording material in a highly stable manner, and the recording material is accurately transported to the transfer and fusing means. Thus, the electrophotographic printing machine is capable of fixing the toner image on the recording material without distortion.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. An electrophotographic printing machine comprising:

photoreceptor means having a photoconductive layer;

toner-image forming means for forming a toner image on a surface of said photoreceptor means;

moving means which moves while making contact with the surface of said photoreceptor means, at least a surface of said moving means which is in contact with said photoreceptor means being dielectric;

transfer means for transferring a toner image formed on the surface of said photoreceptor means to said moving means;

transfer and fusing means, disposed in contact with said moving means, for transferring the toner image on said moving means to a recording material and for fixing it thereon; and

recording material transport means for transporting the recording material onto said moving means moving toward said transfer and fusing means.

2. The electrophotographic printing machine according to claim 1,

wherein said transfer and fusing means includes:

pressurizing means, disposed to press a surface of said moving means, for sandwiching the recording material between said pressurizing means and said moving means; and

heating means, disposed in the vicinity of a pressurized portion between said pressurizing means and said moving means, for heat-fusing toner forming the toner image on the surface of said moving means.

3. The electrophotographic printing machine according to claim 2,

wherein said pressurizing means includes a pressure roller which rotates while exerting pressure onto said moving means.

4. The electrophotographic printing machine according to claim 2,

wherein said heating means is located to sandwich said moving means between said pressuring means and said heating means, and includes an in-plane heater mounted in a position facing a surface of said moving means.

5. The electrophotographic printing machine according to claim 4,

wherein said in-plane heater is an Mo series resistance heater.

6. The electrophotographic printing machine according to claim 1,

wherein said moving means is an endless belt.

7. The electrophotographic printing machine according to claim 6,

wherein said transfer means includes a transfer roller for pressing said moving means in a direction toward said photoconductive layer of said photoreceptor drum, and

wherein a voltage of a polarity opposite to a polarity of electric charges on the toner image formed on said photoconductive layer is applied to said transfer roller.

8. The electrophotographic printing machine according to claim 7, further comprising a tension roller mounted to be rotatable,
wherein said moving means is attached to enclose outer surfaces of said transfer roller, said heating means, and said tension roller.

9. The electrophotographic printing machine according to claim 1,
wherein said moving means is made from a film material including a polyimide resin or a polyamide resin.

10. The electrophotographic printing machine according to claim 1,
wherein said moving means is made by forming a dielectric layer at least on a surface of a metal belt so that said dielectric layer comes into contact with said photoreceptor means.

11. The electrophotographic printing machine according to claim 10,
wherein said metal belt is a nickel belt, and said dielectric layer is formed by coating the surface of said metal belt with fluorocarbon polymers.

12. The electrophotographic printing machine according to claim 1,
wherein said moving means has a thickness of about 10 μm to 200 μm.

13. The electrophotographic printing machine according to claim 1,
wherein said moving means has a rough surface in contact with said photoreceptor means.

14. The electrophotographic printing machine according to claim 1,
wherein said photoreceptor means includes a base, an electrically conductive layer, and a photoconductive layer, said electrically conductive layer and said photoconductive layer being formed in this order on said base,
wherein said toner-image forming means includes:
toner storing means for storing electrically conductive toner and supplying the toner to be in contact with said photoconductive layer;
voltage applying means for applying a voltage to said toner and said electrically conductive layer; and
exposure means for irradiating a portion of said photoconductive layer in contact with said toner, and
wherein the toner image is formed by exposing said photoconductive layer with said exposure means while applying the voltage between said toner and said electrically conductive layer with said voltage applying means.

15. The electrophotographic printing machine according to claim 14,
wherein said base is an optically transparent cylindrical base, said electrically conductive layer is an optically transparent electrically conductive layer, and said photoreceptor means is a photoreceptor drum including said transparent electrically conductive layer and photoconductive layer formed on an outer surface of said transparent base.

16. The electrophotographic printing machine according to claim 15,
wherein said exposure means is installed inside said photoreceptor drum and irradiates light onto said photoconductive layer through said transparent base and transparent electrically conductive layer.

17. The electrophotographic printing machine according to claim 1,
wherein said recording material transport means includes a guide member for guiding the recording material almost horizontally onto said moving means.

18. The electrophotographic printing machine according to claim 17,
wherein said guide member is a guide plate mounted almost horizontally.

19. The electrophotographic printing machine according to claim 18,
wherein an angle θ between said guide plate and said moving means is $0^\circ C \leqq \theta \leqq 40^\circ C$.

20. The electrophotographic printing machine according to claim 1, further comprising a support member for supporting said moving means to be flat, said support member being disposed underneath of said moving means at a contacting position of said moving means and the recording material so that said moving means slides over said support member.

21. The electrophotographic printing machine according to claim 20, further comprising:

an electrically conductive member which is disposed to face said support member with said moving means therebetween; and

power supply means for applying a direct voltage to said support means,

wherein said support member is electrically conductive.

22. An electrophotographic printing machine comprising:

a photoreceptor drum having a transparent base, a transparent electrically conductive layer, and a photoconductive layer, said electrically conductive transparent layer and said photoconductive layer being formed on an outer surface of said transparent base;

a toner storage for storing electrically conductive toner and supplying the toner to be in contact with said photoconductive layer;

a power supply for applying a voltage between the toner and said electrically conductive layer;

an exposure unit, mounted inside said photoreceptor drum, for irradiating said photoconductive layer through said transparent base and said electrically conductive layer;

an endless dielectric transfer belt which moves in contact with a surface of said photoreceptor drum;

a transfer roller for transferring to said transfer belt a toner image formed on the surface of said photoreceptor drum while pressing said transfer belt against the surface of said photoreceptor drum;

a heater for heat-fusing the toner forming the toner image on said transfer belt;

a pressure roller, mounted to face said heater with said transfer belt therebetween, for pressing said transfer belt and a recording material placed on said transfer belt in a direction toward said heater;

recording material transport means having a guide plate, said guide plate being mounted almost horizontally so as to guide the recording material substantially in a horizontal state, said recording material transport means transporting the recording material through said guide plate onto said moving means moving toward said heater;

an electrically conductive support member for supporting said transfer belt to be flat, said support member being disposed underneath of said transfer belt at a contacting position of said transfer belt and the recording material so that said transfer belt slides over said support member;

an electrically conductive member which is mounted in a position facing said support member with said transfer belt therebetween; and

a power supply for applying a direct voltage to said support means,

wherein said transfer belt is attached between said transfer roller and said heater, and an angle θ between said guide plate and said transfer belt is $0^\circ C \leqq \theta \leqq 40^\circ C$.

FIG.1

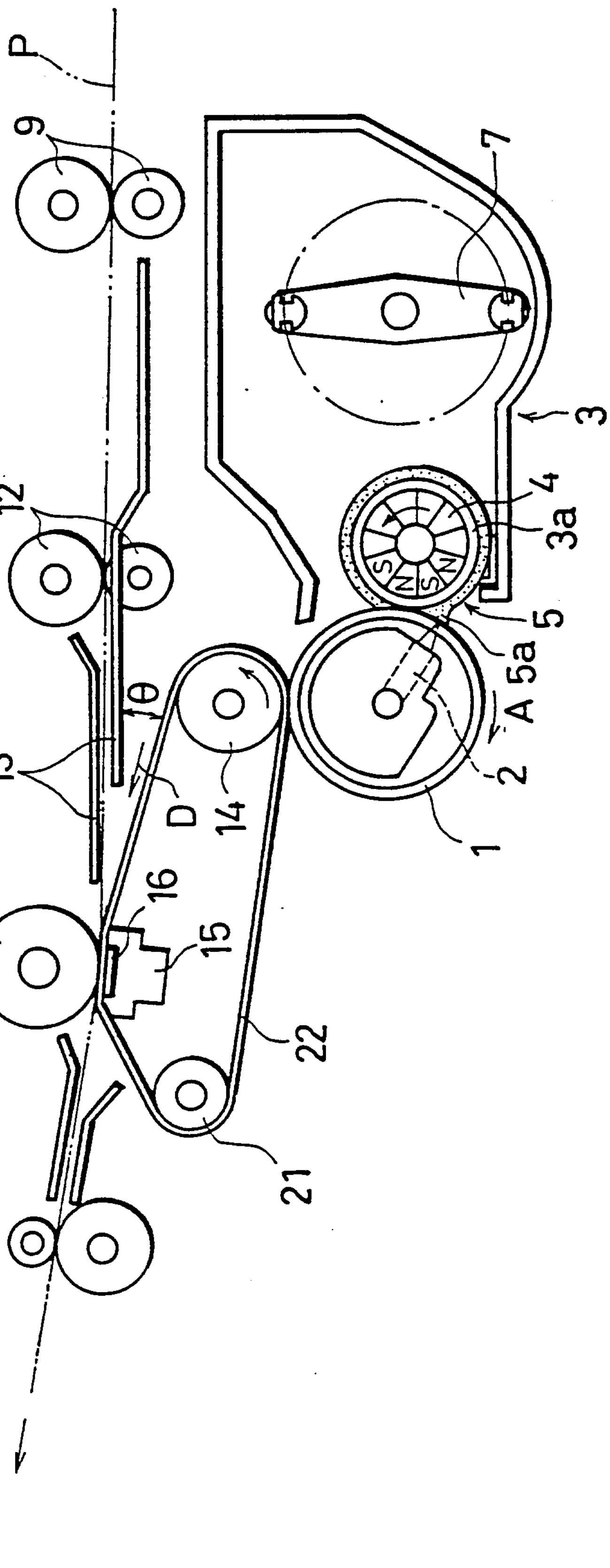

FIG.2

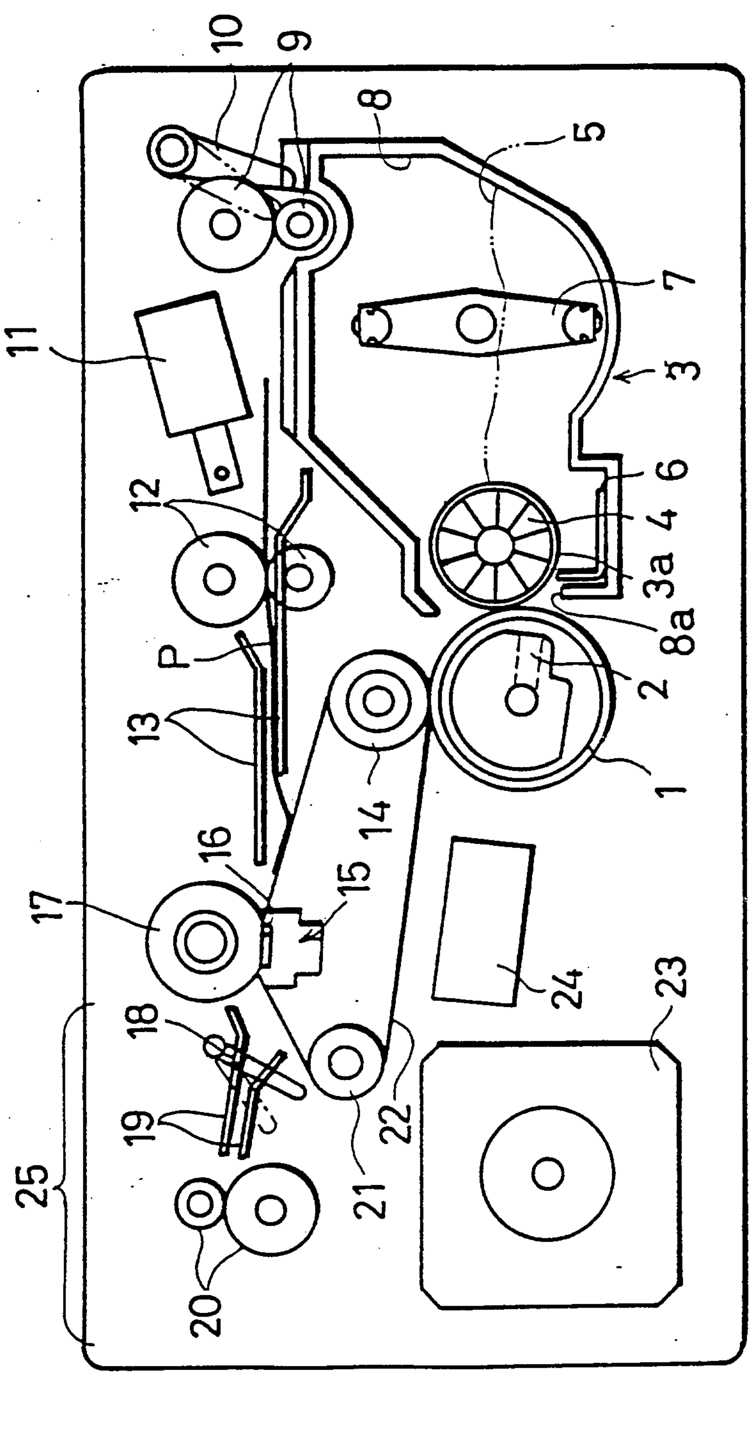

FIG.3

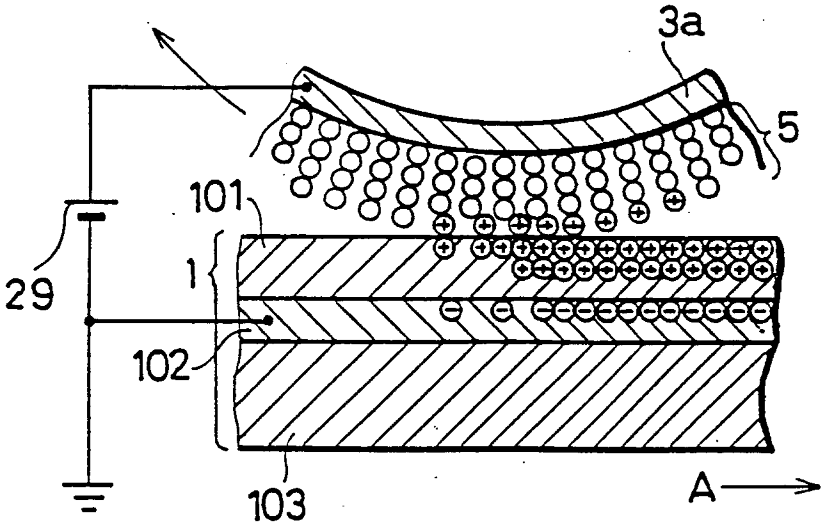

FIG.4

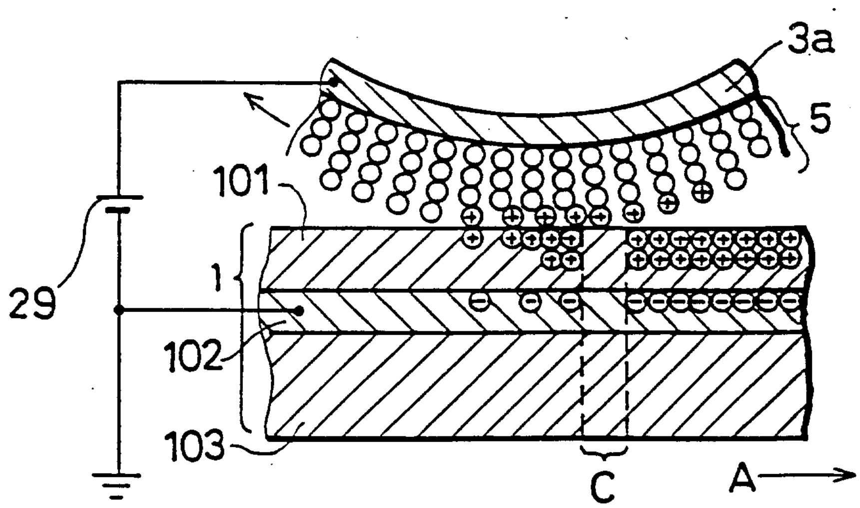

FIG. 5

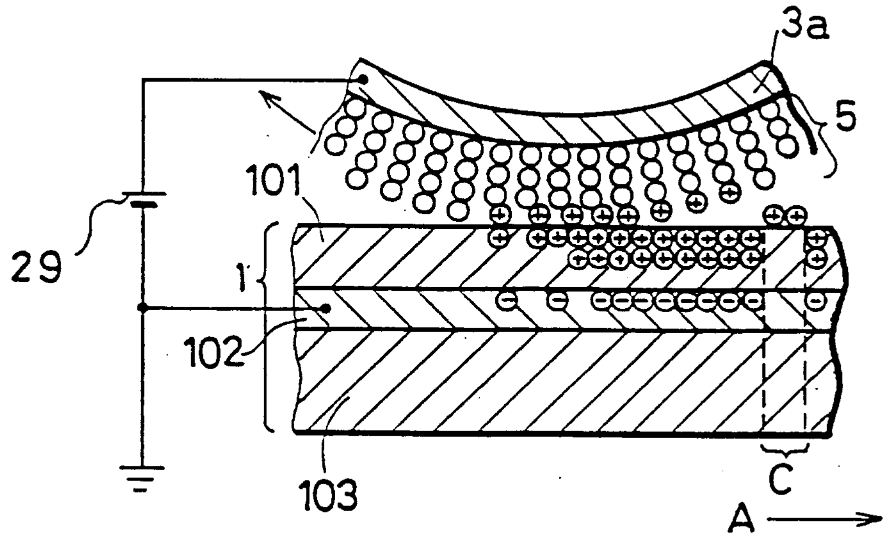

FIG.6

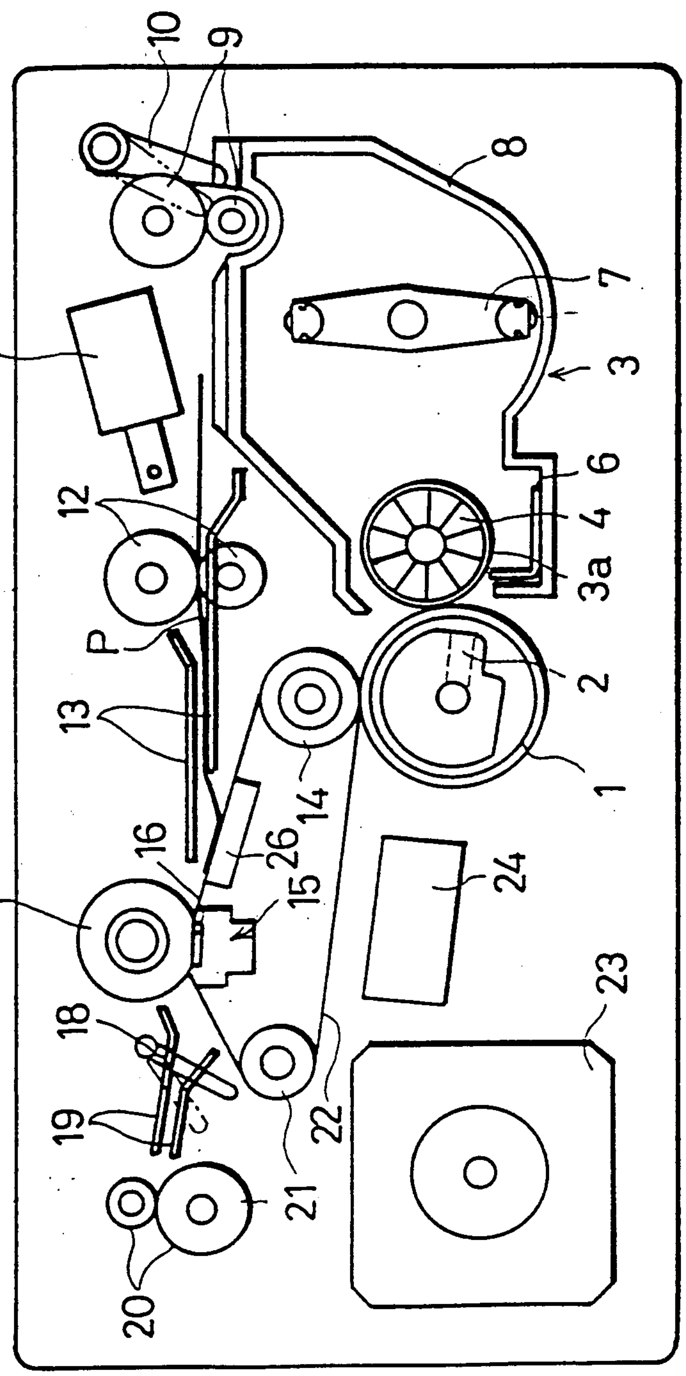

FIG.7

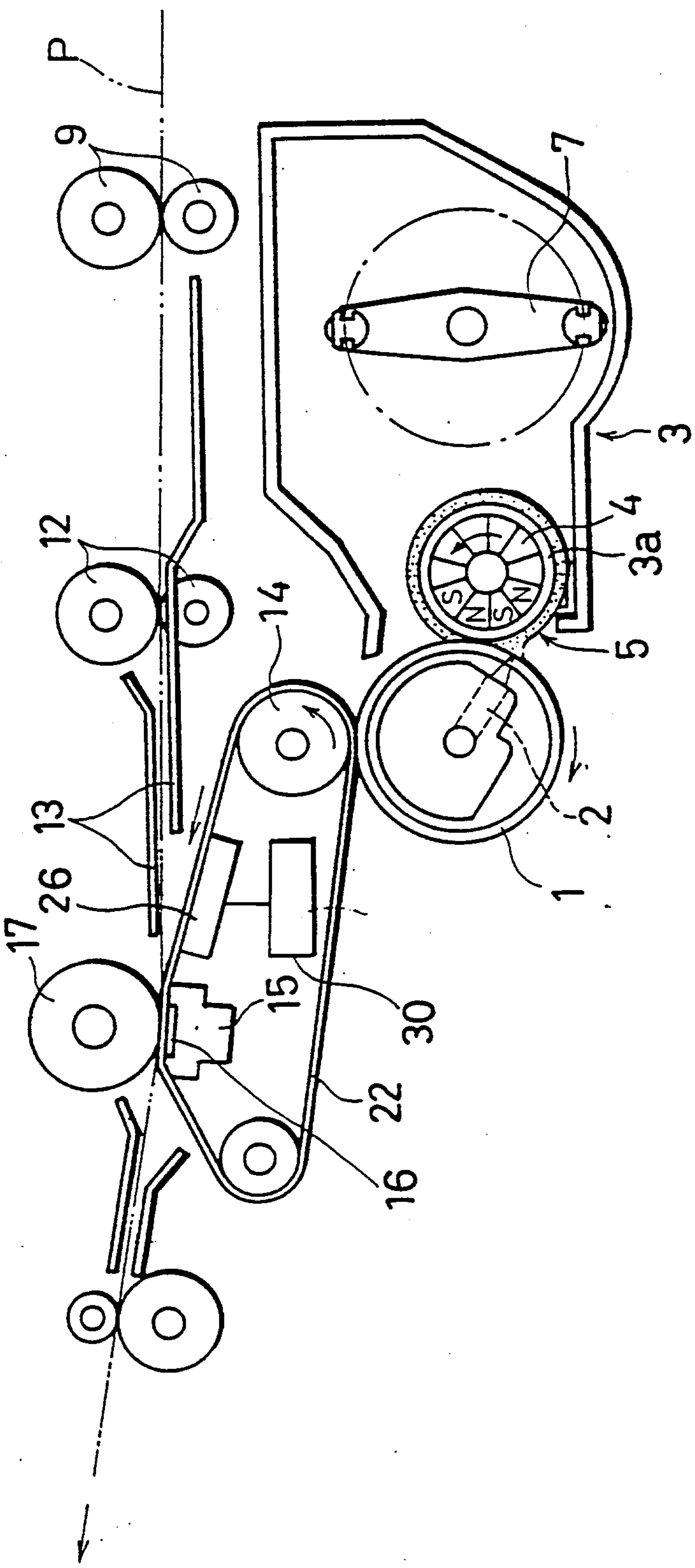

FIG. 8

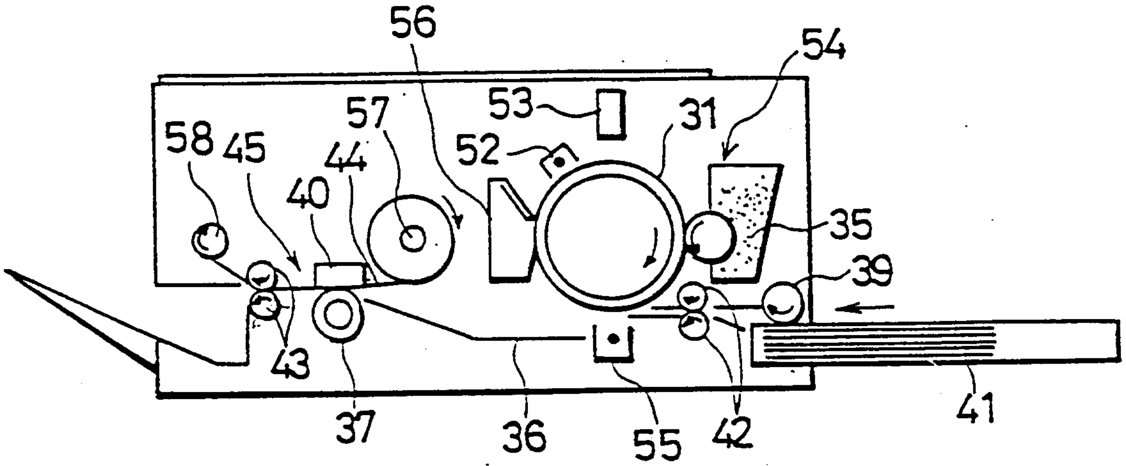
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FIG. 9

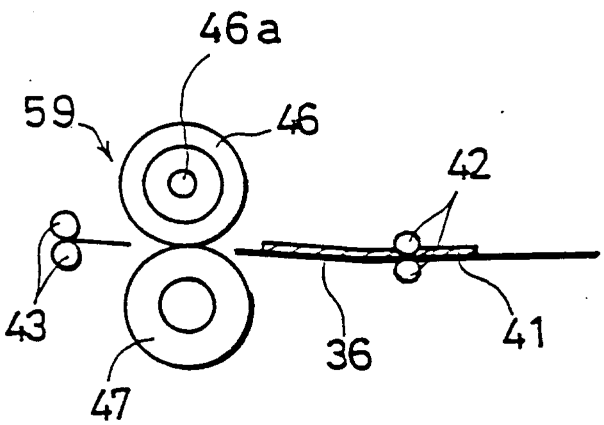
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FIG.10